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RURAL INFRASTRUCTURE, THE SETTLEMENT SYSTEM, AND DEVELOPMENT OF THE REGIONAL ECONOMY IN SOUTHERN INDIA

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FOREWORD

How technological change in agriculture contributes to the overall economic development of rural areas has received substantial research attention at IFPRI. One of the major planks of this effort has been the analysis of policies to develop rural infrastructure. Such policies have proven to be important catalysts for successfully transforming subsistence agriculture into commercial agriculture.

Infrastructure analysis has included work on the supply of and demand for rural infrastructure, its effects, and the dynamics of rural infrastructural development in the context of technological change in agriculture. The studies conducted so far have addressed all of these aspects in South Asia but only a few of them in southern Africa, where work continues.

Interdisciplinary analysis of the two regions provides a rich empirical contrast because of differences in socioeconomic conditions and levels of agricultural development. Whereas in South Asia the impact of rural infrastructure on agricultural and rural development has been impressive and positive (see *Service Provision and Rural Development in India: A Study of Miryalguda Taluka,* Research Report 37, *Rural Household Use of Services: A Study of Miryalguda Taluka, India,* Research Report 48, and *Developmental Impact of Rural Infrastructure in Bangladesh,* Research Report 83), a serious lack of rural infrastructure in the smallholder farming regions of southern Africa acts as a major constraint to development in that part of the world (see *Service Provision and Its Impact on Agricultural and Rural Development in Zimbabwe: A Case Study of Gazaland District,* a 1992 occasional paper).

The analysis conducted so far at IFPRI has shown that geographical as well as economic aspects of rural infrastructural development have far-reaching implications. Better road infrastructure, for example, has been shown to influence agricultural production favorably through prices, diffusion of new agricultural technology, and use of inputs. It also improves the incomes of the poor, whether they derive their living from farm or nonfarm activities. IFPRI's work has also shown that provision of services—both public and private—plays a major role in rural development.

In this report, Sudhir Wanmali adds another component to the overall structure of IFPRI's work in this important area of research. The study uses a theoretical framework developed in economic geography to analyze the regional implications for development of access to rural service infrastructure in a southern district of India. It suggests that, by juxtaposing regional and household-level analyses, ways to improve the distribution system in the study region will be evident. This is within the conceptual framework of IFPRI's overarching emphasis on agriculture's role in the development of a region and on access for the rural poor to the producer and consumer goods and services they need to improve their lives.

Per Pinstrup-Andersen

Washington, D.C.

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This research report is the product of a collaborative study conducted in North Arcot District of Tamil Nadu, India, by the International Food Policy Research Institute (IFPRI); the Centre for Agricultural and Rural Development Studies of Tamil Nadu Agricultural University, Coimbatore; and by the Department of Geography of the University of Madras, Madras. It is part of a collaborative research program on the future growth in Indian agriculture developed by IFPRI under a memorandum of understanding with the Indian Council of Agricultural Research and with funding from the United States Agency for International Development. The overall objective of the research program, undertaken in collaboration with research institutions and scholars in India, is to contribute toward increased understanding of the options and complexities in the future policies for agricultural growth and development.

I am most grateful to the Director General of IFPRI for his continued interest in this area of research. I have benefited greatly from the suggestions made by my colleagues and friends, which were instrumental in improving the content of this study. Not all can be mentioned, but the following are gratefully acknowledged: Raisuddin Ahmed, Gunvant Desai, B. H. Farmer, Lawrence Haddad, Mahabub Hossain, Dayanatha Jha, C. Ramasamy, A. Ramesh, Joseph E. Schwartzberg, Girish Chandra Srivastava, Timothy Unwin, and Stephen Vosti. None, however, is responsible for the acts of omission and commission in this study.

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1

SUMMARY

The relationships between rural infrastructure, settlement systems, and regional economic development should distinguish between soft infrastructure (services), institutional infrastructure (government agencies), and hard infrastructure (such as roads). For example, government investment in various types of infrastructure, based on the spatial, economic, and demographic characteristics of regional settlement systems, has encouraged complementary investment by the private sector, leading to overall regional economic development in India.

Once established, the use of services is influenced by the distance between the household and the service, and by the household's net income level. Services are located in settlements that have the capacity to sustain them, but they are also used by people from neighboring settlements. Establishing services in distant towns may be of little help to villagers.

This analysis of the settlement system is undertaken within the framework of Walter Christaller's central place theory, which attempts to explain the distribution of services and service centers in a region based on the functional and demographic characteristics of the settlements of a region. This report analyzes the provision and use of soft infrastructural services in the eastern part of North Arcot District, Tamil Nadu State, India. The area studied consists of 5,508 square kilometers inhabited by approximately 1.6 million people. Data were collected in 1982/83 on 134 types of services located in 535 larger settlements (those with populations greater than 750). In that year, data were also collected from 345 sample households distributed among 11 sample villages. Based on that data, the characteristics of provision and use of soft infrastructural services are noted.

The soft infrastructure considered in this study is divided into nine service categories: education, health, communication, finance, transport, cultivation inputs and implements, animal husbandry, output marketing, and retail services. The services are also classified according to settlement population sizes associated with various services: low order, 48 services, which first occur in settlements with less than 1,000 residents; middle order, 75 services, which first occur in settlements with 1,000-3,500 residents; and high order, 11 services, which first occur only in settlements with more than 3,500 residents. Settlements are themselves categorized by level of service provision, as defined by "centrality" values based on the number and hierarchy of services provided and the population level at which each of these services first occur.

Since service availability is not uniform among all settlements, an attempt is made to categorize settlements as service centers (which provide services to other villages), or self-sufficient settlements, or dependent settlements. If a settlement has more than 50 percent of the services that constitute a given order and provides any of those services to another settlement, then it is considered to be a service center for that order. If only the first criterion is met, the settlement is deemed to be self-sufficient

and thus serves only itself. Conversely, a settlement that depends upon any other settlement for more than 50 percent of the services associated with a given order is a dependent settlement. For low-order services, 12 settlements qualified as service centers, but 461 others were self-sufficient. For middle-order services, 17 were service centers, and for high-order services, 12 were service centers.

The provision of services within the subregions served by service centers is also evaluated. By examining a subregion's availability of services (calculated as the ratio of the quotients of the service provision score divided by area served for the subregion and the study region as a whole), it is possible to note whether the subregion is relatively sufficient or deficient in services.

To identify gaps within subregions and those at the settlement level, "entry zones" based on population sizes of the settlements are determined for each service, and settlements that have a larger population than the "zone" but lack the service are noted. Settlements that are deficient in a particular service, but have the necessary population, are considered prime candidates for public and private investment to establish the missing services in the settlement system.

The literature on rural service infrastructure observes that, in addition to population size, access to hard infrastructure such as roads is an important determinant in deciding where to locate soft infrastructural services This hypothesis is tested using data on the settlement populations and on distances to the nearest bus stop (road transportation infrastructure). Based on statistically significant logit regression results, the effect of isolation from road transportation infrastructure is simulated: if the specified settlement is of average size (say, 1,953 persons), and the nearest bus stop is located 1 kilometer farther away (say 1.7 kilometer instead of 0.7 kilometer), the probability of a service being located in a particular community would be 6 percent rather than 12 percent for a high school, 1 percent rather than 2 percent for a primary health center, 0 percent rather than 2 percent for a post office, 23 percent rather than 25 percent for a telegraph office, 1 percent rather than 2 percent for a lead bank (a bank responsible for coordinating development financing), 7 percent rather than 11 percent for a fertilizer shop, 1 percent rather than 3 percent for a veterinary dispensary, and 3 percent rather than 4 percent for a groundnut market.

A number of household characteristics influence consumer expenditure decisions. However, the most important influences are total per capita expenditure (a proxy for permanent income), distance to the nearest bus service, and accessibility of transport (measured as a percentage of a village's households owning various modes of transport). The hypothesis is tested using two-stage least-squares estimations of modified Working-Lesser variations of Engel functions. The total per capita expenditure instrument is predicted in the first stage. Marginal budget shares of total expenditure are indicated for paddy and nonpaddy farmers. For both average and marginal budget shares, nonpaddy farmers spend more on low-order goods (purchased food and personal items), and paddy farmers spend more on middle-order goods (consumer durables). Within the geographical hierarchy or economic classification of goods and services, households of all four types—paddy farmers, nonpaddy farmers, cultivation laborers, and noncultivators—spend a larger share on low-order goods than on middle-order goods.

Access to rural service infrastructure also has an effect on farmers' use of inputs (supplies of fertilizer, seed, and farm credit): for paddy farmers, an increase of 1 kilometer in distance to credit services decreases spending on fertilizer by Rs 25.97

and a 1-kilometer increase in distance to fertilizer services decreases spending on fertilizer by Rs 24.70. The larger the share of households owning bicycles or motorcycles in a village, the higher the demand for the three inputs.

The demand for output marketing services is also influenced by infrastructure access. A 1-kilometer increase in distance to the nearest output market results in a Rs 124.53 decrease in annual crop marketing revenue for paddy farm-operating households. Access to a bicycle has a positive effect on output marketing.

The findings on regional and locational gaps, population thresholds, and the impact of access to services on household expenditure patterns can be combined to plan a distribution system for producer and consumer services in the study region. For example, since a decrease of 1 kilometer in the distance to the nearest fertilizer shop would increase the farm operating household's fertilizer demand by Rs 24.70, and the median population threshold for fertilizer centers is 5,340 persons, it is recommended that investments in new fertilizer establishments be concentrated in the four settlements of sufficient population size that lack this service, with the aim of serving some of the seven subregions that are deficient in input services.

Notwithstanding the subregional and locational gaps that exist in the distribution systems of goods and services, the study region presently encompasses most of the service centers where rural households do their shopping and where they spend nearly all their money. This is not to say that there are not any important trade linkages between the study region's service centers and larger centers located elsewhere, but these are primarily trade flows of intermediate goods that usually form the content of interregional trade. Most of the goods and services considered for this study are either locally produced or distributed or both, and the demand for them is expected to have significant income and employment multiplier effects in the larger villages and small towns that supply them to the rural households.

Historically, the positive changes that took place in North Arcot's agriculture between 1974 and 1983 are reflected in changes in the distribution of population and service provision among settlements, the spatial features of middle-order service centers, and the index of service provision. By 1983, additional viable locations were available for services because the proportion of settlements with populations between 2,500 and 9,999 persons had grown from 25 to 30 percent, and, along with the investment in agricultural technology, public and private investment in rural infrastructure had been decentralized. The provision of services was more balanced, with the former domination by large towns and cities being significantly diluted. With the emergence of eight new middle-order service centers, it is expected that each center need not cover as wide a geographic area as in the earlier period. Indeed, during the period of agricultural transformation, the mean service provision score per square kilometer rose for total service, public service, private service, and for each service category except banking, for which the geographic coverage remained static but the business volume grew. Other studies have shown that the development of rural service infrastructure benefited from income growth brought about by agricultural transformation, but these studies have also noted that the "green revolution" was itself facilitated by investment in rural infrastructure.

The principles of central place theory are applicable for explaining the development in North Arcot. The hierarchy of services and service centers is as expected in theory. High-order service centers do provide a greater variety of services to a broader area and a larger population than do low-order service centers. However, the

theoretically predicted hexagonal shape for service areas is not apparent. And, in contradiction to theory, more than one of the three factors—marketing, transport, and administration—that are supposed to singularly influence spatial organization affect the service system in North Arcot. Marketing and transport principles influence the emergence and growth of low-order services and service centers, whereas all three principles are relevant for the emergence and growth of middle- and high-order services and service centers.

Coupling economic theory on consumer behavior with geographic theory on spatial organization provides even greater insight for analysis of infrastructure policy than does either alone. Central place theory is a helpful construct for applied analysis of this kind, and the present study helps to validate, correct, and expand the theory, particularly for planning the distribution systems of goods and services in developing countries.

2

INTRODUCTION

Rural Infrastructure and Agricultural Development

Although researchers' and policymakers' interest in rural infrastructure and its impact on agricultural and regional development in developing countries is growing, infrastructure is not easy to define. Generally, when the research community refers to infrastructure, they mean roads, telecommunications, electrification, and irrigation—that is, hard infrastructure. But focusing only on hard infrastructure provides only a partial picture. Other elements of infrastructure are equally important, notably institutional and "soft" infrastructure.

Local data on climate, physiography, soils, water, vegetation, and population need to be collected, stored, and analyzed by government agencies before agricultural development is planned. Normally this task is performed by national institutions in collaboration with their regional and local counterparts. The absence of this institutional infrastructure can lead to unsound agricultural development planning.

Similarly, soft infrastructure—various services such as transport (bus and truck), finance (credit and banking), input distribution (of seeds, fertilizers, pesticides, agricultural machinery, and animal husbandry inputs), and marketing (of agricultural and other rural produce)—is also necessary for the development of agriculture.

The economic and spatial features of the distribution systems for these services are strong. Since the services are available in only a few settlements but are used by a large number of settlements, economic transactions take place over a given geographical area in which these settlements are located. Depending on their distribution, these spatial features can improve or hinder access of the rural population and alter the prospects for agricultural and economic development.

Relationship between Hard and Soft Infrastructure

Previous work in India and Bangladesh by IFPRI and others has shown that investment in hard infrastructure such as roads and irrigation systems, when coupled with simultaneous investment in the type of soft infrastructure described above, facilitates intensive agricultural development, which in turn has led to overall regional development and a reduction in poverty.[1] In India, the location of soft infrastructure services was planned after studying demographic, functional, and spatial characteristics of a regional settlement system consisting of both towns and villages (Wanmali 1983a). In addition, the Indian research also shows that the private sector

[1]See, for example, Ahmed and Hossain (1990); Wanmali (1983a, 1983b, 1985); Andhra Pradesh, Government of (1975); and Sen et al. (1971, 1975).

was influenced in its decision to provide complementary soft infrastructure services by government investment in similar services (Wanmali 1983a).

Access to and Use of Services

Earlier work also indicated that the use of soft infrastructure services was influenced not only by the income of the households but also by the distance of these services from the households (Wanmali 1985). In analyzing the spatial implications of access to services, it was seen that some services, broadly categorized as agroservices, that were at a greater distance from consumers were used less frequently, which theoretically could have had an adverse effect on overall agricultural development. It was noted that making such services available at shorter distances from households could improve their use. This could also be achieved by making the services mobile, that is, moving them about to increase their availability (Wanmali 1985). The savings in both money and time in obtaining these services could be retained locally and could be used in both the producer and consumer sectors of the rural economy. This, in turn, would strengthen the service and demand linkages in that region, thus reinforcing regional economic growth and development (Wanmali 1985).

Only by understanding hard, institutional, and soft infrastructure, can the effects of infrastructural development on agricultural development in any region be adequately explained. In doing so, it is important not to equate national investments in hard infrastructure with direct economic gains at the local level and to realize that long-term economic gains cannot be achieved without simultaneous local investment in soft infrastructure. It is also important to understand the spatial implications of national investment in hard and soft infrastructures for regional development.

Rural Infrastructure and the Geographical Analysis

Geographical analysis can help in studying the distribution of infrastructure and people over space and time, particularly in analyzing access of people to infrastructure. The geographer categorizes infrastructure and people in order to understand their relationships and to address the question of access. In addition to categorizing infrastructure as hard, institutional, and soft, the geographer categorizes people as urban or rural, agriculturalist or nonagriculturalist, skilled or unskilled, rich or poor, males or females, adults or children, and literate or illiterate. Distance, which separates people from infrastructure, is categorized not only by geographical distance (in kilometers), but also by time and money spent in obtaining these services.

Towns and Villages

Infrastructure and people are mostly located in towns and villages. Accessibility can vary depending upon where a specific settlement is located in the wider settlement system. Towns, being larger, provide better access to services than villages. Locating services properly throughout a region is therefore crucial to improving access of the farming population to them. Making services available in distant towns is not of much help locally.

Settlement System

All activities in a region (such as agriculture, mining, manufacturing, trade, services, transport, finance, and governance) are part of the settlement system of that region. An analysis of the settlement system, therefore, can indicate the existing patterns of relationships between a region's population and its infrastructural services.

Services are located in settlements and these locations are a result of the capacity of the settlements to sustain them. Once established, services tend to be used not only by the settlements in which they are located but also by people from the surrounding settlements. Thus, the relationship between a center that offers a particular service or group of services and its dependent territory can provide useful information on the functional and spatial characteristics of the settlement system.[2] This relationship has a variety of implications for the patterns of use of services at both the regional and household levels.

Geographical Aspects of Development

Other properties of service use fundamentally related to distance are worth noting. In geographical studies of development, it is recognized that use of services varies directly with income and social status, and that it declines away from towns and cities. Distance to services is an indicator of ease of access to services. In any development effort, there exists a "distance decay" away from the center and toward the periphery. Analysis of the relationship between the center and the periphery, particularly involving infrastructure and people, is fast becoming a centerpiece in all current literature in geography on regional development planning in the Third World.[3]

Current economic analyses of relationships between infrastructure and people and their effects on each other often use such indicators as income or cost as a means of understanding these relationships. A geographical analysis of use of services as influenced by distance would complement this economic analysis admirably and would result in a fuller understanding of the problem. The theoretical underpinning of such a geographical analysis is central place theory, which has been found useful in conducting geographical exercises in many areas of both the developed and developing worlds (Christaller [1933] 1966).

Scope of the Study

This report presents a geographical analysis of the provision and use of hard and soft infrastructural services in rural regions of North Arcot District of Tamil Nadu, India, based on survey data collected in 1982/83. The analysis relates to the demographic, spatial, and functional features of the settlement system of the study region.

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[2]A number of studies have been conducted in various parts of the world analyzing this relationship. Some of the better-known Indian studies are Rao (1964); NCAER (1965); Wanmali (1968, 1970, 1981, 1983a, 1983b); Misra, Sundaram, and Rao (1974); Sen et al. (1971); Wanmali and Khan (1970); Alam and Khan (1972); Shah (1974); and Bhat (1976).

[3]See, for example, the 10 volumes edited and published by the United Nations Center for Regional Development (Misra 1981).

In this report, the term "settlement" means a census village, not a sociofunctional entity, as exists in the study region. The analysis identifies service center hierarchies in the study region based on the provision of both hard and soft rural infrastructural services. It also identifies "gaps" in the provision of these rural infrastructural services within the study region. An attempt is made to determine what effect hard infrastructure such as roads has on the emergence and development of soft infrastructural services, such as the distribution of credit, banking, seeds, fertilizers, pesticides, marketing of agricultural products, animal husbandry, communication, health, education, and other goods and services. A brief discussion of the socioeconomic characteristics of sample households sets the scene for analysis of the impact of access to rural infrastructural services on the expenditure patterns of the households. Special attention is paid to household expenditure on production and consumption goods and services. The geographical analyses of gaps in the provision of rural infrastructural services, the median population threshold for services, and the results of the analysis of the impact of access to rural service infrastructure on the expenditure patterns for consumption and production goods and services at the household level help provide a list of locational priorities to enable policymakers to make decisions on the geographical pattern of investment in rural infrastructural services. The implications of this analysis for initiating improvements in the distribution systems of soft infrastructural services are noted. Changes in the agricultural sector that occurred between 1974 and 1983 in the study region and in the regional pattern of provision and use of services are outlined.

Data Base

Two sets of data were collected from the study region during a field survey in 1982/83 by IFPRI and its collaborating organization, Tamil Nadu Agricultural University (TNAU), one relating to the pattern of provision and use of services at the village and town levels and the other relating to the pattern of expenditure on them at the household level. Data also included demographic and socioeconomic characteristics of households.

Regional Data

The first data set covered the availability of 134 services belonging to different groups, which included education, health, communication, banking and finance, transport, agricultural inputs, animal husbandry, marketing, and retail services in the 535 larger settlements in the six *taluks* of North Arcot. Information was also gathered on which settlements use which other settlements for what services, over what distances, and with what modes of transport. Settlements with fewer than 750 people were excluded from the study because of time and cost constraints. When analyzed, these data describe the geographical patterns of provision and use of services at the village and town levels and provide the basis for identifying gaps in the provision of rural infrastructural services.

Of the nine groups of services noted above, all except communication services are provided by both the government and the private sectors. Thus, in the study region, it is commonplace to find government and private schools and colleges, clinics and hospitals, banks and financial institutions, bus and truck transport sys-

tems, fertilizer, seed, pesticide, and agricultural machinery depots, veterinary clinics and hospitals, agricultural marketing centers, and, of course, retail services of various kinds coexisting side by side. The communications services dealing in postal and telecommunication activities, however, are solely provided by the government.

Some recall data were also collected in 1982/83 regarding the pattern of distribution and use of services in 1973/74, when a household-level survey of the region was conducted by the universities of Cambridge and Madras. The Cambridge/Madras survey did not collect data on the pattern of distribution and use of services, but the 1982/83 survey by IFPRI and TNAU made a reference to it in order to jog the memory of the respondents. Since the quality of this recall data is not very good, only broad generalizations can be made with regard to changes in the geographical distribution and use of services on the basis of its analysis.

Household Data

The second set of data, also collected in 1982/83 by IFPRI and TNAU, covered the details of services used by 345 households, sampled separately according to household type: paddy farm operator, nonpaddy farm operator, cultivation laborer, and noncultivator. The households were similar to those covered by a large longitudinal survey of 11 sample villages from the 6 *taluks* of the study region during 1982/83. This collaborative data collection exercise by IFPRI and TNAU obtained information on income and expenditure of the sample households for one year through monthly surveys.

There is, however, one important lacuna in this data base. No information was obtained on prices of goods and services in the study region. Considering that the study covers 134 different services and that there are differences in prices of goods and services based on differences in quality, it was too difficult to obtain information on prices for all the goods and services. For inputs and outputs, the prices in the study region were administered by the government, and even the private sector set its prices very close to the administered prices. What appears to govern the consumption of input and output services is the many nonprice factors identified in the study. This is not to say that prices are unimportant in the study region, but, for the reasons stated, the task of gaining price information was too formidable to undertake and accomplish.

What the data contain, however, are details of expenditures on items that make up the various groups of services in the econometric analysis undertaken in Chapter 5. These expenditure data are used in estimating the impact of access to rural service infrastructure on expenditure patterns at the household level.

Another lacuna that needs to be mentioned here is that the data do not contain any information on the time required by households to obtain a service, even when it is accessible. Although this is an important factor influencing the use of services, no information on it was collected during the 1982/83 field surveys.

Survey Design

The households were sampled for the field survey in the following way. The choice of the study region and of the sample villages in which the sample households

are located was governed by the availability of earlier data from the surveys conducted by the universities of Cambridge and Madras.[4]

1973/74 Rural Survey by the Universities of Cambridge and Madras

A two-stage sampling design was used. The first stage involved the selection of a representative sample of 11 villages for the study region. The sampling frame used was the 1971 census of all villages in the study region having a population between 50 and 5,000 people, but excluding villages located in reserved forests or hilly regions.

The 11 villages were selected from a population of 989 villages using simple systematic random sampling. The list was obtained by arranging the villages in the following order: (1) by contiguous *taluks*, (2) by distance from town within a *taluk*, (3) by 1971 population size, (4) by the ratio of agricultural laborers to cultivators, and (5) by spatial proximity (as indicated by village location codes given in the 1971 census). Then every k^{th} village (where k is the inverse of the sample ratio) was selected from the list, the first selection being at random from the first k units in the list.

All the households in the selected villages were listed, and, for each household, basic information was collected on the size and composition of the family, their principal means of livelihood, and their landholdings. These data were used to select the second-stage samples.

Several different household samples were selected and questionnaires used to obtain socioeconomic data on the households. The first survey was a sample of 161 paddy farm households who participated in a detailed farm management survey for the agricultural year ending with the 1974 *sornavari* crop. (The light monsoon season, the *sornavari*, occurs in the summer months and ends in August or September.) A paddy farm was defined as a holding of one-quarter acre or larger on which paddy could be grown. Prior to selection, the paddy farms in each village were arranged according to whether they grew high-yielding varieties (HYVs) and had an irrigation pumpset or an iron plow. They were further ranked by farm size and by the maximum area planted to paddy in any one season. Once ordered in this way, systematic sampling with equal probability was used to select a sample in each village.

The second survey was a household sample of 57 paddy farms, 3 nonpaddy farms, and 77 noncultivator households who participated in a monthly income and expenditure survey between April 1973 and May 1974. The 57 paddy farm households were selected from the sample of 161 paddy farmers included in the farm management survey. The sampling procedure used was the same as described above.

The sample of 77 noncultivator households was selected by circular systematic sampling, with equal probability, after arranging the noncultivator households in each village by (1) principal means of livelihood, (2) region and caste, and (3) household size. A noncultivator household was defined as a household with less than a quarter acre of land available to them. It also includes landless agricultural laborer households.

[4]For details of the survey conducted by the University of Cambridge (UK) and the University of Madras (India) in the early 1970s, see Farmer (1977).

The sample of three nonpaddy farm households was selected by simple systematic sampling with equal probability from the list of households in each village having only dry land. Before sampling, the households were arranged in increasing order by area of operated land, by land tenure classes, and by household size.

1982/83 Rural Survey by IFPRI and TNAU

As in the 1973/74 survey, all the households in the 11 villages were listed, and basic information was collected to form a sampling frame. The 1973/74 listing questionnaire was used, and this involved collecting information on the size and composition of the family, occupation, primary source of income, landholding, ownership of irrigation wells and lifting equipment, type and condition of house, and ownership of cycles and radios.

The listing data were used to classify the households into three groups: paddy cultivators, nonpaddy cultivators, and noncultivating households. As in 1973/74, a cultivator was defined as a farmer operating more than a quarter acre. Different sampling procedures were used to draw a sample within each group.

The paddy cultivators in each village were first sorted into six subgroups according to whether they possessed a pumpset and whether they were tenant farmers, owner-occupiers, or both. Within each group, they were then classified by operated farm size. Preliminary calculations using the 1973/74 survey data showed that a sample size of 160 should provide estimates of aggregate household expenditure that would have a 90 percent chance of falling within plus or minus 10 percent of their true values. Hence, using a predetermined sample size of 160 paddy cultivators for the 11 villages, the sample was allocated among the villages to obtain the same sampling ratio in each village. Systematic random sampling with equal probability was used.

The nonpaddy cultivators in each village were sampled by simple random sampling. Since households fell into this category in 1982/83, it was decided to select a total sample size of 25 households from the 11 villages. The sample for each village was determined so as to obtain equal sample ratios across villages.

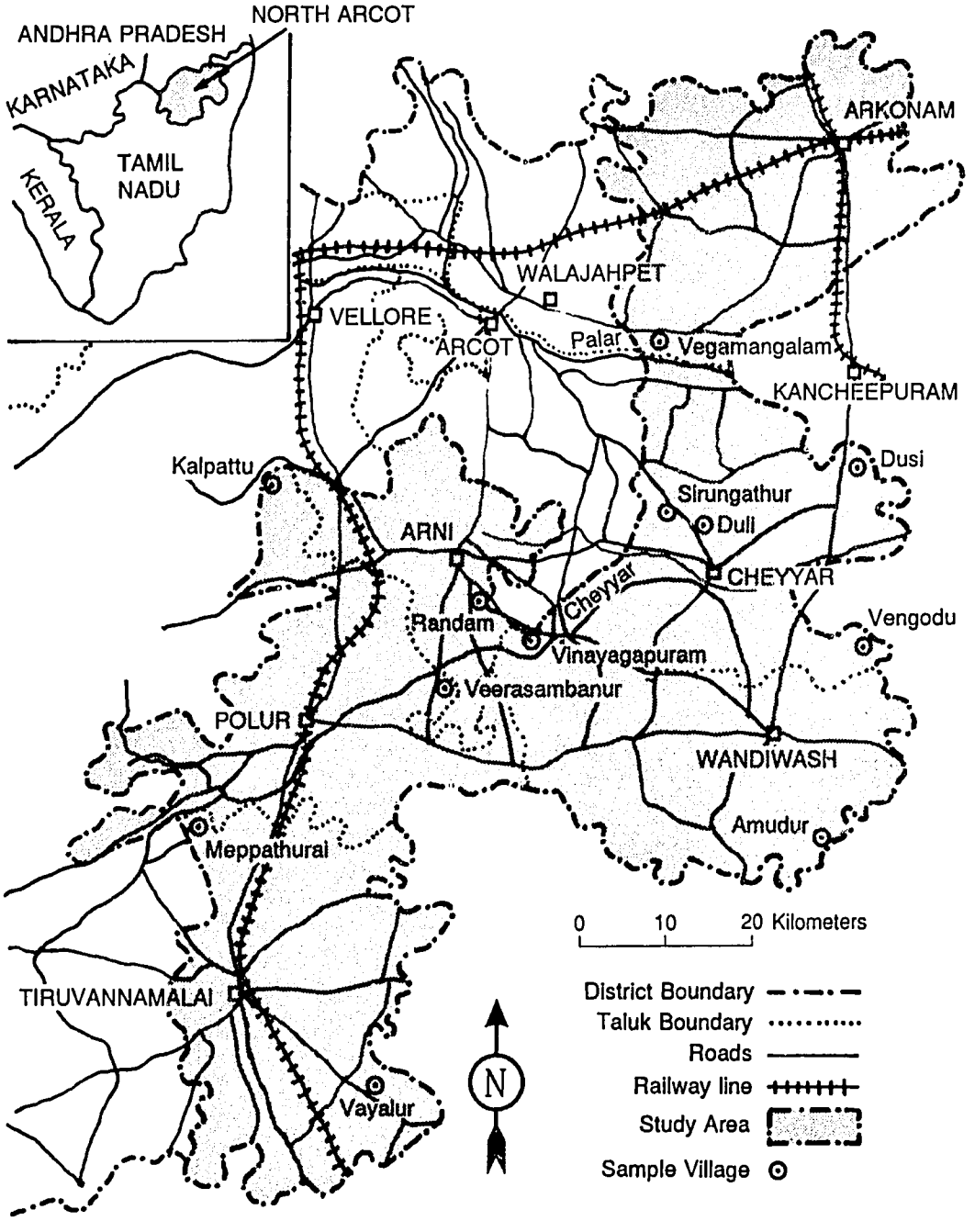
The noncultivator households were selected by systematic random sampling. A total sample size of 160 households was allocated among the villages to obtain a constant sampling ratio. Within each village, households were sorted into nine groups according to their primary source of income: agricultural labor, other casual labor, trader, village artisan, cottage or village industry, professional service, landlord or renter, money lender, and others. Within each group, the households were then arranged by family size.

All the selected rural households were administered inventory questionnaires in February 1982 and June 1983. From March 1982 to April 1983 they participated in a monthly income and expenditures survey, which also included detailed farm management and nonfarm business data where appropriate. These data are used in the analysis of household patterns of service use in the study.

The Study Region

Six eastern *taluks* of North Arcot District form the study region. The *taluks* are Arkonam, Arni, Cheyyar, Polur, Tiruvannamalai, and Wandiwash (see Figure 1). For the purposes of development administration, these *taluks* are further divided into the

Figure 1—The study region



following 17 community development blocks: in Arkonam Taluk, Arkonam, Kaveripakkam, and Nemili; in Arni, Arni and West Arni; in Cheyyar, Cheyyar, Anakavur, and Vembakkam; in Polur, Polur, Kalasapakkam, and Chetpet; in Tiruvannamalai, Tiruvannamalai, Thurinjapuram, and Kilpennathur; and in Wandiwash, Wandiwash and Thellar.

The study region has an area of 5,508 square kilometers, and it lies between 11°55′ and 13°15′ north latitude and 78°50′ and 79°50′ east longitude. The general slope of the region is from west to east. The western part of the study region is partly bordered by the Javadi Hills, which are a part of the Eastern Ghats. According to the *Census of India* (1981), the population of the study region is about 1.6 million, giving it a population density of 290 persons per square kilometer. There are 1.1 million workers in the study region. Sixty-eight percent of the region's work force is engaged in agriculture or agriculture-related activities. Of the total population of the district, only 23 percent are in urban centers.

Agriculture is the predominant activity in the study region, and paddy, groundnuts, ragi, pulses, and sugarcane are the most important crops. Milk production is also important. A thriving agroprocessing industry is an important part of the manufacturing sector. Other prominent manufacturing activities are tanneries and silk and cotton textile mills.

In the chapter that follows an attempt is made to introduce the theoretical frame of reference of the study. This relates to the theory of location of services in a settlement system of a region and the impact of these locations on economic development in the region.

3

THEORETICAL FRAMEWORK: CENTRAL PLACE THEORY

The theoretical frame of reference of this study is based on the central place theory formulated by Walter Christaller ([1933] 1966) and modified by others (Haggett 1965).[5] In this chapter six basic concepts of central place theory are defined with a view to understanding how they may be applied, and further developments in theory are noted.

Definitions of Basic Concepts

Centralization as an Ordering Principle

The centralization of mass around a nucleus is an elementary form of organization. This centralistic order exists in all patterns of matter, whether inorganic or organic. Christaller believes that services tend to concentrate around points that are more important rather than around those that are less important.

The Central Place

The most important aspect of Christaller's idea of the central place system is the central place itself. The basic unit is a settlement: it could be a city or a town or a village. The distinguishing characteristic of a central place is that it provides goods and services to an area larger than itself. The services may be extensive or limited, but the *service function* is common to all central places.

The central place is the center of a region, but the term *central* is relative. Settlements that are mainly centers of a region are called central settlements; those that are not central are known as dispersed places.

According to central place theory, places that have central functions and that cater to the population of a larger region in which central places of lesser importance also exist are central places of higher order. Those that are only important in their immediate vicinity are called, correspondingly, central places of lower order. Small places usually not having central importance are called central places of auxiliary nature.

Importance and Centrality

Every place has a degree of importance, which usually is defined rather inexactly by its size of population or by its areal size. Neither population or area precisely expresses the meaning of the word "importance" or centrality. The theory says that

[5]In addition to Christaller (1966), see Berry and Garrison (1958); Berry and Pred (1961); Berry (1967), particularly chapter 4; Beavon (1977); and Berry and Parr (1988).

the importance of a settlement is not the sum of the number of its inhabitants, but rather the sum of their combined economic efforts.

The Central Functions

Central functions are those which, by their nature, are available in a few places but are availed of by a number of places. In fact, the degree of importance of a function varies inversely with the frequency of its occurrence. Central place theory, therefore, classifies central functions as *higher-* and *lower-order* functions. The lower-order functions belong to a lower-order central place or an auxiliary central place. Christaller believes that all consumer-oriented functions belong to the central place. In fact, he suggests that the processing of raw materials could be done at a central place. Industries like food processing, dairies, sugar refineries, and fruit preservation plants could very well be located in central places of higher order. The central functions considered by Christaller are trade, banking, administration, education, commerce, and transportation.

Complementary Regions

Intraregional complementarity includes both the relation of the place to its region and vice versa. The complementary region of a central place is difficult to delineate because, in essence, it involves the demarcation of the variable ranges of the many functions performed by a central place. Where a central place has a surplus of importance, a complementary region has a deficit: one counterbalances the other.

Economic Distance and the Range of a Good

In classical central place theory, geographical supply of and demand for goods and services are determined by freight, insurance, and storage costs; delivery time; loss of the good; and by the ease of movement, travel cost, and travel time. Two notions are used to describe the geographical movement of goods and services. One represents the maximum distance over which the demand for a good is positive, called the *range* of a good or the upper limit. The other represents the minimum distance wherein exists the minimum volume of demand for the good to ensure normal profits to the seller. This is the *threshold* or the lower limit.

It can be shown that each good or function has its own characteristic range, which is likely to vary from one central place to another and to change over time. The range of central functions offered at central places of higher order is larger than the range of lower-order places. When the range is expressed spatially as a radius, it forms a circle or a ring around the central place. The range has an upper and a lower limit. The former is a *spatial* index determined by the farthest distance from the central place where a good or function can be obtained; the latter is a *quantity* index determined by the minimum number of people required to support that function in the central place.

The Process of Emergence and Growth of a Central Place

What effects do distribution of population, the size of the region, and the range of central functions have on the emergence and growth of central places?

Demand for Central Functions

The consumption of (demand for) central functions depends upon the distribution of population and the pattern of transportation—an important factor affecting the development of a central place. The higher the population of a region, the greater is the consumption of a central function; this will result in a higher-order central place offering these functions and vice versa.

Supply of Central Functions

Dispersed distribution of population, particularly on scattered farms, is not conducive to satisfactory access to central functions of even the lowest order. For example, where the population is dispersed, even grocers, bakers, and butchers are significantly absent. Such a situation will result in comparatively better development of higher-order central places because all services will be located there, but there will be very few places of lower order. In a region where villages predominate, however, the higher-order central place is deprived of its central functions to some extent because some of the large villages perform lower-order central functions. Therefore, central places of both higher and lower order will be found in such a region. Thus the development of central places in regions of dispersed farms is generally poorer than that in regions with many villages.

Interaction of Demand for and Supply of Central Functions

Although demand for central functions is very important in the development of central places, demand is itself dependent upon other factors. First, where incomes are limited, demand is restricted because consumers do not have money to spend. Second, demand is restricted where the existing supply—volume or amount—of functions is limited.

An example of a central function with a given quantity and a set price is a hospital with a fixed number of beds. If the beds are filled in hospital A, the people whose demand could not be met there will have to go to hospital B, which may be located in a neighboring area. However, they then have to consider the cost of transportation. Therefore, the most favorable location for a central place is the one where the total existing amount of the function is just equal to the total demand.

Other Factors Influencing the Distribution of Central Functions

The size of the area, the landscape, the means of transportation, natural conditions, fertility of the soil, availability of minerals, and whether the whole or a part of the region belongs to a central place characterize the complementary regions. In thinly populated regions, the consumption of functions per unit of area is less than that in thickly populated regions. Hence, low population density and large areal size in a region lead to the development of a central place system with an inferior pattern. Conversely, high population density and small areal size may lead to a superior pattern.

The importance of transportation in the development of central places should not be underestimated. Transport represents an economic relationship between consumers and central places, and as a result of the preference consumers show for central places, transport forms a network of interconnected settlements around places of higher order. This network tends to cover places of lesser order also. Therefore, a

good transport system tends to strengthen central places. However, in an area where the transportation network is poor, central places will be poorly developed.

The quality of functions also affects the growth of central places, but this factor appears to come into play at a stage when the economy is well developed. In an earlier stage, when physical availability itself is the crucial aspect, the quality of a function is relatively unimportant in the emergence and development of a central place.

Central Place Models

In its most comprehensive formulation, the central place theory would provide a complete framework for the study of the formal and functional attributes of settlements and regions, the types and patterns of linkages between them, and their dynamics. But neither Christaller's model ([1933] 1966) nor that of Loesch (1954)—the two most elaborate models of the central place concept—are comprehensive enough to fulfil this role. However, because these two models form the basis of the central place theory, an examination of their salient features is in order. The two models are described here in broad terms, touching only on their main arguments, both explicit and implicit. Finally, recent developments in the theory are examined in the light of the two classical models.

General Description

The two central place models explain the horizontal (spatial) and vertical (functional) distribution of settlements in a region and their interrelationships (hierarchies). The locale of activity is assumed to be an unbounded, homogeneous plain (isotropic surface), where uniform distribution of population, resources, producers, consumers, and so forth is the rule; movement in every direction is unimpeded; and unit costs are equal.

Christaller's model is developed by describing, first, how market areas (the complementary regions described earlier) for different goods emerge. Market areas are bounded areas, determined by the cost of transportation (the range of a good discussed earlier). The quantity demanded of a good decreases spatially with every increase in the distance between the sites of supply and demand because of the rise in the cost of transportation. At a particular demand site, the price plus the transport cost of a good may become prohibitive, and the quantity demanded drops to zero. Since ease of movement and the unit cost of transportation in any direction around the central settlement (site of supply) are assumed to be uniform, the distance between the site of supply and the point where quantity demanded is zero will be the same in each direction. Therefore, the market area will be circular in shape. But, as will be seen presently, this has to be regarded as a first approximation of the shape of the bounded area. What needs be stressed here, however, is that the market area indicated by the range of a good should also generate the minimum demand (threshold) to allow normal profits to sellers. This would be the minimum size market. Further, it can be demonstrated that in a competitive situation the market available to each individual seller of a good will always be of the minimum size.

Circular market areas are not ideal in a competitive situation for reasons that can be easily demonstrated. There are two possible ways for circular market areas to fit into a given space. First, a number of unserved areas could arise between three or

more circular market areas; second, two or more market areas could overlap considerably. In the first case, instability is inherent because new firms could locate in the unserved populated areas, thereby encroaching seriously on the market areas of the neighboring sites. The ultimate solution would be to split the unserved areas equally between the neighboring market areas. Where market areas overlap, it is evident that the overlapping zones will tend to be distributed between the competing sites. Thus, hexagonal market areas of the minimum size would emerge for each good.

This general description is valid for both Christaller's and Loesch's constructions.

Differences Between Christaller and Loesch

As far as the *horizontal* arrangement of settlements is concerned, Christaller's solution yields uniform spacing of equal-order settlements; higher-order central places are more widely spaced than lower-order ones. In Loesch's model, concentration of settlements occurs in sectors separated from each other by sectors of low settlement density. Further, settlement size (in terms of geographical area) increases with distance from the central settlement and, consequently, small-sized settlements are sandwiched midway between two larger settlements.

Equally, if not more, important are the differences in *vertical* (functional) organization between the two models. The fixed-K assumption of Christaller yields a rigid hierarchy in which higher-order central places provide *all* lower-order goods (provided by the lower-order central places) *plus* one or more higher-order goods.

Similarly, for every higher-order central place in Christaller's model, there is a fixed number of lower-order central places, but this number varies according to the three principles of spatial organization that Christaller recognizes. These are the marketing principle, where for every higher-order central place, there are two lower-order central places; the transport principle, where the number of lower-order central places is three; and the administrative principle, where the number of lower-order central places is six. These numbers are known as k-values in the theory.[6]

The variable-K assumption of Loesch, which recognizes functional specialization of places, implies, first, that *all* central places of the *same order* need not contain the same functions; and second, that higher-order central places need not have all the functions performed by the lower-order central places. Vertical organization in the Loeschian model is more continuous than in Christaller's construction, with its discrete distribution of central places. Thus, in Loesch's model, it would not be impossible for points derived from several principles of spatial organization to converge at the same place. This is not the case with Christallerian construction, where only one principle is seen to influence the emergence of central places.

Departures from the Hexagonal Form

Isard (1956) has pointed out that Loesch retains the hexagon although it is not consistent with some of the implications of his solution. Loesch postulates uniform distribution of the consuming population (see isotropic surface, p. 27), but his model indicates varying degrees of concentration of activities and functions (agglomera-

[6]In discussion of central place hierarchy, the capital letter K indicates the span of control of higher-order centers. Thus, according to the marketing principle, k represents the three next lower-order complementary regions.

tions) at different central places. Implicitly, the density of population is higher around the highest-order central place and declines progressively as one moves outward from that point. Thus, areally, the minimum-size market areas (see threshold and range of a good) nearer the core should be smaller and those at increasing distances from it should be larger. As a result of this distortion, market areas would assume rectilinear or rhomboidal shapes.

Besides agglomerations, any resource localization pattern that differs substantially from the uniform distribution of resources (isotropic surface) assumed by the classical models is bound to distort the hexagonal geometry. Three such hypothetical distribution patterns can be visualized. In the first case, resources are assumed to occur only at one point (for example, a coal field with all active pits concentrated in a relatively small space). Three patterns of settlement locations and market areas would result. In the first, settlements would cluster around a node, all sharing with the node the market areas at whose apexes they are located. In the second, resources are assumed to occur in a wide zone, but not uniformly over the entire unbounded space. Central places of the resource-poor areas will locate as close to the resource-rich zone as possible and not necessarily in the exact center of their respective market areas. In the third, resources are assumed to occur linearly. Central places will be located along the resource line with their market areas diagonal to it on either side (provided the resource line does not hinder movement across it) or on the side on which the central place is located (Haggett 1965).

Nonhexagonal Central Place Models

The hexagon, the means of formalizing central place hierarchy in the classical models, is a pure concept. But the central place concept is not a pure or formal idea in that sense. Even if all the assumptions on which the constructions of Christaller and Loesch are based were relaxed, the concept of central place functional hierarchy would be unaffected. There are two well-known variants of the central place model, not based on the classical formal assumptions, that provide satisfactory exposition of functional hierarchies. Both are empirically derived and are amenable to geometrical interpretations.

The first of these is the regular cluster model associated with Kolb and Brunner (1946). It has a remote skeletal prototype in the observations of Galpin regarding the evolution of movement-networks in agricultural communities (Berry 1967). The regular cluster model, which in essence is an alternative hypothesis to the regular model, specifies neither directions nor distance. Its basic assumption, which conforms to the real situation, is spatial interaction between settlements on the principles of a positive relationship between their size and pull (attraction) and an inverse relationship between their distance and pull. Thus, the following patterns characterize spatial interaction: the largest settlement (town) is centrally located; the next smaller settlements in size (villages) find locations on the periphery of the zone of pull of the town; and the next smaller settlements (hamlets) ring around the villages. Smaller settlements are likely to develop close to each other rather than close to the larger ones. The functional hierarchy implied in the model is one of direct dependence of smaller settlements on larger, and of the latter on the largest settlement of the system.

The other case referred to earlier in this connection is a study of the functional hierarchy of settlements in southwest Iowa, in which Berry (1967) deals with and defines a system of central places, without the aid of geometrical forms, using only

maps, flow charts, and—only incidentally—rudimentary geometry. The findings of this study can also be interpreted in the terminology of the classical models. In a more recent statement, Berry and Parr (1988) observes characteristics of central place systems in areas of formal and informal trade and exchange in rural, suburban, urban, and metropolitan economies.

A "Mobile" Central Place Model

Finally, mention should be made of the model of periodic central places proposed by Stine (1962), which is of interest because of its operational potential in areas with low population densities or poor communications or both.

Stine observes that if the range of a good (the upper limit) and its threshold (the lower limit) are expressed as circles with radii of appropriate lengths, then the circle representing the maximum range of a good will contain the circle representing the threshold. However, in a physical setup that restricts free movement of consumers, the relationship between the two circles may become inverted. In a situation like this, since the minimum necessary demand conditions are not fulfilled, the firm supplying the good—if it sets up business at all—will soon disappear, being unable to sustain recurring losses. However, the firm may still make normal profits and offer services, provided it gives up its fixed location and becomes mobile. If the firm becomes mobile, the number of trips it may have to make and the distance over which it may have to travel in order to find the minimum necessary demand will depend on the difference between the radii of the circles describing the range of the good it deals in and its threshold. The itinerant vendors operating periodic markets in the countryside, particularly in the Third World, are an example. This model suggests the use of mobile units for the provision of specific rural infrastructural facilities.

Relevance of Central Place Theory to the Current Analysis

In any exercise analyzing the availability and use of rural service infrastructure, the central place theory can serve as the basic framework. It is true that the theory was originally formulated to explain the locations and functions of and relationships between urban areas (cities and towns). But this need not detract from its application to nonurban areas. With certain modifications, the main construction, with all its essential features, can be employed for such areas. In brief, the central place theory has three main elements: urban centers, their hexagonal market areas, and transport networks. By replacing rural settlements for urban centers, service areas for hexagonal market areas, and movement patterns for transport networks, the theory can be made applicable to a nonurban hierarchy.

The relevance of this theoretical framework has been tested extensively in South Asia, but less often in other parts of the Third World.[7] Although approaches to these studies have tended to be varied even in the South Asian context, their findings have

[7]See, for example, Wanmali (1970, 1981, 1987); Sen et al. (1971); Misra, Sundaram, and Rao (1974); and Alam and Khan (1972).

unmistakably pointed toward the applicability of central place concepts in the urban and rural areas of the countries of South Asia. An attempt is made in the subsequent chapters of this report to analyze the settlement system of North Arcot District within the theoretical framework noted in this chapter and to demonstrate what aspects of the theory are applicable to the settlement system of the study region. An attempt is also made to investigate what influence household expenditure patterns can have on the emergence and growth of central places in South Asia. Given that Christaller only referred to this influence but never pursued it in his deductive theory, it would be a useful extension of the theory to identify inductively how central places emerge and grow as a consequence of household expenditure patterns. Since this is one of the few studies, if not the only study, that looks at both the regional provision of and household use of central functions in a Third World region, the study helps to extend the application, and understanding, of central place concepts in the Third World more fully than ever.

4

REGIONAL PROVISION AND USE OF SERVICES

The state of Tamil Nadu has paid increasing attention to rural development schemes since the early 1960s.[8] These schemes have had a strong impact on agricultural, industrial, and infrastructural development in North Arcot District. As will be seen in this report, provision of services in the villages and towns of the study region, as a result of policies to expand public utilities and other governmental, quasi-governmental, and private-sector schemes, has greatly influenced the patterns of service use at both regional and household levels.

Services such as bus and truck transport, credit, banking and marketing of animal husbandry inputs, seeds, fertilizers, pesticides, agricultural machinery, agricultural produce, and rural products form the core of soft infrastructural services. Some other services can also be added to this list, including education and health services, as well as the entire gamut of retail services. In this analysis, these are all considered to be soft infrastructural services. They can also be defined as central functions, as noted in the previous chapter.

In this part of the analysis, details of service provision and use at the settlement level are given, with particular reference to the identification of service centers and their spatial characteristics and the incidence of service provision. As mentioned earlier, these spatial characteristics relate to areas and populations served by service centers and to functional hierarchies, which in their turn are helpful in identifying and delineating the progressively complex specializations in the pattern of provision and use of services in a settlement system. This analysis helps in identifying gaps in the provision of services in the study region. It also helps in understanding the regional context within which the sample households are located. Access to these services and their effects on the expenditure patterns of the sample households will be analyzed in the next chapter.

Services and Their Distribution

The total service provision in the study region can be divided into nine major groups: (1) education, (2) health, (3) communications, (4) banking and finance, (5) transport, (6) cultivation inputs, (7) animal husbandry, (8) marketing, and (9) retail services.

The list of individual services in each group in Table 1 was compiled after visiting each of the 535 settlements selected for this study. Table 1 also indicates the number of settlements in the study region that have that particular service. It depicts

[8]For lack of space, this report does not include all of the details of administrative history, physical and economic features, adoption of new agricultural technology and modern inputs, and broad patterns of development in recent years for the study region.

Table 1—Service groups and ranking of services

Service	Number of Villages with Service
Education services	
Primary school	522
Middle school	272
High school	96
Higher secondary school	28
College	3
Health services	
Allopathic clinic	246
Family planning camp (mobile)	22
Family planning clinic	30
Primary health center	27
Private hospital	33
Government hospital	26
Pathological and radiological tests	8
Communication services	
Postage	457
Money order	387
Registration	384
Postal order	66
Telegram	44
Radio license	131
Telephone	149
Banking services	
Primary cooperative credit society	135
Land development bank	10
Agriculture cooperative bank	18
Commercial bank	17
Nationalized bank	15
Lead bank	22
Transport services	
Passenger bus service	354
Transport of goods by road	17
Passenger train service	16
Transport of goods by train	15
Agricultural input and implements services	
Purchase of	
Tools	368
Implements	49
Electric motors	4
Electric pump sets	5
Oil engines	4
Sugarcane crushers	3
Sprayers	4
Dusters	4
Threshers	1
Seeds	63
Fertilizer and pesticides	82
Rental of	
Tools	443
Implements	448
Oil engines	299
Sugarcane crushers	103
Sprayers	352
Dusters	282
Threshers	100
Tractors	153
Cage wheel	122
Servicing of	
Tools	466
Implements	422
Electric motors	90
Electric pump sets	81
Oil engines	57
Sugarcane crushers	18
Sprayers	95
Dusters	83
Threshers	6
Tractors	3
Cage wheel	3
Animal husbandry services	
Key village centers	116
Veterinary dispensaries	42
Marketing services	
Sale of	
Vegetables	100
Fruits and coconuts	52
Paddy	34
Bajra	155
Jowar	163
Pulses	98
Castor	85
Groundnuts	34
Other oilseeds	91
Sugarcane	22
Jaggery	27
Chilies	110
Turmeric	11
Tamarind	34
Poultry products	425
Dairy products	519
Firewood	89
Retail services	
Blacksmith	494
Carpenter	492
Cobbler	495
Retail petty shop	524
Retail cloth shop	58
Tea and coffee shop	483
Laundry	497
Barber	510
Bakery	395
General provisions	382
Ready-made garments	33
Household utensils	17
Medical shops	15
Glassware	5
Pottery	457
Electrical goods	32
Footwear	17
Bicycle sales	6
Bicycle repair	410
Timber	15
Fuel	404
Bricks/tile	406

(continued)

Table 1—Continued

Service	Number of Villages with Service	Service	Number of Villages with Service
Cement	32	Jewelry	11
Stone	348	Furnishings (bed mattresses)	23
Lime	35	Arrack[a] shops	463
Hardware	17	Foreign liquor	10
Wooden furniture	273	Bookbinding	17
Steel furniture	8	Printing	17
Opticals	2	Sweet shops	27
Stationery	76	Leather goods	11
Watch sales	6	Photography	16
Watch repair	23	Purchase of vegetables	281
Radio sales	4	Purchase of fruits	347
Radio repair	24	Purchase of poultry products	485
Transistor sales	4	Purchase of meat products	405
Transistor repair	21	Purchase of dairy products	501
Scooter repair	7	Cold drinks	503
Automobile repair	7	Restaurant	291
Petrol, diesel fuel, and lubricants	8		

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

[a]Arrack is an Asian alcoholic beverage distilled from a fermented mash of malted rice, coconut palm juice, and date palm juice.

a pattern of distribution of services in which the more rudimentary services exist in a large number of settlements and the more complex exist in only a few of them.

Hierarchy of Services

In the present pattern of distribution of villages and towns in the study region, there appears to be a lack of settlements of certain population sizes.[9] These "breaks" in the regional settlement system were observed at different population sizes and are the basis for dividing the total service provision structure into three groups. This categorization reflects the complexity of services available in settlements: (1) low-order services, which are defined as those first occurring in settlements with populations smaller than 1,000; (2) middle-order services, which first occur in settlements with populations between 1,000 and 3,500; and (3) high-order services, which first occur in settlements with populations larger than 3,500. Some settlements in the last group are towns. There are 48 services in the low-order category, 75 in the middle-order, and 11 in the high-order (Table 2).

Entry Thresholds of Services

Entry thresholds of services, in this part of the analysis, are defined by the population size at which a service first occurs within the study region. These thresh-

[9]This feature is not unique to this settlement system. Such gaps in settlements of a certain size exist in all settlement systems; however, their exact location varies from one region to another. See, for example, Sen et al. (1971) and Wanmali and Khan (1970). Further, over time, the location of such gaps may shift, in terms of population size, within a settlement system (Wanmali 1983a, 1983b).

Table 2—Hierarchy of services according to size of settlement where they first appear

Low Order (48)		Middle Order (75)			High Order (11)
Primary school	Marketing of dairy products	High school	Thresher (rental)	Jaggery market	College
Middle school	Blacksmith	Higher secondary school	Cage wheel (rental)	Chili market	Pathological and radiological testing
Allopathic clinic	Carpenter	Family planning camp	Electric motor (service)	Turmeric market	Bicycle sales
Postage	Cobbler	Family planning clinic	Electric pumpset (service)	Tamarind market	Opticals
Money order	Petty shop	Primary health center	Oil engine (service)	Firewood market	Watch sales
Registration	Tea and coffee shop	Private hospital	Sugarcane crusher (service)	Retail cloth shop	Transistor sales
Postal order	Laundry	Government hospital	Duster (service)	Ready-made garment	Radio sales
Telegram	Barber	Land development bank	Thresher (service)	Household utensil	Scooter repair
Radio license	Bakery	Agriculture cooperative bank	Tractor (service)	Medical shop	Automobile repair
Telephone	General provisions	Nationalized bank	Cage wheel (service)	Glassware	Petrol, diesel fuel, and lubricants
Primary cooperative credit society	Pottery	Lead bank	Seed (purchase)	Electrical goods	Leather goods
Commercial bank	Bicycle repair	Railway station	Fertilizer and pesticide (purchase)	Footwear	
Bus stop	Fuel	Rail shipment	Veterinary dispensary	Timber	
Tools (purchase)	Bricks/tile	Road shipment	Vegetable market	Cement	
Tools (rental)	Stone	Implements (purchase)	Fruit and coconut market	Hardware	
Implements (rental)	Lime	Electric motor (purchase)	Paddy market	Wooden furniture	
Oil engines (rental)	Arrack (local liquor) shop	Electric pumpsets (purchase)	Bajra market	Steel furniture	
Sprayers (rental)	Vegetables (purchase)	Oil engine (purchase)	Jowar market	Stationery	
Tractors (rental)	Fruits (purchase)	Sugarcane crusher (purchase)	Pulse market	Watch repair	
Tools (service)	Poultry products (purchase)	Sprayer (purchase)	Castor market	Transistor radio repair	
Implements (service)	Meat products (purchase)	Duster (purchase)	Groundnut market	Jewelry repair	
Sprayers (service)	Dairy products (purchase)	Thresher (purchase)	Other oilseed market	Furnishing	
Key village center (veterinary subcenter and dairy collection center)	Cold drinks	Sugarcane crusher (rental)	Sugarcane market	Foreign liquor	
Marketing of poultry products	Restaurant	Duster (rental)		Bookbinding	
				Printing	
				Sweet shop	
				Photography	

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

olds are noted for all services. It should not come as a surprise that the more rudimentary and, therefore, more commonly available services have low entry threshold values (Table 3).

Ranking of Services and Centrality of Settlements

Although there are nine groups of services in the study region as a whole, not all settlements have all services, nor are services available in all settlements at the same level of complexity. That is, not all of the components of a service group are necessarily available in each settlement. The services, therefore, can be arranged on the basis of their entry thresholds in order to arrive at their ranking.[10] Depending upon its threshold value, each of the services has a "weight" assigned to it to help arrive at a score for a settlement's total service provision, which is referred to as the centrality of a settlement (Table 3). For example, if the entry threshold value of a primary school is a population of 806, its weight would be 1.00; for a middle school where the entry population threshold is 918, the weight would be 1.14.

The centrality of a settlement is a measure of its importance, which is defined here as a function of all the services provided by it. By considering the variety, hierarchy, and number of services available in a settlement and multiplying the number by the appropriate weight, it is possible to arrive at an indicator of the settlement's centrality. Thus, continuing with the same example, if a settlement has two primary schools and one middle school, its centrality score for education services will be $(2 \times 1.00) + (1 \times 1.14) = 3.14$. Centrality was calculated for all 535 settlements.

Broad Patterns of Service Provision

It is possible to argue that higher levels of concentration of population in settlements would result in better provision of services and conversely that these services would be physically more accessible to greater concentrations of population. When centrality scores and distances of services were plotted against the population size of settlements in this study, it was not surprising to see that, as population size increases, the distance to services generally declines and the level of service provision (centrality) improves appreciably for all services (Figures 2 and 3).

These patterns of physical access to services are of particular interest. Some services are easily accessible in terms of distance to all settlements; others are uniformly inaccessible. Still others are inaccessible to all settlements with populations below 2,000 (there are 360 settlements in this category and all are villages), but are easily accessible to settlements with populations of more than 5,000 (many of the 23 settlements in this category are towns).

The centrality patterns are exactly the opposite of the physical accessibility patterns. For example, as the population size increases, the centrality scores increase. Thus, the association between higher centrality scores and larger population size is unmistakable.

[10]For a detailed discussion of methods of ranking see Wanmali (1971, 1983a, 1983b).

Table 3—Thresholds and weights of services

Service	Threshold of Service	Weight of Service
	(minimum population)	(population/108)
Education services		
Primary school	806	1.00
Middle school	918	1.14
High school	1,021	1.27
Higher secondary school	1,334	1.66
College	19,274	23.91
Health services		
Allopathic clinic	806	1.00
Government hospital	1,075	1.33
Family planning clinic	1,084	1.34
Primary health center	1,084	1.34
Family planning camp	1,480	1.84
Private hospital	1,505	1.87
Pathological and radiological tests	5,583	6.93
Communication services		
Postage	860	1.07
Money order	860	1.07
Registration	860	1.07
Radio license	860	1.07
Telephone	860	1.07
Postal order	918	1.14
Telegrams	918	1.14
Banking services		
Commercial bank	860	1.07
Primary cooperative credit society	918	1.14
Lead bank	1,075	1.33
Agriculture cooperative bank	1,440	1.79
Nationalized bank	1,440	1.87
Land development bank	1,508	1.87
Transport services		
Passenger bus stop	806	1.00
Passenger train stop	1,327	1.65
Transport of goods by train	1,327	1.65
Transport of goods by road	1,961	2.43
Agricultural input and implements services		
Tools, purchase	806	1.00
Tools, rental	806	1.00
Sprayers, rental	806	1.00
Implements, rental	806	1.00
Oil engines, rental	806	1.00
Tools, servicing	806	1.00
Implements, servicing	806	1.00
Tractor, rental	806	1.07
Sprayer, servicing	918	1.14
Sugarcane crusher, rental	1,002	1.24
Dusters, rental	1,002	1.24
Electric motor, servicing	1,012	1.26
Oil engine, servicing	1,012	1.26
Dusters, servicing	1,012	1.26
Seed	1,012	1.26
Fertilizer/pesticides	1,012	1.26
Cage wheel, rental	1,015	1.26
Thresher, rental	1,023	1.27
Implements, purchase	1,072	1.33
Sugarcane crushers, servicing	1,254	1.56
Threshers, servicing	1,380	1.71

(continued)

Table 3—Continued

Service	Threshold of Service	Weight of Service
	(minimum population)	(population/108)
Tractors, servicing	1,380	1.71
Cage wheel, servicing	1,380	1.71
Electric pump sets, purchase	1,829	2.27
Oil engine, purchase	1,829	2.27
Sugarcane crushers, purchase	1,829	2.27
Sprayers, purchase	1,829	2.27
Dusters, purchase	1,829	2.27
Threshers, purchase	1,829	2.27
Electric motor, purchase	2,443	3.03
Animal husbandry services		
Key village centers	806	1.00
Veterinary dispensaries	1,035	1.28
Marketing services		
Sale of		
Poultry products	806	1.00
Dairy products	806	1.00
Other oilseeds	1,002	1.24
Vegetables	1,012	1.26
Fruits and coconuts	1,012	1.26
Chilies	1,012	1.26
Pulses	1,015	1.26
Tamarind	1,021	1.27
Firewood	1,021	1.27
Jowar	1,028	1.28
Bajra	1,030	1.28
Castor	1,042	1.29
Jaggery	1,042	1.30
Sugarcane	1,050	1.30
Paddy	1,119	1.39
Turmeric	1,119	1.39
Groundnuts	1,133	1.41
Retail services		
Blacksmith	806	1.00
Carpenter	806	1.00
Cobbler	806	1.00
Petty shop	806	1.00
Tea and coffee	806	1.00
Laundry	806	1.00
Barber	806	1.00
Bakery	806	1.00
Bicycle repair	806	1.00
Bricks/tile	806	1.00
Stone	806	1.00
Arrack shops	806	1.00
Purchase of vegetables	806	1.00
Purchase of fruit	806	1.00
Purchase of poultry products	806	1.00
Purchase of meat products	806	1.00
Purchase of dairy products	806	1.00
Cold drink	806	1.00
General provisions	806	1.07
Pottery	806	1.07
Lime	806	1.07
Restaurant	806	1.07
Fuel	918	1.14
Stationery	1,012	1.26

(continued)

Table 3—Continued

Service	Threshold of Service	Weight of Service
	(minimum population)	(population/108)
Cement	1,014	1.26
Wooden furniture	1,015	1.26
Retail cloth shop	1,031	1.28
Hardware	1,036	1.29
Ready-made garments	1,075	1.33
Watch repair	1,075	1.33
Radio repair	1,075	1.33
Transistor repair	1,075	1.33
Sweet shop	1,075	1.33
Foreign liquor	1,075	1.33
Timber	1,164	1.44
Furnishings (bed mattresses)	1,270	1.58
Electrical goods	1,352	1.68
Household utensils	1,395	1.73
Photography	1,924	2.39
Footwear	1,924	2.39
Jewelry	2,443	3.03
Medical shops	2,456	3.05
Steel furniture	2,540	3.15
Bookbinding	2,540	3.15
Printing	2,540	3.15
Glassware	3,426	4.25
Leather goods	5,026	6.24
Petrol, diesel fuel, and lubricants	5,583	6.93
Scooter repair	7,889	9.79
Automobile repair	7,889	9.79
Radio sales	16,083	19.95
Transistor sales	16,083	19.95
Bicycle sales	16,083	19.95
Watch sales	16,083	19.95
Opticals	38,664	47.97

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

The distribution of service provision in the study area is such that numerous settlements with low scores—below 70—dominate the rural scene; there are only a few settlements with very high scores—up to 4,000 (Table 4 and Figure 4). These gaps in service provision exist, as will be seen later, because service provision for large rural areas in the study region is poorly planned, which adversely influences the use of rural services.[11]

Travel Patterns and Categorization of Settlements

Since the availability of services is not uniform across the study region, nor are all services needed and used located in a settlement, people must travel in order to

[11]This pattern of distribution of service provision is also not unique to the study area. It has been found to exist in other parts of India, although the location of the gaps according to the centrality scores will vary from one region to another. See Sen et al. (1971) and Wanmali (1970, 1983a, 1983b).

Figure 2—Relationship between population size and average distance to services by service category

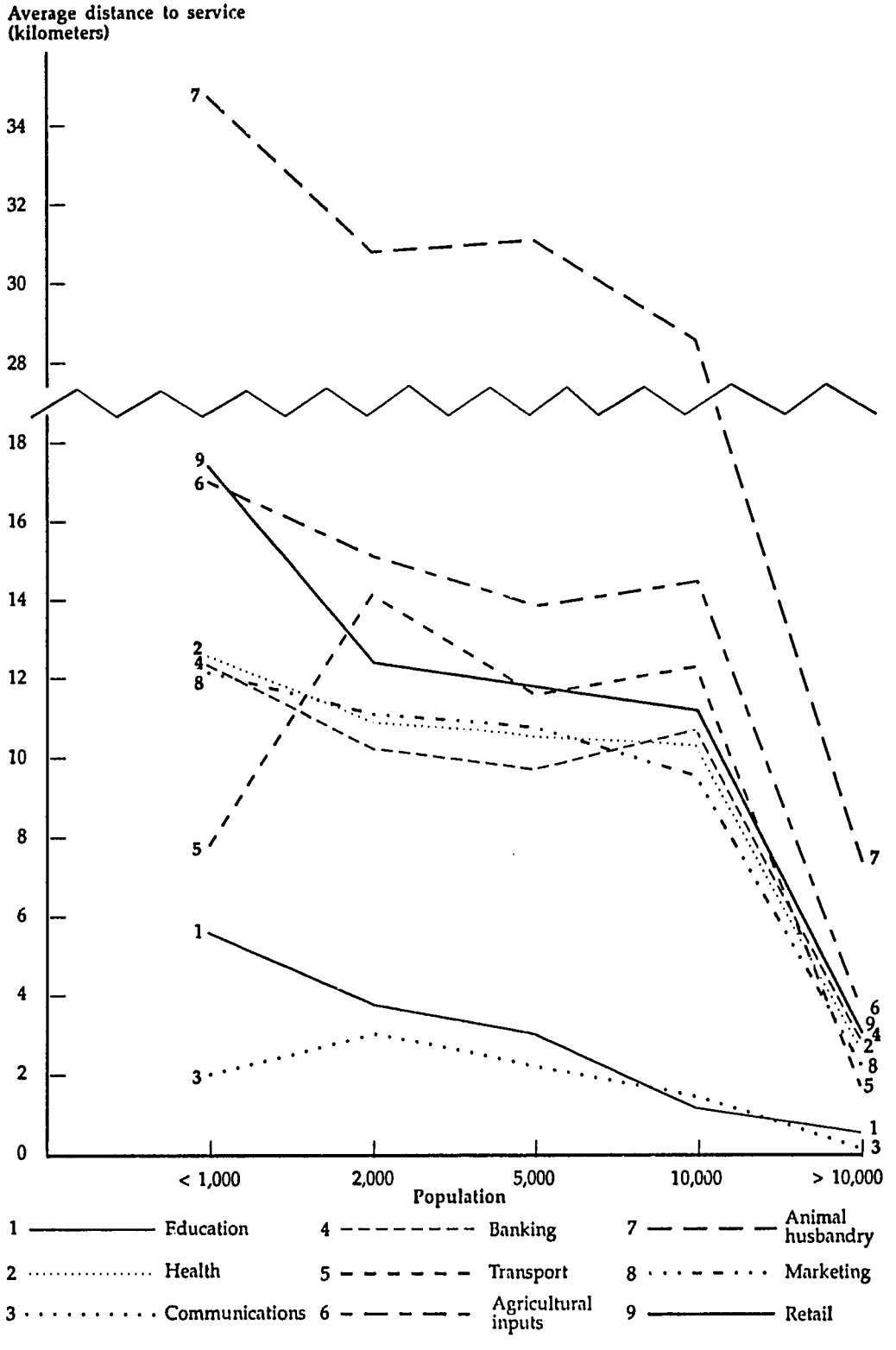


Figure 3—Relationship between population size and average centrality of services by service category

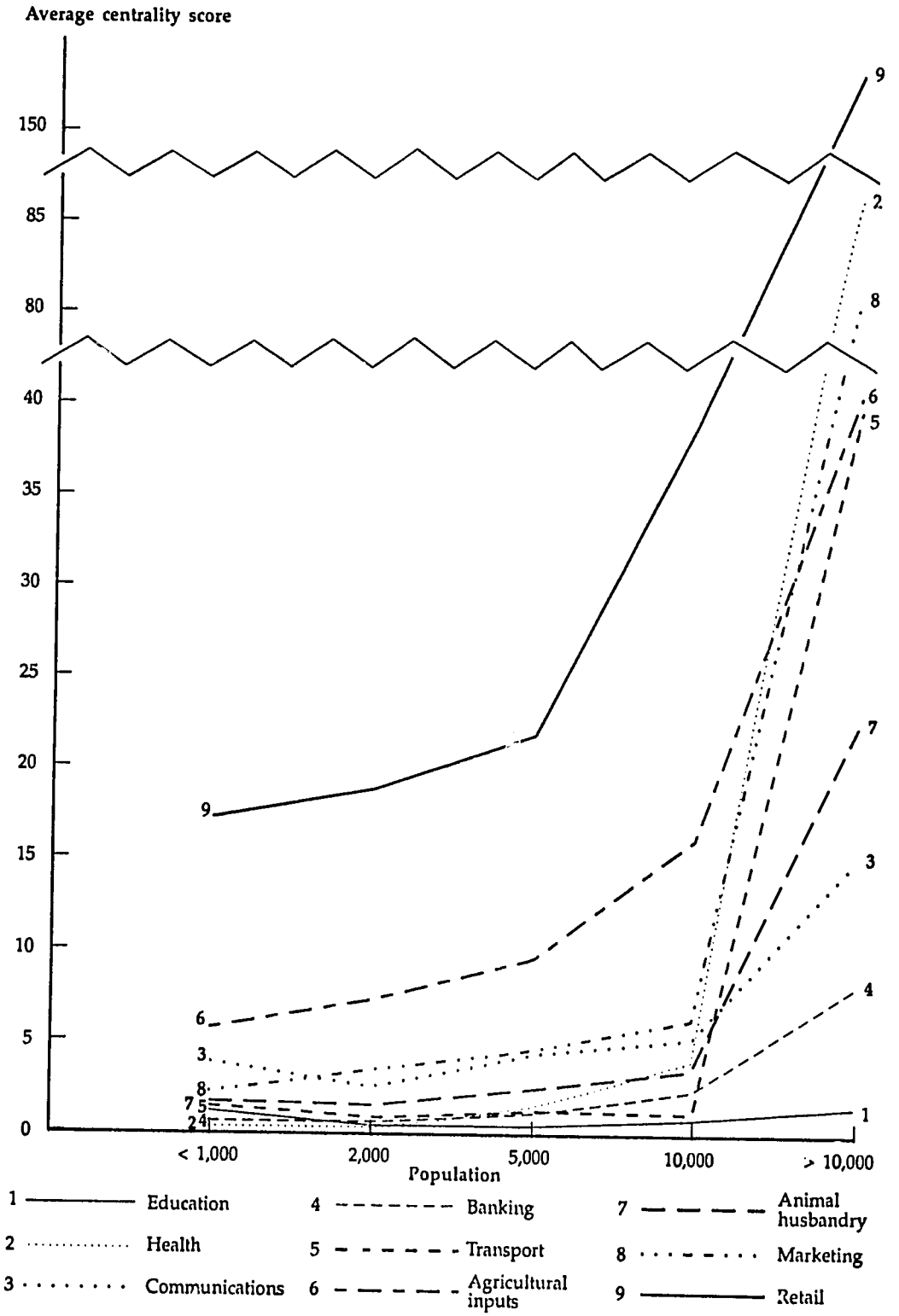


Table 4—Centrality scores for service provision and distribution of settlements

Score	Number of Settlements	Sum of Scores	Percent of Total
10.00 - 40.00	334	10,686.95	46.52
40.01 - 70.00	169	7,976.84	34.69
70.01 - 100.00	15	1,230.24	5.35
100.01 - 130.00	9	1,085.68	4.73
130.01 - 3,999.99	8	2,000.80	8.71
Total	535	22,980.51	100.00

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

avail themselves of services located outside of their own settlements. Which settlements have what types of services and what is the pattern of regional travel to them?

All settlements in the study region were visited in order to obtain information about the availability and use of services. These data provided the basis for identifying the patterns of travel to each service by people from each settlement. These individual settlement-based patterns are grouped in order to understand the generalized pattern of both service provision and use.

Settlements are categorized as service centers or dependent settlements in the following way: if any settlement has more than 50 percent of services at any level of service hierarchy and if it serves any other settlement, then that settlement is termed a service center for that level of the service hierarchy. On the other hand, if a settlement depends upon any other settlement for more than 50 percent of services at any level of the service hierarchy, then that settlement is considered to be dependent on the other settlement at that level.[12] The same method can be applied separately to the provision of services at the three different levels of hierarchy.

At least two different kinds of analysis can be undertaken on the basis of the survey data: one relates to the identification of service centers, their dependent settlements, service population, service areas, and the number of settlements served; the other concerns the service population and service area for each of the services. In both these analyses it can be expected that higher-order service centers and services will serve larger areas and populations than lower-order service centers and services.

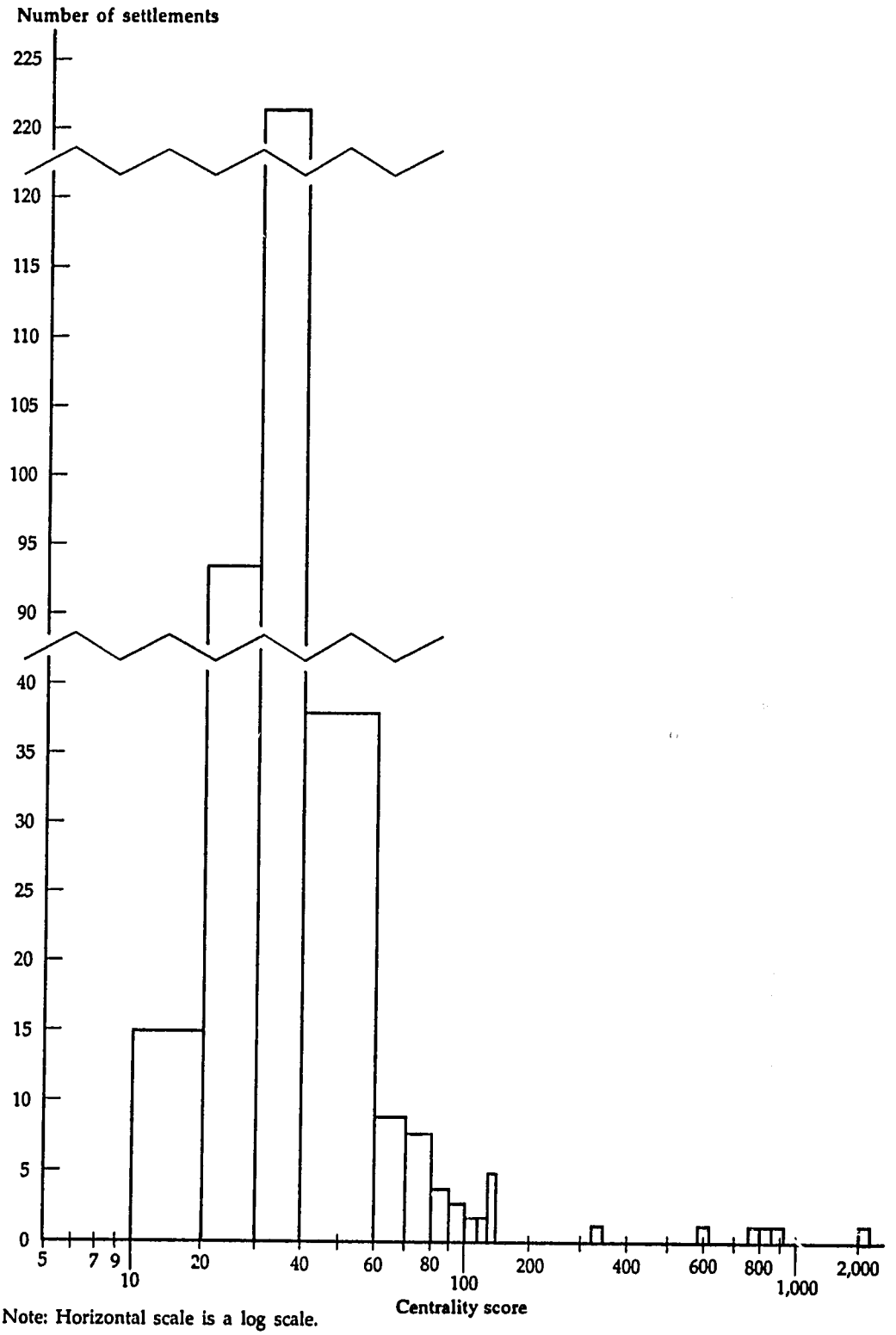
The Hierarchy of Service Centers

Low-Order Service Centers

There are 12 settlements in the study region that qualify as service centers at the low level of service provision, having more than 50 percent of the services considered and serving at least one additional settlement. However, there are 461 other settlements that have more than 50 percent of the services considered but serve only

[12]Sen et al. (1971) uses the same type of categorization.

Figure 4—Histogram of centrality scores



Note: Horizontal scale is a log scale.

themselves. These settlements are called "relatively self-sufficient" in the sense that, at this level of service provision, they do not depend upon any other settlement to satisfy their demand for services. Given that the services provided are rudimentary, it is not surprising that so many qualify as relatively self-sufficient. Combined they serve 493 settlements out of 535 in the study region. On average, each low-order service center serves 1.04 settlements including itself; together they serve almost a million people and cover almost 3,075 square kilometers.

Middle-Order Service Centers

There are 22 middle-order service centers serving the study region. Five of these, however, are located outside of the region. Of the 17 within the region, 10 are small service centers, servicing a total of 21 settlements (an average of 2.1 settlements per service center). The other 7 are quite large, serving altogether 311 settlements (an average of 44.4 settlements per service center). Among the outside service centers, Kancheepuram in Chengalpet District is significant because it serves 21 settlements from the study region (Table 5). It is interesting to note that, for the middle-order services, the influence of Vellore (which is acknowledged locally to be the most important service center in the district) is nonexistent. This is because Vellore is outside the study region, and because other service centers of this order of hierarchy within the region provide middle-order services to the settlements of the study region.

Of the 17 service centers within the study region, 6 are *taluk* headquarters (Arkonam, Arni, Polur, Thiruvathipuram (Cheyyar), Tiruvannamalai, and Wandiwash); 8 are block headquarters (Chetpet, Desur, Kalasapakkam, Kaveripakkam, Kilpennathur, Nemili, Peranamallur, Thellar); and 3 have no revenue or developmental administrative functions (Kannamangalam, Panapakkam, and Vettavalam). The 6 *taluk* headquarters have functioned as such since at least the turn of the century, while the block headquarters were created in the early 1950s. The older centers—the *taluk* headquarters—have more services, larger service areas, greater service populations, and higher service scores than the young [illegible]ers—the block headquarters and other centers (Table 5 and Figure 5). This fi[illegible] only substantiates the theory but adds an element of "time" to the explana[illegible] range of services offered by service centers. At this level of service provi[illegible]fluence of the service centers within the study region on service provision [illegible]ant. Service centers within the study region serve 89.71 percent of the m[illegible] service area (out of 2,198 square kilometers), 90.72 percent of middle-ord[illegible]vice-using settlements (out of 366), and 92.20 percent of the middle-order service population (out of 876,365 people).

High-Order Service Centers

There are 12 high-order service centers in the study region, serving a total of 391 settlements, 975,051 people, and 2,470 square kilometers of area. Seven service centers—Arkonam, Arni, Chetpet, Polur, Thiruvathipuram (Cheyyar), Tiruvannamalai, and Wandiwash—are within the study region and serve 64 percent of the high-order service-using settlements, 67.4 percent of the high-order service population, and 62.5 percent of the high-order service area. Of these, Arkonam, Arni, Tiruvannamalai, and Wandiwash are the most important because they serve a large number of settlements. Of the outside service centers, two—Kancheepuram and Vellore—are significant. Six of the seven service centers from within the study region are *taluk* headquarters and thus are important administrative centers for revenue and

Table 5—Spatial features of the study region for middle-order service centers

Center and Subregion	Total Score[a]	Service Population	Service Area	Number of Services	Settlements Served[b]
			(square kilometers)		
Centers and subregions inside the study region					
Chetpet	919.47	35,226	87.37	92	17
Desur	110.70	4,301	6.59	90	1
Kalasapakkam	109.99	2,443	2.08	85	1
Kannamangalam	129.44	5,026	9.98	94	1
Kilpennathur	166.70	10,471	24.60	96	2
Nemili	170.67	6,498	14.77	96	3
Peranamallur	126.74	4,256	14.97	96	1
Thellar	122.43	6,513	14.70	74	2
Arkonam	3,314.67	108,085	201.87	117	33
Arni	5,160.26	154,661	420.18	116	59
Polur	1,228.76	32,318	57.55	102	11
Thiruvathipuram (Cheyyar)	1,281.55	35,821	61.78	103	14
Tiruvannamalai	8,245.30	267,490	650.83	109	108
Wandiwash	2,081.55	71,656	212.86	103	35
Kaveripakkam	709.27	14,141	32.68	99	5
Panapakkam	149.10	8,748	9.94	88	2
Vettavalam	196.50	12,121	23.46	92	3
Centers and subregions outside the study region[c]					
Kancheepuram	887.71	40,599	140.78	n.a.	21
Solingar	262.76	12,846	42.73	n.a.	7
Tirukovilur	40.93	1,482	2.89	n.a.	1
Tirutani	159.77	12,376	34.32	n.a.	4
Uthramerur	39.63	1,061	6.25	n.a.	1

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Notes: A subregion is the area surrounding a service center and served by it; it takes its name from the town that is the service center. n.a. is not available.

[a]The total score is derived from the weighted population size at which a service first appears in a village.

[b] This is the number of villages dependent on the service center for at least 50 percent of services.

[c]Information about service centers outside the study region is incomplete.

development, and the seventh is a block headquarters. When the data are carefully analyzed, it becomes clear that settlements that have some form of administrative or development function are also the more important service centers at the higher levels of functional hierarchy (Table 6 and Figure 6). There is a greater dependence on outside service centers at this level of service provision than at any other level. The emergence and growth of these service centers with development and administrative functions and the middle- and high-order services are the consequence of several principles of spatial organization operating in the study region.

Functional Characteristics of Service Centers

At each level of service provision, the most important service center (the one with the highest total score) has the greatest number of services, the highest service

Figure 5—Middle-order service centers

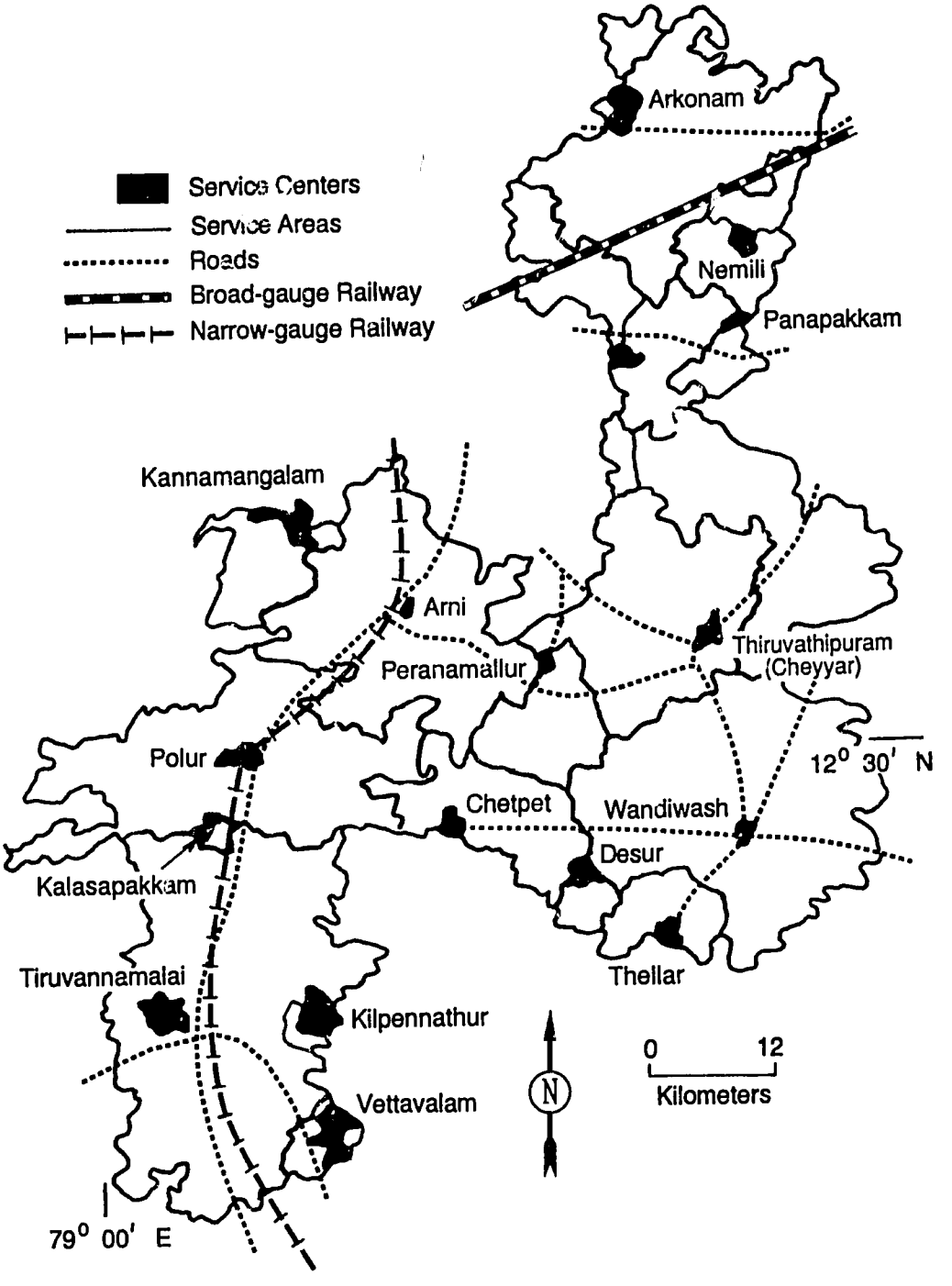


Table 6—Spatial features of the study region for high-order service centers

Center and Subregion	Total Score[a]	Service Population	Service Area	Number of Services	Settlements Served[b]
			(square kilometers)		
Centers and subregions inside the study region					
Chetpet	457.56	9,375	15.96	92	4
Arkonam	3,384.25	111,398	222.11	117	34
Arni	4,664.82	129,879	325.11	116	44
Polur	1,228.76	32,318	57.55	102	11
Thiruvathipuram (Cheyyar)	1,281.55	35,821	61.78	103	14
Tiruvannamalai	8,245.30	267,490	650.83	109	108
Wandiwash	2,081.55	71,656	212.86	103	35
Centers and subregions outside the study region[c]					
Kancheepuram	2,322.89	101,753	328.50	n.a.	53
Madras	1,030.49	54,728	138.36	n.a.	21
Thindivanam	41.57	1,257	2.93	n.a.	1
Tirutani	202.93	13,672	36.88	n.a.	5
Vellore	2,328.29	145,701	417.92	n.a.	61

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Notes: A subregion is the area surrounding a service center and served by it; it takes its name from the town that is the service center. n.a. is not available.

[a]The total score is derived from the weighted population size at which a service first appears in a village.

[b]The number of villages dependent on the service center for at least 50 percent of services.

[c]Information about the service centers outside the study region is incomplete.

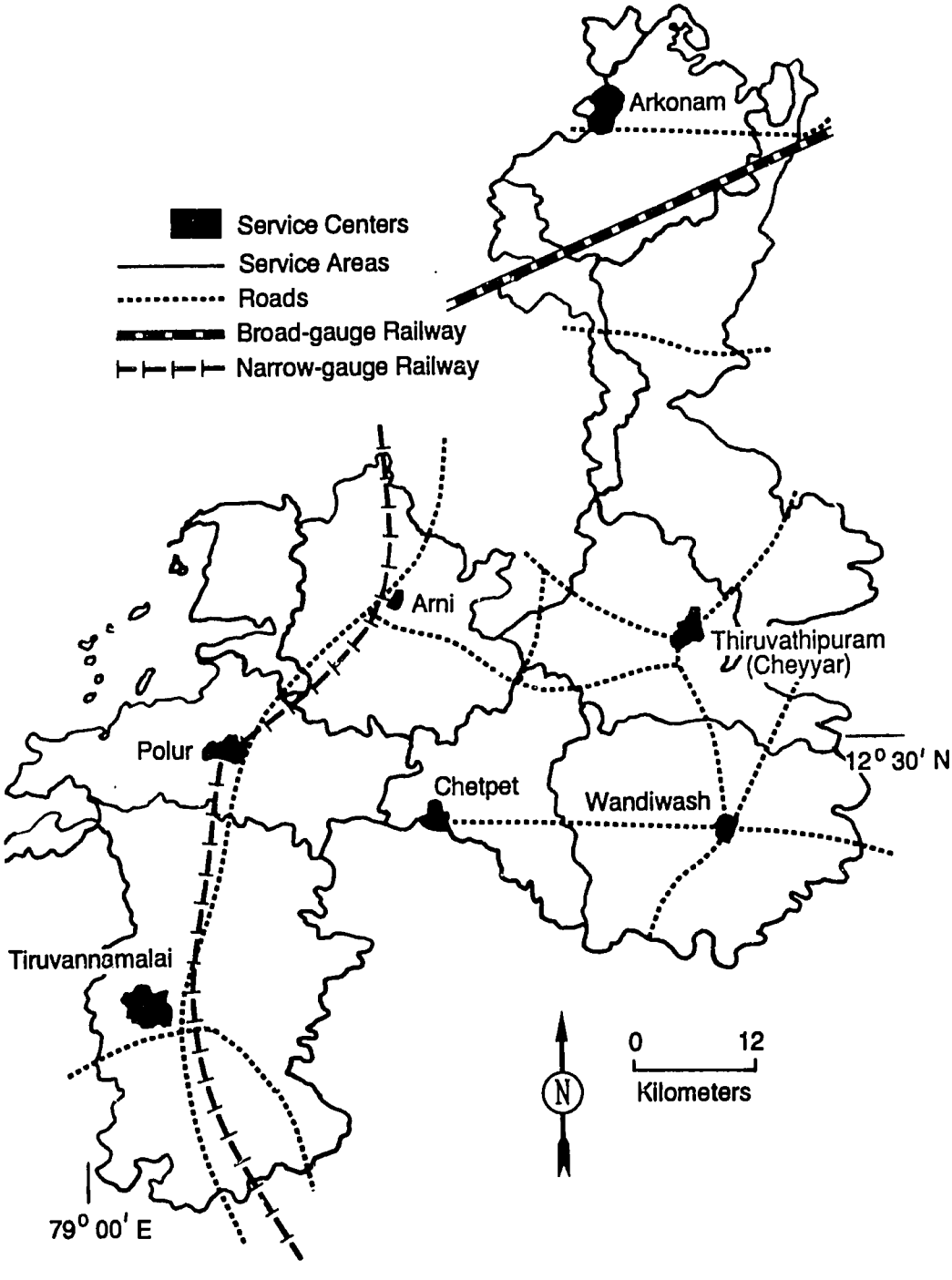
population, the most extensive service area, and the largest number of settlements served. It can therefore be said that other less important service centers "nest" under the influence of the most important service center.[13]

Further, even individual service centers display this nesting pattern. For example, Tiruvannamalai is a service center at all three levels of service provision. Its service region for the low-order services is the smallest and that for the high order is the largest. As a high-order service center, therefore, Tiruvannamalai has nested areas of successively less complex services. This exemplifies the characteristics of vertical organization of central places of different orders, noted in the previous chapter.

At the low order of service provision, every settlement is almost self-sufficient and, therefore, there is very little specialization in the provision of services. With greater complexity in service provision, there are specializations that result in spatial interaction. The low- and middle-level service centers combined, for example, provide 123 (of the 134) services; thus, the patterns of interaction for these two levels of service hierarchy provide the most complete picture of regional service use. As will be seen later, the service centers from outside the study region have only a marginal impact on service provision and that for only a handful of services.

[13]Most of the studies on settlement systems throughout the world, including India, have validated this observation. See Wanmali (1970, 1983a, 1983b), Wanmali and Khan (1970), Alam and Khan (1972), Sen et al. (1971), and Bhat (1976).

Figure 6--High-order service centers



All of the spatial characteristics of service centers conform with the principles of central place theory, with two exceptions: the shape of the service area of a service center and the factors that govern the number of lower-order service centers for each higher-order service center. In theory, the shape of the service area is hexagonal, but in reality, none of the service areas is hexagonal. Theoretically, the factors that govern the emergence and growth of lower-order service centers are administrative, marketing, and transport. In theory, under the administrative factor, there are six lower-order centers for every higher-order center; under the marketing factor, there are two; and under the transport factor, three. But the reality is more complex than the theory. Analysis of the data indicates that no one particular factor governs the emergence and growth of lower-order service centers in the study region. There is enough historical evidence to show, however, that a combination of all three factors has been responsible at all levels of the settlement hierarchy. There is a preponderance of marketing and transport factors governing the emergence and growth of low-order service centers, whereas all three factors govern the middle- and high-order service centers.

Two other observations are required to explain Tables 5 and 6. Data on services available in service centers outside the study region were not collected by the survey. However, data were available on travel patterns from settlements in the study region to these outside service centers. Hence, population, service areas, and service scores were derived from that data. Second, of the 535 settlements, the survey shows only a few interacting with outside service centers, perhaps because the cut-off point for service interaction was set at 50 percent. It is possible that the settlements not included in the tables belonged to categories where they depended on outside service centers for less than 50 percent of the services considered, or they depended on more than one center.

It becomes clear from the analysis of the travel patterns that the study region's dependence on service centers outside of the region increases as one moves to the high-order services. The study region is largely self-sufficient in low- and middle-order services, which together account for 123 of the 134 services used. However, many settlements use service centers located outside the study region for high-order services. Interestingly, the district headquarters town, Vellore, is used for only 11 high-order services, and then only by 61 of the 535 settlements in the study region. As was noted earlier, this is partly because of the peculiarity of Vellore's location, which makes it accessible only to settlements in the northern part of the study region.

Spatial Characteristics of Services

What is true with regard to the nesting patterns of service centers is even more true of the services themselves. For each type of service, the service area and service population tend to increase with the order of service complexity (Table 7) (Wanmali 1983a, 1983b). This neat vertical organization of services becomes somewhat confused when viewed in terms of their provision by service centers, because, at the service-center level, one is concerned with the patterns of use of all services provided by that center, not just one. This observation also conforms to the theory that lower-order services are subsumed under higher-order services.

Table 7—Average areas and populations served by services

Service	Service Area	Service Population
	(square kilometers)	(persons)
Education services		
Primary school	6.03	1,969
Middle school	10.40	3,386
High school	24.25	7,894
Higher secondary school	61.14	19,923
College	194.78	63,594
Health services		
Allopathic clinic	11.07	3,594
Private hospital	54.00	17,599
Family planning clinic	60.05	19,320
Primary health center	60.06	19,018
Family planning camp	60.77	19,627
Government hospital	74.14	24,296
Pathological and radiological tests	142.56	46,402
Communication services		
Postage	6.81	2,215
Money order	7.76	2,536
Registration	7.84	2,554
Telephone	16.83	5,442
Radio license	19.04	6,211
Postal order	33.01	10,767
Telegram	42.87	13,981
Banking services		
Primary cooperative credit society	18.64	6,083
Lead bank	63.94	20,792
Nationalized bank	65.37	21,281
Commercial bank	79.80	25,917
Agriculture cooperative bank	120.14	39,185
Land development bank	285.29	93,104
Transport service		
Passenger bus service	8.57	2,784
Passenger train service	72.97	23,789
Transport of goods by train	77.70	25,309
Transport of goods by road	86.52	28,092
Agricultural input services		
Fertilizers and pesticides	30.80	10,038
Seeds	40.18	13,051
Animal husbandry services		
Key village centers	8.66	2,788
Veterinary dispensaries	44.23	14,360
Marketing services		
Sale of		
Turmeric	4.92	3,369
Dairy products	5.98	1,967
Poultry products	6.13	2,039
Castor	7.38	2,612
Jowar	10.23	3,483
Bajra	11.02	3,735
Pulses	11.89	4,036
Other oil seeds	12.68	4,153
Firewood	15.58	5,041
Chilies	16.34	5,316
Tamarind	17.53	6,013
Fruits and coconuts	22.43	7,516
Vegetables	22.83	7,546
Jaggery	26.78	8,943

(continued)

Table 7—Continued

Service	Service Area	Service Population
	(square kilometers)	(persons)
Groundnuts	58.85	19,481
Paddy	62.52	20,575
Sugarcane	92.58	30,881
Agricultural inputs and implements services		
Tools, service	6.55	2,134
Tools, rental	6.85	2,236
Implements, rental	6.89	2,246
Implements, service	7.23	2,349
Tools, purchase	8.33	2,720
Sprayers, rental	8.41	2,737
Oil engines, rental	9.76	3,166
Dusters, rental	10.04	3,304
Tractors, rental	16.46	5,406
Cage wheel, rental	19.67	6,459
Sugarcane crushers, rental	20.94	6,906
Threshers, rental	21.62	7,104
Sprayers, service	26.50	8,626
Electric motors, service	28.94	9,414
Electric pump sets, service	29.03	9,464
Dusters, service	29.07	9,460
Oil engines, service	38.67	12,590
Implements, purchase	43.68	14,217
Sugarcane crushers, service	71.82	23,423
Threshers, service	111.54	36,415
Sprayers, purchase	120.47	39,156
Dusters, purchase	130.86	42,586
Tractors, service	134.47	43,975
Cage wheel, service	136.58	44,516
Threshers, purchase	156.19	50,946
Electric pump sets, purchase	156.89	51,112
Electric motors, purchase	163.86	53,373
Sugarcane crushers, purchase	180.23	58,967
Oil engines, purchase	184.89	60,174
Retail services		
Petty shop	6.07	1,976
Barber	6.14	2,006
Cold drinks	6.18	2,010
Purchase of dairy products	6.21	2,027
Blacksmith	6.28	2,049
Carpenter	6.29	2,050
Laundry	6.29	2,051
Cobbler	6.33	2,061
Purchase of poultry products	6.45	2,099
Tea and coffee	6.46	2,105
Arrack shops	6.60	2,154
Pottery	6.61	2,155
Bicycle repair	7.38	2,403
Bricks/tile	7.50	2,433
Purchase of meat products	7.54	2,455
Fuel	7.56	2,469
Bakery	7.67	2,503
General provisions	7.96	2,592
Purchase of fruits	8.58	2,792
Stone	8.77	2,860
Restaurants	10.13	3,290
Purchase of vegetables	10.39	3,386

(continued)

Table 7—Continued

Service	Service Area	Service Population
	(square kilometers)	(persons)
Wooden furniture	10.90	3,547
Stationery	29.83	9,725
Retail cloth shop	36.95	12,025
Lime	50.12	16,305
Electrical goods	59.84	19,542
Cement	60.95	19,772
Sweet shops	61.52	20,030
Ready-made garments	65.10	21,116
Transistor repair	69.65	22,698
Watch repair	69.97	22,778
Radio repair	70.08	22,811
Furnishings (bed mattresses)	76.59	24,932
Household utensils	77.95	25,449
Hardware	91.74	29,977
Bookbinding	98.29	31,901
Printing	98.30	32,005
Photography	98.43	32,042
Medical shops	101.09	32,950
Footwear	101.38	33,003
Timber	112.28	36,538
Leather goods	115.87	37,632
Glassware	123.32	40,489
Steel furniture	125.32	40,734
Scooter repair	143.32	46,603
Foreign liquor	148.28	48,350
Bicycle sales	155.49	50,830
Automobile repair	156.47	50,945
Jewelry	163.79	53,235
Petrol, diesel fuel, and lubricants	165.27	53,650
Watch sales	195.85	63,760
Transistor sales	196.13	63,871
Radio sales	196.76	64,087
Opticals	209.54	68,163

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Pattern of Incidence of Services

In Tables 5 and 6, where the spatial features of service centers are noted, the names of the centers listed are also the names of the subregions. Thus, Chetpet subregion has a total centrality score of 919.47, a service population of 35,226, a service area of 87.37 square kilometers, and a total number of 92 services (out of a possible 134); all these are available to residents of Chetpet town and to the 17 settlements that it serves besides itself. Thus, the subregion takes the name of the service center on which it depends for its services. The incidence of services is calculated by dividing the score values of service provision by the area for the subregions and for the study region as a whole and then obtaining the ratios of the two values. For example, if a subregion has an area of 50 square kilometers and a total service provision score of 50, and if the study region has an area of 1,000 square

kilometers and a total service provision score of 2,000, then the service provision score per square kilometer would be 1.00 for the subregion and 2.00 for the study region. The ratio for the subregion would be 0.50. In this study, wherever the value of the ratio is more than 1.00, then service provision is considered above average for that subregion in that service.

Because the number of service centers is exceedingly large (473), the ratios of low-order service centers are not given in a table. However, the ratios for the other two levels of service provision appear in Tables 8, 9, 10, and 11.

In identifying the regional patterns more specifically, it is possible to note which subregions have below-average provision of which services. This exercise, however, can only be undertaken with some degree of certainty for those subregions that are fully in the study region, which should be kept in mind in examining the tables.

Middle-Order Service Provision

Kalasapakkam is the only subregion with uniformly high ratios in individual and total services. Overall, service provision in Arkonam, Arni, Desur, Kannamangalam, Kaveripakkam, Panapakkam, and Tiruvannamalai, is above average, but there are some gaps in their service provision since the values of ratios for some services are less than 1.00. Wandiwash has consistently low ratios in all services. On the whole, provision of services is below average in Chetpet, Kilpennathur, Nemili, Peranamallur, Polur, Thellar, Thiruvathipuram (Cheyyar), and Vettavalam but provision of some services is above average, as indicated by some ratios higher than 1.00 (Table 9).

High-Order Service Provision

Service provision in the subregions of Chetpet, Thiruvathipuram (Cheyyar), and Tiruvannamalai is uniformly above average in individual and total services. Arkonam, Arni, and Polur have above average values for total services, but provision of some of the individual services is below average. Wandiwash, on the other hand, has below average values for total services but some individual services are above average (Table 11).

Implications of Ratio Values

The ratio values for total service provision and for individual services in subregions primarily indicate the levels of rural service infrastructural development within these subregions. For example, Table 9 indicates that, for the total middle-order services category, 8 of the 17 subregions have above-average levels of rural service infrastructural development (ratio values of more than 1.00), and 9 have below-average levels (ratio values less than 1.00). Similarly, in the total higher-order services category, 6 of the 7 subregions providing high-order services have above-average levels of rural service infrastructural development (Table 11).

The subregions with below-average infrastructural development are those that have gaps in the provision of this rural service infrastructure. The subregions consist of a service center and several settlements; therefore, the gaps that are identified in Tables 9 and 10 are indeed gaps in service provision in the settlements of the subregion. Another angle that could be explored on the basis of the analysis of ratio values is the question of what the ratio values indicate about the stages of development in the study region. Only the ratios of total service provision for the middle-

Table 8—Service scores per square kilometer served for each middle-order service center and the study region

Center and Subregion	Education	Health	Communi-cation	Banking	Transport	Agricultural Inputs and Implements	Animal Husbandry	Marketing	Retail Trade	Total Services
Centers and subregions inside the study region										
Arkonam	0.35	0.76	0.58	0.09	0.53	1.66	0.03	1.68	10.74	16.42
Arni	0.35	0.58	0.53	0.09	0.25	1.33	0.04	0.69	8.44	12.28
Chetpet	0.46	0.41	0.64	0.13	0.37	1.37	0.11	0.98	6.04	10.52
Desur	0.77	1.12	1.16	0.72	0.15	3.74	0.19	2.26	6.68	16.80
Kalasapakkam	2.43	2.66	3.66	2.04	1.17	17.38	0.61	4.02	18.80	52.77
Kannamangalam	0.51	0.74	0.76	0.47	0.67	2.47	0.00	0.96	6.38	12.97
Kaveripakkam	0.39	1.11	0.56	0.24	0.90	1.38	0.07	2.06	15.00	21.70
Kilpennathur	0.29	0.30	0.40	0.19	0.18	1.34	0.05	0.70	3.32	6.78
Nemili	0.48	0.50	0.52	0.41	0.37	2.12	0.09	1.45	5.61	11.55
Panapakkam	0.73	0.84	0.77	0.41	0.20	2.98	0.13	0.91	8.03	14.99
Peranamallur	0.34	0.28	0.51	0.32	0.23	1.99	0.09	1.08	3.64	8.47
Polur	0.32	0.38	0.58	0.08	0.28	1.50	0.06	0.86	6.99	11.05
Thellar	0.49	0.38	0.56	0.39	0.07	2.08	0.09	0.50	3.67	8.33
Thiruvathipuram (Cheyyar)	0.54	0.46	0.64	0.13	0.28	1.43	0.08	1.24	6.23	11.03
Tiruvannamalai	0.49	0.74	0.70	0.10	0.38	1.65	0.08	1.09	10.87	16.09
Vettavalam	0.35	0.22	0.55	0.23	0.13	1.36	0.05	0.84	4.63	8.38
Wandiwash	0.33	0.33	0.53	0.09	0.22	1.33	0.05	0.75	5.22	8.84
Centers and subregions outside the study region										
Kancheepuram	0.32	0.16	0.49	0.05	0.14	1.22	0.04	0.65	3.22	6.31
Solingar	0.28	0.05	0.45	0.05	0.09	1.14	0.00	0.99	3.10	6.15
Tirukovilur	0.35	0.35	1.11	0.00	0.35	2.07	0.00	2.46	7.47	14.15
Tirutani	0.25	0.03	0.47	0.11	0.09	0.78	0.00	0.64	2.29	4.66
Uthramerur	0.16	0.00	0.17	0.00	0.15	1.38	0.00	1.34	3.14	6.34
Average for the study region	0.39	0.51	0.59	0.11	0.30	1.48	0.06	0.99	7.64	12.08

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Information about the service centers outside the study region is incomplete.

Table 9—Ratios of subregional to study region scores for middle-order services

Center and Subregion	Education	Health	Communi-cation	Banking	Transport	Agricultural Inputs and Implements	Animal Husbandry	Marketing	Retail Trade	Total Services
Centers and subregions inside the study region										
Arkonam	0.897	1.490	0.983	0.818	1.767	1.122	1.500	1.697	1.406	1.359
Arni	0.897	1.137	0.898	0.818	0.833	0.899	0.667	0.697	1.105	1.017
Chetpet	1.179	0.804	1.085	1.182	1.233	0.926	1.833	0.990	0.791	0.871
Desur	1.974	2.196	1.966	6.545	0.500	2.527	3.167	2.283	0.874	1.391
Kalasapakkam	6.231	5.216	6.203	18.545	3.900	11.743	10.167	4.061	2.461	4.368
Kannamangalam	1.308	1.451	1.288	4.273	2.233	1.669	0.000	0.970	0.835	1.074
Kaveripakkam	1.000	2.176	0.949	2.182	3.000	0.932	1.167	2.018	1.963	1.796
Kilpennathur	0.744	0.588	0.678	1.727	0.600	0.905	0.833	0.707	0.435	0.561
Nemili	1.231	0.980	0.881	3.727	1.233	1.432	1.500	1.465	0.734	0.956
Panapakkam	1.872	1.647	1.305	3.727	0.667	2.014	2.167	0.919	1.051	1.241
Peranamallur	0.872	0.549	0.864	2.909	0.767	1.345	1.500	1.091	0.476	0.701
Polur	0.820	0.745	0.983	0.727	0.933	1.014	1.000	0.869	0.915	0.915
Thellar	1.256	0.745	1.119	3.545	0.233	1.405	1.500	0.505	0.480	0.690
Thiruvathipuram (Cheyyar)	1.385	0.902	1.085	1.182	0.933	0.966	1.333	1.253	0.815	0.913
Tiruvannamalai	1.256	1.451	1.186	0.909	1.267	1.115	1.333	1.101	1.423	1.332
Vettavalam	0.897	0.431	0.932	2.091	0.433	0.919	0.833	0.848	0.606	0.694
Wandiwash	0.846	0.647	0.898	0.818	0.733	0.899	0.833	0.758	0.683	0.732
Centers and subregions outside the study region										
Kancheepuram	0.821	0.314	0.831	0.455	0.467	0.824	0.667	0.657	0.421	0.522
Solingar	0.718	0.098	0.763	0.455	0.300	0.770	0.000	1.000	0.406	0.509
Tirukovilur	0.897	0.686	1.881	0.000	1.167	1.399	0.000	2.435	0.978	1.171
Tirutani	0.641	0.059	0.797	1.000	0.300	0.527	0.000	0.646	0.300	0.386
Uthramerur	0.410	0.000	0.288	0.000	0.533	0.932	0.000	1.354	0.411	0.525

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Information about the service centers outside the study region is incomplete.

Table 10—Service scores per square kilometer served for each high-order service center and the study region

Center and Subregion	Education	Health	Communi-cation	Banking	Transport	Agricultural Inputs and Implements	Animal Husbandry	Marketing	Retail Trade	Total Services
Centers and subregions inside the study region										
Arkonam	0.31	0.67	0.52	0.08	0.48	1.63	0.03	1.56	9.95	15.24
Arni	0.37	0.74	0.58	0.12	0.30	1.30	0.04	0.74	10.15	14.35
Chetpet	0.97	2.01	1.15	0.57	1.67	2.44	0.27	2.04	17.55	28.67
Polur	0.39	1.17	0.50	0.14	0.73	1.66	0.09	1.82	14.86	21.35
Thiruvathipuram (Cheyyar)	0.96	1.26	0.85	0.22	0.60	1.90	0.09	2.45	12.40	20.75
Tiruvannamalai	0.41	0.54	0.63	0.10	0.29	1.52	0.06	0.94	8.18	12.67
Wandiwash	0.37	0.43	0.50	0.10	0.27	1.35	0.04	0.77	5.95	9.78
Centers and subregions outside the study region										
Kancheepuram	0.35	0.18	0.51	0.08	0.15	1.47	0.05	0.78	3.50	7.07
Madras	0.33	0.18	0.48	0.13	0.15	1.60	0.05	1.04	3.49	7.45
Thindivanam	0.34	0.00	1.10	0.39	0.34	1.37	0.00	2.94	7.73	14.20
Tirutani	0.26	0.05	0.52	0.10	0.11	0.83	0.00	0.93	2.69	5.50
Vellore	0.23	0.08	0.46	0.06	0.10	1.28	0.06	0.48	2.82	5.57
Average for the study region	0.36	0.46	0.56	0.10	0.27	1.45	0.05	0.93	6.85	11.04

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Information about the service centers outside the study region is incomplete.

Table 11—Ratios of subregional to study region scores for high-order services

Center and Subregion	Education	Health	Communi-cation	Banking	Transport	Agricultural Inputs and Implements	Animal Husbandry	Marketing	Retail Trade	Total Services
Centers and subregions inside the study region										
Arkonam	0.861	1.457	0.929	0.800	1.778	1.124	0.600	1.677	1.453	1.380
Arni	1.028	1.609	1.036	1.200	1.111	0.897	0.800	0.796	1.482	1.300
Chetpet	2.694	4.370	2.054	5.700	6.185	1.683	5.400	2.194	2.562	2.587
Polur	1.083	2.543	0.893	1.400	2.704	1.145	1.800	1.957	2.169	1.934
Thiruvathipuram (Cheyyar)	2.667	2.739	1.518	2.200	2.222	1.310	1.800	2.634	1.810	1.880
Tiruvannamalai	1.139	1.174	1.125	1.074	1.074	1.048	1.200	1.011	1.194	1.148
Wandiwash	1.028	0.935	0.893	1.000	1.000	1.000	0.800	0.828	0.869	0.886
Centers and subregions outside the study region										
Kancheepuram	0.972	0.391	0.911	0.800	0.556	1.014	1.000	0.839	0.511	0.640
Madras	0.917	0.391	0.857	1.300	0.556	1.103	1.000	1.118	0.509	0.675
Thindivanam	0.944	0.000	1.964	3.900	1.259	0.945	0.000	3.161	1.128	1.286
Tirutani	0.722	0.109	0.929	1.000	0.427	0.572	0.000	1.000	0.393	0.498
Vellore	0.639	0.174	0.821	0.600	0.370	0.813	1.200	0.516	0.412	0.505

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Information about the service centers outside the study region is incomplete.

order services are examined here, as an example, but each of the other services could be looked at in a similar manner.

As can be seen in Table 9, the ratios of total service provision in the subregions vary. Of the subregions with below-average infrastructural development (values of less than 1.00), there are three subregions (Nemili, Polur, and Thiruvathipuram (Cheyyar) with values of 0.913-0.956; one (Chetpet) with a value of 0.871; two (Peranamallur and Wandiwash) with values of 0.701 and 0.732; two (Thellar and Vettavalam) with values of 0.690 and 0.694, and one (Kilpennathur) with a value of 0.561.

If one were to divide these values into four equal parts, those subregions with values up to 0.249 would be categorized as the most poorly developed infrastructurally; those with values from 0.250–0.499 would be more poorly developed; those with values from 0.500–0.749, poorly developed; and those with values of 0.750–0.999, the least poorly developed subregions. Nevertheless all are "poorly developed" subregions because their ratio values are less than 1.00.

Once the exercise below on median population thresholds is completed, two approaches can be taken to fill in these gaps. In the one termed "equity" approach, the most poorly developed subregions are invested in first and the least poorly developed subregions last. The second, the "efficiency" approach, begins with investment in the least poorly developed subregions first and ends with the most poorly developed subregions.

In geographical terms, the objective of the exercise is to bring all poorly developed subregions up to a ratio of 1.00, thus ensuring overall development of the study region. For the current exercise, however, the efficiency approach, where investment begins with the least poorly developed subregions, is recommended because it is less costly and less time-consuming to bring subregions up from 0.750 to 1.00 than it is to bring them up from 0.249 to 1.00.

The question of how one should go about identifying the settlements in which such gaps exist within the subregions is tackled in the section below on median population thresholds. What these levels of rural service infrastructural development mean for the sample villages and for the sample households in overall availability of and accessibility to these services is briefly noted in the section on the regional context of service provision, later in this chapter.

Determination of Median Population Thresholds

The search for quantitative estimates of the entry level of various services in a regional settlement system is important for settlement studies.[14] The logic of central place theory suggests that such thresholds must exist, but their exact definition remains elusive. One major reason for this elusiveness is the complexity of locational decisions. Services are established in a given settlement for a variety of reasons, of which population size is an important but not necessarily overriding factor. As a result, the simple concept of "entry level" must be replaced by "entry zone," at the

[14]This analysis is based on a method used by Haggett and Gunawardena (1964) in rural Ceylon (now Sri Lanka).

lower limits of which all the settlements lack the service, and at the upper limits, all settlements possess it. Therefore, estimates of population thresholds should be designed to include cases where no settlement has a service and, conversely, cases where all settlements have the service.

The Reed-Muench method of determination of median population thresholds of services is used with some modifications for North Arcot district (Haggett and Gunawardena 1954). This analysis, unlike previous studies, uses the percentage of settlements with or without services rather than their absolute numbers in determining the median population thresholds.

Some 42 services were eliminated from the analysis because too few or too many settlements had these services. For instance, all but 13 settlements have a primary school; at the other extreme, no settlement had a technical or professional college. The list of services eliminated from the analysis is given in Table 12.

For 25 services, both the distribution of settlements and of settlements with services, with respect to population size, appear to be normal enough to calculate median population thresholds with a high degree of confidence (Table 13). This leaves 67 services whose geographical distribution relative to population size did not conform well to the original assumptions. These services are divided into three groups: the first consists of services that are not available in all the settlements with populations above the upper threshold. The second consists of services that almost all settlements have. The final group of services poses a difficult problem because they show a declining tendency for the function to exist in higher population categories, rather than an increasing tendency. Because the number of settlements with larger populations is small, in the final group of services a single settlement having or not

Table 12—Services eliminated from the median threshold analysis

Reason for Elimination	Number of Services	Name of Services
Less than 2.5 percent of the settlements have the service	39	College, pathological and radiological tests, land development bank, transport of goods by road, passenger train service, transport of goods by train, purchase of electric motors, purchase of electric pumpsets, purchase of oil engines, purchase of sugarcane crushers, purchase of sprayers, purchase of dusters, purchse of threshers, servicing of threshers, servicing of tractors, servicing of cage wheels, sale of turmeric, medical shops, glassware, footwear, bicycle retail, timber, hardware, steel furniture, opticals, watch retail, radio retail, transistor sales, scooter repair, automobile repair, petrol, diesel fuel, and lubricants, jewelry, foreign liquor, bookbinding, printing, leather goods, photography
More than 97.5 percent of the settlements have the service	2	Primary school, retail petty shop
Very unreliable distributional data	1	Key village center

Source:

Table 13—Services for which median thresholds were calculated with minor modifications of the assumptions

Service	Median Population Threshold
Middle school	3,180
High school	5,400
Higher secondary school	7,040
Family planning camp	7,510
Private hospital	6,960
Postal order	5,210
Telegrams	6,250
Radio license	4,500
Tractor rental	4,810
Servicing of electric motors	5,210
Servicing of electric pumpsets	5,440
Servicing of oil engines	6,170
Servicing of sprayers	6,190
Servicing of dusters	6,300
Fertilizers and pesticides	5,340
Veterinary dispensaries	6,780
Sale of vegetables	6,510
Sale of bajra	6,730
Sale of jowar	6,290
Sale of pulses	7,370
Retail cloth shop	5,550
Ready-made garments	7,140
Electrical goods	6,780
Wooden furniture	2,950
Sweet shops	6,990

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Median population thresholds are rounded to the nearest 10.

having a service can have a dramatic effect on the overall distribution of services (see Table 14).

These peculiarities in the actual distribution of services in the study region were kept in mind when calculating the median population thresholds of these services. Table 15 shows the number of settlements from the study region that have the required population threshold for a given service, but do not have the service. These locational gaps in the service provision structure can also be seen as potential that needs to be developed before long, in order to strengthen the service delivery system.[15] It is expected that once these gaps are filled, the delivery system itself will be better articulated and be better equipped to serve the study region.

[15]Some of these services are provided by the government and others by the private sector, and the implications of this analysis are different for each. For the government sector, recommendations regarding some location of services could be made, which would form the basis of a plan for their provision. For the private sector, however, the analysis notes the possible locations for provision of such services. No specific plans for their provision could be made because other factors also govern their locations.

Table 14—Services for which median thresholds were calculated with major modifications of the assumptions

Service	Median Population Threshold	Service	Median Population Threshold
Services with very high threshold values		Barber	860
Family planning clinic	7,330	Bakery	1,920
Primary health center	7,730	General provisions	2,180
Nationalized bank	8,030	Pottery	1,100
Rental of sugarcane crushers	5,880	Bicycle repair	1,820
Servicing of sugarcane crushers	8,920	Fuel	1,620
Sale of paddy	8,730	Bricks/tiles	1,570
Sale of castor	8,430	Stone	2,800
Sale of groundnuts	8,890	Arrack shop	1,280
Sale of chilies	8,330	Purchase of fruits	2,420
Sale of tamarind	8,580	Purchase of poultry products	1,120
Household utensils	7,250	Purchase of meat products	1,700
Cement	8,650	Purchase of dairy products	880
Lime	7,330	Services with very skewed distributions	
Watch repair	7,990	Government hospital	9,720
Radio repair	7,740	Postage	1,360
Furnishings	8,180	Money order	1,730
Services with very low threshold values		Registration	1,750
Allopathic clinics	3,470	Telephone	4,860
Passenger bus service	2,380	Primary cooperative credit society	4,330
Retailing of tools	1,841	Lead bank	8,670
Rental of implements	1,190	Retailing of implements	8,280
Rental of oil engines	3,270	Seeds	6,500
Rental of sprayers	2,040	Sale of fruits and coconuts	9,420
Rental of dusters	3,060	Sale of other oilseeds	9,480
Rental of threshers	5,940	Sale of sugarcane	10,510
Rental of cage wheels	5,260	Sale of jaggery	10,510
Rental of tools	1,150	Sale of firewood	9,027
Servicing of implements	1,370	Stationery	6,520
Blacksmith	930	Retail of vegetables	3,510
Carpenter	960	Cold drinks	1,290
Cobbler	900	Restaurants	3,270
Tea and coffee shop	1,190		
Laundry	910		

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Relationship between Hard and Soft Infrastructural Services

The literature on rural infrastructure implies that the availability in a settlement of soft infrastructural services such as education, health, communications, banking, agricultural inputs, animal husbandry, agricultural marketing, and retail services is dependent on the availability of hard infrastructure such as roads, as well as on the settlement's population. These hypotheses are tested using 15 logit regressions, for which the dependent variable is the availability of a soft infrastructural service in a settlement. The 15 dependent variables (services) include high school, primary health center, government (public rather than private) hospital, post office, telegraph office,

Table 15—Number of settlements having the median threshold population but not having the service

Service	Number of Settlements Lacking the Service	Service	Number of Settlements Lacking the Service
Education services		Marketing services	
Primary school	13	Sale of vegetables	3
Middle school	12	Sale of fruit	3
High school	4	Sale of paddy	2
Higher secondary school	2	Sale of bajra	2
Health services		Sale of jowar	2
Allopathic clinic	12	Sale of pulses	2
Family planning camp (mobile)	2	Sale of castor	2
Family planning clinic	3	Sale of groundnuts	2
Primary health center	2	Sale of oil seeds	2
Private hospital	2	Sale of sugarcane	1
Government hospital	2	Sale of jaggery	1
Communication services		Sale of chilies	2
Postage	37	Sale of tamarind	1
Money order	29	Sale of poultry products	24
Registration	27	Sale of dairy products	16
Postal order	4	Sale of firewood	2
Telegrams	4	Retail services	
Radio license	6	Blacksmith	41
Telephone	6	Carpenter	43
Banking services		Cobbler	40
Primary cooperative credit society	6	Petty shop	11
		Tea and coffee shop	2
National bank	2	Laundry	32
Lead bank	1	Barber	38
Transportation service		Bakery	25
Passenger bus service	24	General provisions	28
Agricultural input and implement services		Ready-made garments	27
		Household utensils	3
Tools, purchase	51	Pottery	59
Implements, rental	3	Electrical goods	2
Tools, rental	69	Bicycle repair	33
Implements, purchase	68	Fuel	53
Oil engines, rental	15	Bricks/tile	54
Sugarcane crushers, rental	5	Cement	2
Sprayers, rental	28	Stone	23
Dusters, rental	19	Lime	3
Threshers, rental	3	Wooden furniture	25
Tractors, rental	4	Stationery	2
Cage wheel, rental	5	Bicycle retail	2
Tools, servicing	49	Watch repair	2
Implements, servicing	55	Radio repair	2
Electric motors, servicing	6	Transistor repair	2
Electric pump set, servicing	5	Arrack shops	44
Oil engines, servicing	4	Sweet shops	2
Sugarcane crushers, servicing	3	Purchase of vegetables	14
Sprayers, servicing	4	Purchase of fruits	34
Dusters, servicing	4	Purchase of poultry products	46
Seeds	2	Purchase of meat products	50
Fertilizers and pesticides	4	Purchase of dairy products	34
Animal husbandry services		Cold drinks	21
Veterinary dispensary	2	Restaurant	14

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

lead bank, agricultural implements shop, seeds shop, fertilizer shop, veterinary dispensary, agricultural markets for paddy and groundnuts, cloth shop, electrical goods shop, and furnishing stores, and the independent variables are population of the settlement and the settlement's distance to bus service, which is used as a proxy for the hard infrastructural services such as roads and road networks, and which is itself a direct measure of transportation infrastructure.

The logit function describes a relationship in which the probability of a situation existing rises at an increasing rate with increases in the values of dependent variables until a 50-50 chance is reached and rises at a decreasing rate thereafter. It is assumed that once the value of an independent factor becomes so large that the dependent situation is almost guaranteed, further increases have very little additional effect; similar logic applies as the lower bound is approached. This assumption fits well with the way that factors are expected to contribute to location decisions.

As can be seen from the regression results in Table 16, the variable for distance to a bus stop from the settlement has a negative and statistically significant impact on the availability of 8 of the 15 soft infrastructural services. The sign is in the right direction for the other 7 services but is not statistically significant.[16] However, the population of the settlement has a positive and statistically significant effect on the availability of all the soft infrastructural services.[17] It should be recognized that the coefficients represent the direct effects of access to and population of the settlement on location of the specific service, but also include their indirect effects on location of other services, which may result in greater demand for the specific service through an increase in consumers' income and the area's commerce.

Simulating a 1 kilometer increase in distance to the bus stop (for example, from 0.7 to 1.7 kilometers) for an average size settlement (say, 1,953 persons), the probability of a service being present would change from 12 percent to 6 percent for a high school, from 2 to 1 percent for a primary health center, from 2 to 0 percent for a post office, from 25 to 23 percent for a telegraph office, from 2 to 1 percent for a lead bank, from 11 to 7 percent for a fertilizer shop, from 3 to 1 percent for a veterinary dispensary, and from 4 to 3 percent for groundnut marketing (Table 16).[18] These figures suggest the magnitude of the effect of limited access to transportation infrastructure on location of other services.

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[16]Similar results are observed using probit regressions: the distance to a bus stop has a negative and statistically significant effect on the availability of 5 of the 15 services.

[17]The positive and statistically significant effect of population on the availability of all 15 services is also observed when probit regressions are used.

[18]The base probabilities are derived by calculating $P = 1/[1 + e^{-(a + b_1x_1 + b_2x_2)}]$, using the coefficients presented in Table 16, the mean population in thousands of persons (1,953), and the mean distance in kilometer (0.7). The probabilities after a 1-kilometer increase in distance from the settlement to the nearest bus stop is derived by again calculating P, but replacing the mean distance (0.7) with the greater distance (1.7) and retaining the mean population (1,953). The base equation is

$$P = 1/[1 + e^{-(a + b_1 \times 1{,}953 + b_2 \times 0.7)}].$$

The equation for the greater distance is

$$P = 1/[1 + e^{-(a + b_1 \times 1{,}953 + b_2 \times 1.7)}].$$

Table 16—Logit regression analysis of availability of soft infrastructural services in the study region

Services	Coefficient of Population	Coefficient of Distance to Bus Stop	Constant
	(thousands)	(kilometers)	
High school	0.6576*	-0.7652*	-2.7227*
	(5.970)	(-3.512)	(-9.637)
Primary health center	0.5855*	-0.8810*	-4.5435*
	(4.808)	(-2.543)	(-9.447)
Government hospital	0.4113*	-15.8540	-4.0106*
	(3.668)	(-0.009)	(-9.414)
Post office	1.0768*	-2.8645*	-4.2083*
	(7.057)	(-2.509)	(-10.072)
Telegraph office	0.6621*	-0.1352*	-2.2660*
	(6.156)	(-2.470)	(-9.094)
Lead bank	0.5628*	-0.7087*	-4.3370*
	(4.800)	(-1.553)	(9.982)
Agricultural implements shop	0.3245*	-0.2203	-3.0815*
	(3.458)	(-1.202)	(10.206)
Seed shop	0.6172*	-0.0719	-3.5128*
	(5.759)	(-0.567)	(11.201)
Fertilizer shop	0.7029*	-0.5288*	-3.1320*
	(6.182)	(-2.673)	(-10.275)
Veterinary dispensary	0.6165*	-0.8380*	-3.9492*
	(5.234)	(-2.068)	(-10.233)
Agricultural marketing of paddy	0.4426*	-0.3862	-3.8180*
	(4.280)	(-1.355)	(-10.268)
Agricultural marketing of groundnuts	0.4193*	-0.3933*	-3.7516*
	(4.086)	(-2.357)	(-10.199)
Cloth shop	1.0372*	-17.7240	-4.3250*
	(6.506)	(-0.011)	(-9.637)
Electrical goods shop	0.9468*	-16.3010	-5.2490*
	(5.472)	(-0.010)	(8.873)
Furnishings shop	0.5918*	-15.4850	-4.8210*
	(4.636)	(-0.009)	(-9.176)

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Numbers in parentheses are t-statistics.
*Difference from zero is significant at the 0.05 level.

Regional Context of Service Provision

Analysis of regional patterns has shown that a hierarchy of soft and hard infrastructural service provision underlies the hierarchy of settlements in the study region. This has given rise to three distinct levels of service centers and spatial interaction between settlements. The analysis has also shown that there are different levels of development of soft and hard infrastructural services even within the subregions of

the study region. Which services are above or below the average for rural service infrastructural development can be identified not only for the total but also for individual services. Finally, the analysis has shown that poor access to hard infrastructural services in a settlement influences negatively and significantly the availability of soft infrastructural services, and it has also shown that population of the settlement influences positively and significantly the availability of soft infrastructural services.

It is fair to expect that a sample village located in a subregion with above-average infrastructural development would have an advantage over one not so favorably located. All the sample villages, for example, are low-order service centers in their own right. For middle- and high-order services, however, they interact with one or more larger service centers. For example, Vegamangalam is served by Kaveripakkam for middle-order services and by Kancheepuram for high-order services, but Nesal is served by Arni for both middle- and high-order services. In this sense, the sample villages "belong" to certain service centers in the study region. Further, the inhabitants of Nesal village do not have to travel a greater distance than those of Vegamangalam to use the services available in their respective service centers. In addition, the ranking of service centers themselves, at the middle and high levels of service hierarchy, adds to the totality of the regional infrastructural context as far as the sample villages are concerned. For example, Kaveripakkam is a less important service center than Arni at the middle level of the service hierarchy. Therefore, in a regional infrastructural context, Nesal village is superior to Vegamangalam, which makes a great deal of difference in overall availability of and access to services for the inhabitants of these villages.

Central Place Theory and Provision of Services in the Study Region

The foregoing analysis of regional provision and use of services at the settlement level has demonstrated that the principles of central place theory apply to the study region. In the study region, there is a hierarchy of central functions (services) that underlies and explains the hierarchy of central places (service centers). There are complementary regions (subregions) of central places, where the highest order (most important) central place has the greatest number of central functions, the largest service population, and the largest number of smaller central places (dependent settlements) served.

The highest-order central place thus provides all the central functions of the lower-order central places and also provides one or more of the higher-order central functions, which clearly distinguish it from the lower-order central places.

In addition to identifying the high-order central places with a centrality surplus and their centrality-deficit complementary regions, the analysis also finds that between the complementary regions there are centrality-surplus and centrality-deficit subregions.

The analysis has also demonstrated that there are no hexagonal complementary regions and that the number of lower-order central places that exist for each of the higher-order central places is determined by the interplay of marketing and transport

principles at the lower levels of the central place hierarchy, and by the interplay of marketing, transport, and adminstrative principles of the central place theory at the higher levels of the central place hierarchy.

Further, the analysis shows that there is a *range* of central functions (area served by the services) and a *threshold* of central functions (median population necessary to support a service) for all central functions in the study region.

Finally, the analysis has demonstrated that the structure of provision of central functions (services) in the study region has implications for access to them as far as the settlements and the households in the study region are concerned. This access can (and as it will be seen in the next chapter, does) influence the pattern of consumption of the central functions in the study region.

There are two important differences in the approaches taken by the central place theory of Christaller and by this study. The less important of the two, theoretically, is the choice of the study region. Christaller bases his study on the rural regions of southern Germany in the early 1930s: this study is based on the rural regions of southern India in the early 1980s. But the nature of the studies themselves constitutes the more important difference. Christaller's formulation is deductive, proceeding from the top to the bottom, whereas this study is inductive, using grassroots data to identify the structure of the central place hierarchy and system in the study region.

5

HOUSEHOLD PATTERNS OF SERVICE USE

Household use of services depends upon a variety of factors such as distance to services, types of households, their socioeconomic status, and the end use of the services. This chapter aims to understand how households in the study region use services and attempts to integrate these findings with those of the previous chapter to identify locational priorities for investment in rural service infrastructure in the study region.

Sample Households, Sample Villages, and Services

According to an earlier study, the socioeconomic status of a household, as well as the distance to services, influences a household's pattern of use of services in a variety of ways (Wanmali 1985). In that study, however, no data were available on household expenditure patterns to estimate the impact of access on a household's use of services. This finding is investigated here with the help of expenditure data from 11 sample villages of the study region.

The four types of households included in the study use the following number of services from a total number of 134: paddy farm operator, 105; nonpaddy farm operator, 75; cultivation laborer, 77; and noncultivator, 79. The use of these services in the villages wherein the households are located is diverse.

Five villages—Amudur, Kalpattu, Nesal, Veerasambanur, and Vengodu—have a better than average regional service provision structure (Table 17). To obtain various input, output, and transportation services, the sample households have to travel various distances from the village (Table 18).

Such measures of socioeconomic status as family size, per capita land cultivated, land irrigated, access to credit, value of livestock owned, average value of household goods and agricultural implements, and average expenses were found to be directly correlated with the size of an operational landholding in the previous study (Wanmali 1985). In the following descriptive analysis, therefore, the household's involvement in cultivation is considered to be a proxy for the socioeconomic status of the household.

Geographical Relationships of Patterns of Service Use

Tables 19-22 capture in detail the patterns of use of groups of services of the four types of households. Mean frequency of use of each service group, mean

Table 17—Location of services used by sample villages

Sample Village	Number of Services Within Village	Number of Services Outside Village	Percent of Services Located Outside Village
Amudur	45	42	48.28
Duli	31	67	68.37
Kalpattu	54	45	45.45
Meppathurai	39	52	57.14
Nesal	54	63	53.85
Sirungathur	34	59	63.44
Vayalur	34	65	65.66
Veerasambanur	43	33	43.42
Vegamangalam	47	59	55.66
Vengodu	51	34	40.00
Vinayagapuram	37	56	60.22

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

distance traveled, and the number of households using the services are included. There is sometimes an inverse relationship between mean frequency of use of services and the mean distance to services.

When the use of individual services within the major groups of services is categorized by type of household (Table 23), it can be seen that some services are heavily used by all households—farm or nonfarm. These services include primary schools, allopathic clinics, primary health centers, government hospitals, postage, primary cooperative credit societies, bus transport, retail petty shops, retail cloth shops, tea and coffee shops, barber shops, general provision shops, household utensil shops, medical shops, lime shops, pottery shops, fuel shops, furnishings shops, vegetable shops, meat shops, cold drinks shops, and restaurants. As is

Table 18—Distance to nearest input and output markets and bus stop, by sample village

Sample Village	Seed Distributor	Fertilizer Distributor	Credit Lender	Output Buyer	Bus Stop
			(kilometers)		
Amudur	10.0	15.0	15.0	10.0	4.0
Duli	6.2	6.4	5.0	5.0	1.0
Kalpattu	8.0	15.0	15.0	8.6	1.0
Meppathurai	6.4	17.0	17.0	6.4	2.0
Nesal	6.5	10.5	6.5	6.5	2.0
Sirungathur	7.0	7.0	7.0	7.0	0.7
Vayalur	6.4	19.0	17.0	6.4	1.0
Veerasambanur	7.0	17.0	15.0	7.0	1.0
Vegamangalam	6.0	18.0	6.0	6.0	3.0
Vengodu	9.5	17.0	17.0	10.0	6.5
Vinayagapuram	11.5	13.0	13.0	13.0	3.0

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Table 19—Mean frequency of service use, number of households using service, and mean distance traveled to service, paddy farm households

Distance (kilometers)	Education		Health		Communication		Banking		Transport		Agro-Inputs		Animal Husbandry		Marketing		Retail		Total	
	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households
< 2	192.45	35	11.13	52	8.23	41	2.55	37	39.00	51	12.98	51	1.70	31	92.30	50	657.49	53	113.09	53
2 – 4	255.00	30	14.08	40	14.00	32	3.50	27	53.03	39	14.45	38	1.95	28	130.18	38	686.13	40	130.26	40
4 – 6	193.10	19	13.86	29	17.00	24	4.62	21	66.41	29	13.86	29	1.97	23	44.93	29	688.69	29	116.05	29
> 6	268.75	26	12.03	32	12.41	22	8.31	20	72.13	31	17.88	32	2.38	26	128.78	32	669.50	32	132.46	32

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Mean use represents the mean number of times a service is used per year.

Table 20—Mean frequency of service use, number of households using service, and mean distance traveled to service, nonpaddy farm households

Distance (kilometers)	Education		Health		Communication		Banking		Transport		Agro-Inputs		Animal Husbandry		Marketing		Retail		Total	
	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households
< 2	160.00	5	9.50	10	8.40	8	1.40	6	34.90	10	4.60	8	0.50	2	1.60	7	618.00	10	93.21	10
2 – 4	233.33	5	23.83	6	5.83	4	4.50	3	68.83	5	4.67	6	1.00	3	0.83	4	773.17	6	124.00	6
4 – 6	300.00	5	16.17	6	15.33	6	0.33	2	46.17	6	6.67	5	0.83	3	118.00	6	730.33	6	137.09	6
> 6	400.00	2	22.50	2	11.00	2	1.00	1	52.00	1	6.00	2	2.00	1	51.00	2	759.00	2	144.94	2

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Mean use represents the mean number of times a service is used per year.

Table 21—Mean frequency of service use, number of households using service, and mean distance traveled to service, cultivation laborer households

Distance (kilometers)	Education		Health		Communication		Banking		Transport		Agro-Inputs		Animal Husbandry		Marketing		Retail		Total	
	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households
< 2	100.00	27	17.50	67	5.50	49	0.10	4	20.68	65	1.41	32	0.76	15	36.32	12	620.34	68	89.18	68
2 – 4	142.86	7	6.36	13	7.57	9	0.21	2	20.57	14	3.79	8	0.50	3	40.14	6	874.36	14	121.82	14
4 – 6	122.22	17	8.08	36	6.64	20	0.17	3	25.33	36	1.92	14	0.61	11	22.14	8	560.75	36	83.10	36
> 6	200.00	2	8.75	4	10.50	3	5.50	2	71.75	4	3.00	1	1.50	1	100.50	2	613.00	4	112.72	4

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Mean use represents the mean number of times a service is used per year.

Table 22—Mean frequency of service use, number of households using service, and mean distance traveled to service, noncultivator households

Distance (kilometers)	Education		Health		Communication		Banking		Transport		Agro-Inputs		Animal Husbandry		Marketing		Retail		Total	
	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households	Mean Use	Number of Households
< 2	94.12	6	6.29	17	14.82	10	0.18	2	41.82	16	0.71	5	0.18	2	29.41	2	674.88	17	95.82	17
2 – 4	88.89	4	8.44	9	3.11	6	0.00	...	53.89	9	0.89	3	0.00	...	22.00	2	946.33	9	124.84	9
4 – 6	288.89	8	12.33	9	14.56	9	2.67	2	88.00	9	2.56	3	0.78	3	233.67	3	872.89	9	168.48	9
> 6	100.00	1	7.50	2	3.50	2	0.00	...	42.00	2	0.00	...	0.00	...	0.00	...	492.50	2	71.72	2

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Mean use represents the mean number of times a service is used per year.

Table 23—Percentage of households using each service, by household type

Service	Households Using Service			
	Paddy Farm Operator	Nonpaddy Farm Operator	Cultivation Laborer	Non-cultivator
	(percent)			
Primary school	66.57	59.00	37.25	51.61
Middle school	21.26	20.00	9.80	12.90
High school	22.05	20.00	2.94	6.45
Higher secondary school	2.36	5.00	0.98	3.23
College	3.94	0.00	0.98	0.00
Technical institute	0.00	0.00	0.00	0.00
Professional college	0.00	0.00	0.00	0.00
Allopathic clinic	46.46	40.00	46.08	54.84
Family planning camp (mobile)	0.00	0.00	0.00	0.00
Family planning clinic	0.00	0.00	0.98	0.00
Primary health center	37.01	30.00	35.29	22.58
Private hospital	74.80	55.00	27.45	51.61
Government hospital	66.14	65.00	70.59	70.97
Pathological and radiological tests	3.15	0.00	0.00	0.00
Postage	75.59	80.00	64.71	74.19
Money order	3.15	5.00	1.96	0.00
Registration	5.51	0.00	1.96	6.45
Postal order	1.57	0.00	0.98	0.00
Telegram	1.57	0.00	0.00	3.23
Radio license	9.45	5.00	0.98	9.68
Telephone	1.57	0.00	0.00	3.23
Primary cooperative credit society	60.63	40.00	1.96	3.23
Land development bank	18.11	5.00	0.00	0.00
Agriculture/cooperative bank	1.57	0.00	0.98	0.00
Commercial bank	5.51	0.00	0.98	0.0[illegible]
Nationalized bank	14.17	10.00	1.96	[illegible].45
Lead bank	10.24	5.00	3.92	0.00
Passenger bus service	99.21	95.00	97.06	96.77
Transport of goods by road	0.00	0.00	0.00	0.00
Passenger train service	10.24	5.00	4.90	3.23
Transport of goods by train	0.00	0.00	0.00	0.00
Purchase				
Tools	94.49	50.00	21.57	19.35
Implements	77.17	40.00	30.39	19.35
Electric motors	0.00	0.00	0.00	0.00
Electric pump sets	0.79	0.00	0.00	0.00
Oil engines	0.79	0.00	0.00	0.00
Sugarcane crushers	0.79	0.00	0.00	0.00
Sprayers	0.00	0.00	0.00	0.00
Dusters	0.00	0.00	0.00	0.00
Threshers	0.00	0.00	0.00	0.00
Tractors	0.00	0.00	0.00	0.00
Cage wheel	0.00	0.00	0.00	0.00
Purchase of seeds	88.98	45.00	4.90	3.23
Purchase of fertilizers	93.70	45.00	4.90	3.23
Rental				
Tools	14.96	20.00	2.94	0.00
Implements	16.54	35.00	1.96	0.00
Oil engines	0.00	0.00	0.00	0.00
Sugarcane crushers	0.79	0.00	0.00	0.00
Sprayers	85.04	15.00	4.90	3.23
Dusters	0.00	0.00	0.00	0.00

(continued)

Table 23—Continued

Service	Households Using Service			
	Paddy Farm Operator	Nonpaddy Farm Operator	Cultivation Laborer	Non-cultivator
	(percent)			
Threshers	12.60	0.00	0.98	0.00
Tractors	11.81	5.00	0.00	0.00
Cage wheel	3.15	0.00	0.98	0.00
Service				
Tools	92.91	50.00	16.67	19.35
Implements	75.59	30.00	31.37	19.35
Electric motors	39.37	5.00	0.00	0.00
Electric pump sets	39.37	10.00	0.98	3.23
Oil engine	8.66	0.00	0.00	0.00
Sugarcane crushers	0.79	0.00	0.00	0.00
Sprayers	0.79	0.00	0.00	0.00
Dusters	0.00	0.00	0.00	0.00
Threshers	0.00	0.00	0.00	0.00
Tractors	0.79	0.00	0.00	0.00
Cage wheel	0.00	0.00	0.00	0.00
Key village centers	15.75	15.00	3.92	3.23
Veterinary dispensary	61.42	25.00	21.57	12.90
Sale of				
Vegetables	9.45	5.00	0.00	0.00
Fruits	5.51	0.00	0.00	0.00
Paddy	90.55	15.00	4.90	3.23
Bajra	0.79	5.00	0.00	0.00
Jowar	3.15	0.00	0.00	0.00
Pulses	5.51	5.00	0.00	0.00
Castor	1.57	0.00	0.00	0.00
Groundnut pods	88.19	75.00	4.90	3.23
Other oilseeds	7.87	0.00	0.00	0.00
Sugarcane	4.72	0.00	0.00	0.00
Jaggery	0.79	0.00	0.00	3.23
Chilies	10.24	10.00	0.00	3.23
Turmeric	3.94	0.00	0.00	3.23
Tamerind	0.00	0.00	0.00	3.23
Poultry products	2.36	0.00	0.00	0.00
Dairy products	24.41	10.00	4.90	9.68
Firewood	0.00	0.00	9.80	9.68
Blacksmith	86.61	65.00	28.43	12.90
Carpenter	66.14	35.00	4.90	6.45
Cobbler	33.86	15.00	5.88	16.13
Petty shop	97.64	100.00	100.00	93.55
Retail cloth shop	98.43	95.00	99.02	96.77
Tea and coffee shop	45.67	60.00	63.73	67.74
Laundry	76.38	70.00	33.33	35.48
Barber	91.34	95.00	80.39	87.10
Bakery	50.39	40.00	30.39	45.16
General provisions	98.43	100.00	98.04	96.77
Ready-made garments	49.61	35.00	33.33	54.84
Household utensils	66.93	55.00	57.84	58.06
Medical shop	73.23	65.00	42.16	64.52
Glassware	18.90	15.00	10.78	9.68
Pottery	95.28	95.00	93.14	90.32
Electrical goods	58.27	20.00	20.59	19.35
Footwear	44.09	35.00	18.63	35.48
Bicycle sales	0.00	0.00	0.00	0.00
Bicycle repair	20.47	10.00	5.88	12.90
Timber	0.79	0.00	0.98	0.00

(continued)

Table 23—Continued

Service	Households Using Service			
	Paddy Farm Operator	Nonpaddy Farm Operator	Cultivation Laborer	Non-cultivator
	(percent)			
Fuel	90.55	95.00	82.35	93.55
Bricks/tiles	0.79	0.00	0.98	0.00
Cement	0.00	0.00	0.00	0.00
Stone	0.79	0.00	0.00	0.00
Lime	77.17	85.00	63.73	48.39
Hardware	62.99	5.00	5.88	16.13
Wooden furniture	0.00	0.00	0.00	0.00
Steel furniture	0.00	0.00	0.00	0.00
Opticals	0.00	0.00	0.00	0.00
Stationery	42.52	35.00	11.76	16.13
Watch sales	0.00	0.00	0.00	0.00
Watch repair	10.24	0.00	1.96	0.00
Radio sales	0.79	0.00	0.00	3.23
Radio repair	3.94	0.00	0.00	3.23
Transistor sales	0.00	0.00	0.00	0.00
Transistor repair	7.87	0.00	0.98	3.23
Scooter repair	0.00	0.00	0.00	0.00
Automobile repairs	0.00	0.00	0.00	0.00
Petrol, diesel fuel, lubricants	9.45	5.00	0.98	3.23
Jewelry	0.00	5.00	0.00	0.00
Furnishings	62.20	65.00	69.61	61.29
Arrack shop	23.62	35.00	38.24	41.94
Foreign liquor	6.30	0.00	0.00	3.23
Bookbinding	4.72	0.00	0.98	3.23
Printing	0.00	0.00	0.00	0.00
Sweet shop	33.07	25.00	5.88	16.13
Leather goods	3.15	0.00	0.98	0.00
Photography	3.15	0.00	0.98	0.00
Purchase of vegetables	89.76	100.00	98.04	96.77
Purchase of fruits	74.02	70.00	57.84	54.84
Purchase of poultry	18.90	10.00	17.65	16.13
Purchase of meat products	81.10	95.00	84.31	83.87
Purchase of dairy products	28.35	30.00	6.86	25.81
Cold drinks	57.48	55.00	50.00	61.29
Restaurants	65.35	60.00	54.90	67.74

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

expected, high-order services, which cost more, are used more by farm than nonfarm households. All agriculture-related services are also used largely by farm operators, but especially by paddy farm operators. Although all of these services are available in nearby service centers, not all of them are used by all households in equal measure.

Geographical Determinants of Service Use

In an earlier study, it was hypothesized that the frequency of use of services was influenced not only by the socioeconomic status of the households but also by

geographical factors such as the distance at which services are located from the household (Wanmali 1985). That study also noted that a more relevant indicator of service use than frequency of use, such as expenditure, would help to refine the analysis of the impact of access to services on household expenditure. In this section, this relationship is examined with the help of data on household spending on production and consumption goods and services.

In a separate survey of sample households, in which monthly data on income and expenditure were collected, details were obtained on several items of household expenditure (Hazell and Ramasamy 1991). These items sometimes form a complete set and sometimes only a part of the services considered in the present study. The analysis looks at household expenditures on consumption and production services, as well as on revenue from marketed crops. Consumption data were available from the monthly survey of expenditure for services, whereas data were available for only three production-related services: fertilizers, seeds, and credit. Data on revenue from marketed crops also came from the separate survey of sample households in the study region.

Grouping of Services

In order to determine what the expenditure patterns are and to predict responsiveness to changes in distance (measured by expenditure shifts), regression models are developed. Using data on expenditure and household characteristics, the models consider 35 services, grouped to examine distance and expenditure relationships. Low-, middle-, and high-order services form the geographical hierarchy set, and food and personal, consumer durables, health, and transportation services form the economic services set (Table 24). Both sets include the same 35 services, so considerable overlaps occur. This grouping of services, as well as some of the independent variables, is also based on geographical and not merely economic characteristics of services and settlements (see Table 25).

At this point, the reader must be reminded that, for the reasons given in Chapter 2, there is no information on prices of goods and services. Moreover, there is no point in including prices for inputs and outputs because the government administers prices for all of these goods, and the private sector sets its prices very close to the government-administered prices. The results of the analysis, therefore, need to be viewed with this qualification in mind.

The expenditure patterns of the two sets of services were calculated separately in order to obtain a clearer idea of the overlap that exists between them (Table 26). Both analyses cover the four types of households.

Expenditure Share Regressions

Dependent and Independent Variables. For each equation, the dependent variable is the budget share of expenditure for those services, rather than simply the expenditure incurred. This method avoids the estimation problems associated with heteroscedasticity, the increased variability that often occurs with increased total expenditures. Many household characteristics are included to help explain the expenditure patterns (Tables 25 and 27). The percent of households owning various types of vehicles in the village is included to reflect the effects on expenditure patterns of accessibility to various modes of transport (with differing speeds, ranges, and carrying capacities). This method lessens the chance of confusing

Table 24—Definition of service groups for budget share regressions

Service Group	Component Services	
Geographical hierarchy grouping		
Low order	Allopathic clinic	Fuel
	Bus stop	Arrack shop
	Petty shop	Purchase of vegetables
	Tea and coffee shop	Purchase of fruits
	Laundry	Purchase of poultry
	Barber	Purchase of meat
	Bakery	Cold drinks
	General provisions	Restaurant
Middle order	Passenger train service	Hardware
	Retail cloth shop	Wooden furniture
	Ready-made garments	Steel furniture
	Household utensils	Stationery
	Medical shop	Jewelry
	Electrical goods	Furnishings (mattresses)
	Footwear	Sweet shop
High order	Bicycle sales	Transistor sales
	Watch sales	Petrol, diesel, and lubricants
	Radio sales	
Economic services grouping		
Food and personal	Retail petty shop	Arrack shop
	Tea and coffee	Sweet shop
	Laundry	Purchase of vegetables
	Barber	Purchase of fruits
	Bakery	Purchase of poultry
	General provisions	Purchase of meat
	Medical shop	Cold drinks
	Fuel	Restaurant
Consumer durables	Retail cloth shop	Stationery
	Ready-made garments	Watch sales
	Household utensils	Radio sales
	Electrical goods	Transistor sales
	Footwear	Petrol, diesel, and lubricants
	Bicycle sales	Jewelry
	Hardware	Furnishings (mattresses)
	Wooden furniture	
	Steel furniture	
Health	Allopathic clinic	
Transportation	Bus stop	
	Passenger train service	

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

accessibility with household wealth, which might occur if each household's ownership of vehicles was measured. The distance to the nearest bus stop from the village is used as a measure of access to services. It is expected that expenditures for some services might be negatively influenced by poor access (longer distance) to bus services. An irrigation dummy variable is also included to reflect the influence of village agricultural conditions. The equations are estimated by two-

Table 25—Variables included in the expenditure share regressions

Variable	Definition
Dependent	
E	Per capita total expenditure (Rs)
LOWSHR	Low-order expenditure share
MIDSHR	Middle-order expenditure share
HIGHSHR	High-order expenditure share
FPSHR	Food and personal expenditure share
CDSHR	Consumer durables expenditure share
TRANSHR	Transport expenditure share
HEALSHR	Health expenditure share
Independent	
LOGE	Natural log of per capita total expenditure (Rs)
N	Household size (number of members)
LANDPER	Land owned per capita (hectares)
SEX	Sex of head of household (male = 1, female = 0)
ED	Education of household head (1 = above elementary)
PNADULT	Nonadults as percent of household members
PCH_HH	Young child as percent of household members
AGEHH	Age of household head (years)
CYCLE	Percent of households in village owning bicycles
CAR	Percent of households in village owning cars
MOTORCYC	Percent of households in village owning motorcycles or mopeds
TDIS	Distance to nearest bus stop (kilometers)
LDIS	Distance to nearest low-order service (kilometers)
IRRIDUM	Better irrigated village (yes = 1, no = 0)
PPDUM[a]	Paddy farm operator (yes = 1, no = 0)
NPDUM[a]	Nonpaddy farm operator (yes = 1, no = 0)
CLDUM[a]	Cultivation laborer (yes = 1, no = 0)

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

[a]Dummy variables are only used for regressions run on a weighted aggregation of samples.

Table 26—Per capita expenditures on service groups and share of total expenditure, by type of household

Service Group	Paddy Farm Operator		Nonpaddy Farm Operator		Cultivation Laborer		Noncultivator	
	Expenditure	Share	Expenditure	Share	Expenditure	Share	Expenditure	Share
	(Rs)	(percent)	(Rs)	(percent)	(Rs)	(percent)	(Rs)	(percent)
Geographical grouping								
Low order	405.0	56.0	626.0	83.0	477.0	89.0	694.0	88.0
Middle order	95.0	9.0	187.0	8.0	23.0	4.0	66.0	7.0
High order	3.8	0.3	0.0	0.0	2.7	0.3	3.7	0.4
Economic grouping								
Food and personal	376.0	53.0	600.0	80.0	469.0	87.0	668.0	86.0
Consumer goods	96.0	9.0	185.0	7.0	25.0	4.0	62.0	7.0
Transportation	21.5	2.5	15.8	2.2	6.5	1.3	28.1	2.6
Health services	6.5	1.1	5.8	1.6	1.9	0.4	3.8	0.6

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Table 27—Mean values of key variables included in the regressions, by type of household

Variable Description	Paddy Farm Operator	Nonpaddy Farm Operator	Cultivation Laborer	Non-cultivator
Per capita total expenditure (Rs)	752.90	874.32	550.32	789.78
Low-order expenditure share (percent)	56.15	83.17	88.56	87.68
Middle-order expenditure share (percent)	8.98	7.75	3.76	7.13
High-order expenditure share (percent)	0.31	0.60	0.25	0.43
Food and personal expenditure share (percent)	52.86	79.79	87.25	85.57
Consumer durables expenditure share (percent)	8.88	7.33	3.71	6.54
Transport expenditure share (percent)	2.58	2.24	1.27	2.56
Health expenditure share (percent)	1.12	1.58	0.37	0.57
Household size (number of members)	6.42	4.60	4.50	4.19
Land owned per capita (hectares)	0.78	0.30	0.01	0.01
Nonadult as percent of household members	0.35	0.28	0.28	0.30
Young child as percent of household members	0.32	0.24	0.35	0.40
Age of household head (years)	48.78	49.25	47.20	47.45
Sex of head of household (male = 1, female = 0)	0.94	0.90	0.79	0.77
Education of household head (1 = above elementary)	0.48	0.30	0.21	0.48
Distance to nearest bus stop	2.82	2.79	3.05	2.58
Distance to nearest low-order service	1.88	1.32	1.03	1.68
Percent of households in village owning bicycles	0.60	0.51	0.62	0.62
Percent of households in village owning cars	0.01	0.02	0.02	0.02
Percent of households in village owning motorcycle/mopeds	0.01	0.00	0.00	0.01
Better irrigated village (yes = 1, no = 0)	0.50	0.60	0.57	0.61

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

stage, least-squares regressions. All the equations are modifications of the Working-Lesser variation of the Engel function (Hazell and Roëll 1983):

$$E_i = \beta_i E + \delta_i E \ln E + \Sigma \lambda_{ij} E Z_j,$$

which is equivalent to

$$S_i = E_i/E = \beta_i + \delta_i \ln E + \Sigma \lambda_{ij} Z_j,$$

where

E_i is the per capita expenditure on an item,
E is total per capita expenditure,
Z_j is a household, village, access, or distance characteristic,
S_i is an item's share of total per capita expenditure, and
β, δ, and λ are coefficients.

If multicolinearity results from the inclusion of income and factors that have both direct effects on expenditure and indirect effects on expenditure through income, the

accuracy of the estimates may suffer; this may be a necessary shortcoming of using an Engel function to examine the effects of infrastructure. However, pairwise correlations do not indicate the existence of multicolinearity in the expenditure share regressions. As a check on the conclusions drawn from the Engel function, findings from the estimation of reduced-form equations are presented in Appendix 1.[19] By excluding the variable representing total expenditure, the previously mentioned problem of multicolinearity is eliminated. However, to separate income effects from other effects, only results from the Engel function are presented in the main text.

Interpretation of Regression Results. Statistically significant, two-stage, least-squares regression results are presented in Table 28 for paddy farm operators and Table 29 for nonpaddy farm operators. Separate regressions estimated for cultivation laborers and noncultivators are not statistically significant (insignificant F-value). The first-stage estimation results for per capita total expenditure (in natural log form) for each of the four household types is presented in Table 30. However, estimation of the Engel functions, using a weighted aggregation of all household types to transform sample proportions into an approximation of population proportions (roughly one-third farm operators, one-third cultivation laborers, and one-third noncultivators), indicates some statistically significant differences between the expenditure patterns of the four types of households. Budget share regressions are estimated for a weighted aggregation of samples include dummy variables for paddy farm operator (PPDUM), nonpaddy farm operator (NPDUM), and cultivation laborer (CLDUM) in place of per capita land owned, in order to contrast the expenditure patterns of noncultivation-oriented households with various types of cultivation-oriented households (see Appendix 2, Table 45 and Table 46, which includes the first-stage estimation results for the natural log of per capita expenditure by household type).

For nonpaddy farm households, only the share of consumer durables (including clothing) proves to be a constant proportion of total expenditure, as evidenced by a statistically significant intercept term. None of the intercept estimates are statistically significant for paddy farm regressions.

Statistically significant t-ratios for the natural log of total per capita expenditure are associated with middle-order goods and services, consumer durables, and transportation for nonpaddy farmers. As per capita income of nonpaddy farm households rises, expenditures on middle-order goods and services and consumer durables tend to increase, while expenditures on transportation decrease. These households consider consumer durables and middle-order goods and services to be superior and transportation inferior. No signs of inferiority or superiority are uncovered with the paddy farm regressions.

Nonpaddy farm households with more land owned per household member, all else being equal, tend to spend a smaller share on low-order goods and services, including purchased food and personal items, and a larger share on health goods and services. This indicates that, at least for nonpaddy farmers, land acquisition allows more food to be consumed from own production and frees cash earnings for

[19]Ideally, simultaneous estimation of Tobit equations should be conducted, but computer software was not available for Tobit models containing more than two equations.

Table 28—Regression coefficients for budget share equations, by service group, for paddy farm operators

Independent Variable	Dependent Variable						
	LOWSHR	MIDSHR	HIGHSHR	FPSHR	CDSHR	TRANSHR	HEALSHR
Constant	59.973	390.877	-32.773	-28.038	310.190	182.320	-28.801
	(0.173)	(0.618)	(-0.640)	(-0.069)	(0.565)	(0.812)	(-0.668)
LOGE	5.1225	-57.5210	4.7708	17.552	-45.478	-26.903	4.5304
	(0.099)	(-0.607)	(0.622)	(0.289)	(-0.553)	(-0.800)	(0.701)
N	-0.7618	-1.3705	0.1853	-0.4319	-1.0083	-0.8090	0.2375
	(-0.507)	(-0.499)	(0.834)	(-0.246)	(-0.423)	(-0.831)	(1.270)
LANDPER	-7.5505	16.0718	-0.6983	-11.235	13.241	7.0730	-0.6014
	(-0.567)	(0.661)	(-0.355)	(-0.721)	(0.627)	(0.819)	(-0.363)
PNADULT	0.4366	-27.2643	0.6818	3.8893	-24.2340	-8.3361	1.6301
	(0.023)	(-0.793)	(0.245)	(0.176)	(-0.812)	(-0.683)	(0.696)
PCH_HH	6.6197	1.7339	1.4327	5.4190	2.3657	0.1627	2.0992
	(0.625)	(0.090)	(0.915)	(0.437)	(0.141)	(0.024)	(1.592)
AGEHH	-0.0113	0.1310	-0.0263	-0.0320	0.0921	0.0836	-0.0407
	(-0.066)	(0.420)	(-1.043)	(-0.160)	(0.341)	(0.756)	(-1.917)*
SEX	0.0819	0.8307	0.9046	0.9291	1.7529	-1.5428	0.3446
	(0.015)	(0.082)	(1.107)	(0.144)	(0.200)	(-0.431)	(0.501)
ED	-4.7138	12.8999	-1.1830	-7.6820	10.3030	6.1208	-1.1542
	(-0.531)	(0.795)	(-0.901)	(-0.739)	(0.732)	(1.064)	(-1.044)
IRRIDUM	-5.3558	3.8497	-0.0470	-5.3830	3.1573	0.8358	0.3251
	(-1.044)	(0.410)	(-0.062)	(-0.895)	(0.388)	(0.251)	(0.509)
CYCLE	-50.617	-27.5131	3.6479	-40.670	-21.326	-14.842	1.3636
	(-1.844)*	(-0.548)	(0.898)	(-1.265)	(-0.490)	(-0.834)	(0.399)
CAR	78.365	-115.711	15.958	78.297	-86.449	-38.283	19.864
	(0.703)	(-0.568)	(0.968)	(0.600)	(-0.489)	(-0.530)	(1.431)
MOTORCYC	64.959	544.005	-54.903	-24.590	425.530	249.880	-74.010
	(0.113)	(0.517)	(-0.644)	(-0.036)	(0.466)	(0.669)	(-1.032)
TDIS	2.4156	-0.6061	-0.0972	2.3323	-0.6302	0.0555	-0.1088
	(3.352)*	(-0.460)	(-1.912)*	(2.762)*	(-0.551)	(0.119)	(-2.212)*

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Notes: The sample size of paddy farm operators is 154. The numbers in parentheses are t-ratios. The first stage of the two-stage, least-square regression is presented in Table 30. See Table 25 for definitions of the variables.

*Significant at the 0.10 level (two-tailed test).

health-related expenditures. Again, statistically significant effects are not apparent for paddy farmers.

The age composition of the household also matters for nonpaddy farmers. The larger the share of nonadults in the household, the smaller the portion of per capita expenditure allocated to low-order goods and services, purchased food and personal items, and transportation. Conversely, the larger the share of young children in the household, the larger the shares of expenditures on low-order goods and

Table 29—Regression coefficients for budget share equations, by service group, for nonpaddy farm operators

Independent Variable	Dependent Variable					
	LOWSHR	MIDSHR	FPSHR	CDSHR	TRANSHR	HEALSHR
Constant	101.4020	-61.5517	103.3570	-71.6540	25.5320	-13.7260
	(1.321)	(-1.590)	(1.306)	(-1.899)*	(1.609)	(-0.922)
LOGE	0.7401	10.5787	0.7277	12.3150	-3.5272	1.4230
	(0.072)	(2.040)*	(0.069)	(2.436)*	(-1.660)	(0.714)
N	0.4895	1.3718	-0.0182	1.5225	0.1468	0.0953
	(0.228)	(1.265)	(-0.008)	(1.441)	(0.331)	(0.229)
LANDPER	-24.8722	1.1439	-29.4487	0.1036	0.8412	3.8414
	(-2.798)*	(0.255)	(-3.211)*	(0.024)	(0.458)	(2.228)*
PNADULT	-41.4025	8.6569	-28.2521	7.1229	-8.7507	-2.4281
	(-2.836)*	(1.175)	(-1.876)*	(0.992)	(-2.900)*	(-0.858)
PCH_HH	56.4395	-6.5501	38.2988	-4.7834	3.4101	14.3090
	(3.005)*	(-0.691)	(1.977)*	(-0.518)	(0.878)	(3.929)*
AGEHH	0.3591	-0.1629	0.3916	-0.1617	-0.0607	0.0172
	(2.061)*	(-1.853)*	(2.179)*	(-1.887)*	(-1.686)	(0.509)
SEX	-15.8794	2.5937	-17.9383	1.1952	1.1364	2.1755
	(-2.228)*	(0.721)	(-2.440)*	(0.341)	(0.771)	(1.574)
ED	-2.9064	-7.2853	-6.0614	-8.0696	3.8468	0.3908
	(-0.553)	(-2.749)*	(-1.119)	(-3.124)*	(3.542)*	(0.384)
IRRIDUM	-17.4923	-2.0762	-19.2676	-3.8377	2.2671	1.5677
	(-2.377)*	(-0.559)	(-2.538)*	(-1.060)	(1.490)	(1.098)
CYCLE	4.9990	-18.9584	3.4686	-17.6800	-1.5862	0.4899
	(0.244)	(-1.836)*	(0.164)	(-1.757)	(-0.375)	(0.123)
CAR	-647.3590	484.8960	-649.4010	458.7600	49.1030	-4.3295
	(-4.082)*	(6.060)*	(-3.970)*	(5.883)*	(1.498)	(-0.141)
MOTORCYC	369.2950	248.9160	491.4390	264.5600	-5.9874	-144.9900
	(1.013)	(1.354)	(1.307)	(1.476)	(-0.079)	(-2.051)*
TDIS	2.1000	0.0706	2.0089	0.2959	-0.0567	-0.0413
	(1.968)*	(0.131)	(1.825)*	(0.564)	(-0.257)	(-0.200)

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Notes: The HIGHSHR coefficients were not included in this table because the F-tests were not significant. The first stage of the two-stage, least-square regression is presented in Table 30. See Table 25 for definitions of the variables. The numbers in parentheses are t-ratios. The sample size of nonpaddy farm operators is 24.

*Significant at the 0.10 level (two-tailed test).

services, purchased food and personal items, and health care. Although nonadults effectively demand less purchased food and personal items, younger children appear to receive more purchased food than their older siblings. And more health care is obtained for younger children. Children of all ages in nonpaddy farm households have less demand for fee-charging transport services.

Among paddy farm households, older household heads tend to spend a smaller share of income on modern health care, perhaps relying more on traditional reme-

Table 30—Coefficients of ordinary least squares regressions for per capita income equations, by type of household

Independent Variable	Dependent Variable = LOGE			
	Paddy Farm Operator	Nonpaddy Farm Operator	Cultivation Laborer	Non-cultivator
Constant	6.5349 (51.364)*	7.2775 (53.918)*	6.8674 (72.438)*	7.1036 (13.151)*
N	-0.0322 (-4.728)*	-0.1378 (-8.489)*	-0.0915 (-11.035)*	-0.0445 (-1.275)
LANDPER	0.2832 (12.095)*	0.3545 (3.916)*	-0.0135 (-0.085)	-0.5957 (-0.487)
PNADULT	-0.3520 (-3.194)*	-0.2033 (-1.410)	0.1740 (1.611)*	-0.1044 (-0.262)
PCH_HH	0.0328 (0.737)	-0.2331 (-1.218)	-0.1090 (-2.438)*	-0.0695 (-0.359)
AGEHH	0.0011 (0.697)	-0.0072 (-3.768)*	0.0043 (3.321)*	-0.0062 (-0.993)
SEX	-0.0064 (-0.104)	0.2434 (3.659)*	-0.1363 (-3.350)*	0.0293 (-0.123)
ED	0.2135 (4.985)*	0.4125 (5.991)*	0.0178 (0.396)	0.1792 (0.944)
CYCLE	-0.3057 (-2.753)*	1.0268 (-8.551)*	-0.8773 (-8.520)*	-0.2365 (-0.560)
CAR	-1.9820 (-2.476)*	4.3682 (13.683)*	-2.1611 (-3.066)*	-6.2075 (-2.737)*
MOTORCYC	7.7901 (3.298)*	2.7104 (4.274)*	7.8893 (4.448)*	12.1753 (2.307)*
IRRIDUM	0.1268 (2.114)*	0.2918 (4.449)*	0.1401 (2.728)*	0.0714 (0.404)
TDIS	-0.0019 (-0.224)	-0.0051 (-0.526)	0.0236 (3.363)*	-0.0113 (-0.437)
LDIS	-0.0613 (-0.832)	-0.5049 (-7.947)*	0.0933 (1.593)*	-0.1082 (-0.696)
Adjusted R^2	0.544	0.972	0.666	0.354
F	38.682	176.520	40.565	3.756
Sample size	154	24	122	37

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Notes: The numbers in parentheses are t-ratios. See Table 25 for a definitions of the variables.
*Significant at the 0.10 level (one-tailed test).

dies than households with younger heads. This pattern is not found among nonpaddy farm operators. Instead, older nonpaddy farm operators tend to spend a smaller share on middle-order goods and services and consumer durables but a larger share on low-order goods and services and purchased food and personal items. Day-to-day needs seem to be different for nonpaddy farmers—diversifica-

tion of expenditures might be constrained by a need to meet food requirements through cash purchases.

Male nonpaddy farmers spend a smaller share on purchased food and personal items than do female heads. This does not hold true for paddy farmers. It may be that a female's concern for feeding the family is more apparent when the acquisition of food requires cash, as appears to be the case for nonpaddy farm households. Female household heads are, therefore, more likely to allocate cash to food and personal expenditures when consumption from their own production is not adequate.

Higher-educated nonpaddy farmers spend more on transportation relative to consumer durables and middle-order goods and services. The relative magnitudes of the coefficients suggest that the educated also shift consumption toward consumption from their own production, since the coefficient for transportation is smaller than the coefficient for consumer durables.

In the better-developed villages, nonpaddy farmers produce more for their own tables and spend a smaller share of income on low-order goods and services such as purchased food and personal items. Irrigation development seems to increase self-sufficiency at the household level for nonpaddy farmers. This is probably a spurious result since there is no reason for the quality of irrigation to affect the behavior of farmers who do not have access to irrigation, except through the effect of village irrigation on household income, which has already been estimated (see Table 30).

Paddy farmers in villages where bicycles are more accessible tend to spend a smaller share on low-order goods and services and consume more from own production than those in villages with a smaller proportion of bicycle-owning households. However, nonpaddy farm households spend a smaller share on middle-order goods and services, particularly consumer durables. Bicycles may increase production by allowing more inputs to be transported to food crops, resulting in more consumption from own production by paddy farm households. Production on the unirrigated nonpaddy farms may also benefit, but not to such an extent that purchases of food are affected.

In villages where automobiles are more accessible, nonpaddy farm households spend less on the locally accessible low-order goods and services (including purchased food and personal items) and spend more on middle-order goods and services (including consumer durables). In addition to extending the range of travel, cars provide extra carrying capacity. However, it is not known why automobile accessibility has no observed effect on paddy farm households.

It is also a mystery why greater accessibility to motorcycles and motorscooters should lead to a lower share of income being spent on health services (specifically, allopathic clinics) by nonpaddy farm households. Although these vehicles are not ideal for transporting someone who is ill, their availability should be irrelevant; instead there is a negative effect.

Why the expenditure patterns of paddy and nonpaddy farm households are influenced by the distance to the nearest bus stop is not puzzling, however. Where bus service is less accessible, people cannot travel easily to distant markets. Therefore, they select from among the locally available low-order goods and services (including purchased foods and personal items). As expected, when buses are less accessible, paddy farm households (but not nonpaddy farm households)

spend a smaller share of their income on services in the high-order category and in the health category. The signs of the statistically significant variables are summarized in Table 31 for paddy and nonpaddy farm households.

Average and Marginal Budget Shares. Because paddy farm households consume more food from their own production than do other households, the average budget share for low-order goods is lower for paddy farm households than for any of the other household types (Table 32). Cultivation laborers spend a smaller share of total per capita expenditure on middle-order services, which include clothing and other consumer durables. All of the household types spend very little on high-order goods and services.

Paddy farm households also spend a smaller share of an incremental addition to per capita income on low-order goods and services than do nonpaddy farm households (Table 32). Thus, the trend will be for paddy farmers to continue to consume more from their own production. However, as paddy farm incomes increase, their demand for middle-order goods and services will expand at a faster rate than would be the case for nonpaddy farm households experiencing a similar increase in per capita income. Marginal budget shares are not calculated for cultivation laborers and noncultivators, because regression estimates were statistically significant for farm households only.

Expenditure share elasticities are calculated using the average and marginal budget shares. Most categories of cash expenditure are associated with elasticities of 1.0 or greater (Table 32). Higher incomes tend to shift consumption toward market purchases and away from consumption of own production. Thus, agricultural growth linkages are apparent for both paddy and nonpaddy farm households.

Marginal Expenditures and Elasticities with Respect to Distance. Given that the average total annual per capita expenditure for paddy farmers is Rs 752.90, the

Table 31—Signs for statistically significant regression coefficients for paddy and nonpaddy farm operators by service category

	Hierarchy Classification			Economic Classification			
Variable	LOWSHR	MIDSHR	HIGHSHR	FPSHR	CDSHR	TRANSHR	HEALSHR
Constant	...	...	...	...	- NP	...	...
LOGE	...	+ NP	...	...	+ NP	- NP	...
N	...	...	...	...	...	...	...
LANDPER	- NP	...	...	- NP	...	...	+ NP
PNADULT	- NP	...	...	- NP	...	- NP	...
PCH_HH	+ NP	...	...	+ NP	...	...	+ NP
AGEHH	+ NP	- NP	...	+ NP	- NP	- NP	- P
SEX	- NP	...	...	- NP	...	...	...
ED	...	- NP	...	...	- NP	+ NP	...
IRRIDUM	- NP	...	...	- NP	...	...	...
CYCLE	- P	- NP	...	...	- NP	...	...
CAR	- NP	+ NP	...	- NP	+ NP	...	...
MOTORCYC	...	...	...	...	...	...	- NP
TDIS	+ P, NP	...	- P	+ P, NP	...	...	- P

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Notes: P = paddy farmers, NP = nonpaddy farmers. See Table 25 for definitions of the variables. There are 154 paddy farmers and 24 nonpaddy farmers in the sample.

Table 32—Average and marginal budget shares and elasticities, by type of household

Service Group	Average Budget Share				Marginal Budget Share		Elasticity	
	Paddy Farmer	Nonpaddy Farmer	Cultivation Laborer	Non-cultivator	Paddy Farmer	Nonpaddy Farmer	Paddy Farmer	Nonpaddy Farmer
Low order	56.15	83.17	88.56	87.68	52.90	86.12	0.942	1.035
Middle order	8.98	7.75	3.76	7.13	13.88	8.83	1.546	1.139
High order	0.31	0.00	0.25	0.43	1.24	1.47	4.000	1.110
Food and personal	52.86	79.79	87.25	85.57	53.45	83.64	1.011	1.048
Consumer durables	8.88	7.33	3.71	6.54	15.17	11.55	1.708	1.575
Transport	2.58	2.24	1.27	2.56	1.05	2.52	0.407	1.125
Health	1.12	1.58	0.37	5.57	2.95	3.31	2.634	2.095

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

following marginal expenditures with respect to distance are derived from negative and statistically significant budget-share regression coefficients: −0.73 for high-order goods and services and −0.81 for health (allopathic clinics). These figures represent the change in expenditure in rupees for a 1-kilometer increase in distance to the nearest bus stop. Given a mean distance of 2.82 kilometers to the nearest bus stop and per capita expenditures of Rs 2.33 on high-order services and Rs 8.43 on health, the percentage change in expenditure brought about by a 1 percent increase in distance is described by the following elasticities: −0.88 for high-order services and −0.27 for health.

For policy purposes, the marginal value is probably more relevant. Expansion of bus access to rural paddy farmers may not have much effect at the household level, since the average paddy farmer need not travel more than 3 kilometers to catch a bus, and only two extra rupees would be spent per person on high-order goods and services if bus service were brought into the village. However, the location of the consumer services to which people travel may be more important, as is suggested by the following analyses of producer services. (Unfortunately, the locations of consumer services were highly correlated with each other, and services were located at widely varying distances from the villages. Therefore, distances to specific consumer services could not be used, and no meaningful measure of mean distances to services could be derived. So, distance to bus service was the most useful proxy for access to services.)

Demand Regressions for Input Services

Dependent and Independent Variables. Regression models were also developed to help explain the effects of access (based on distance) to inputs on the patterns of purchases of fertilizer, seeds, and credit. Using data from the separate income and expenditure study of North Arcot, the dependent variables chosen were the values of fertilizers, seed, and credit bought by the household, the latter being the amount of credit received for farming purposes (including loans for farmland, livestock, machinery, and other agriculture-related purchases). These estimations of effective demand are based on total value of fertilizer, seeds, or credit purchased by a household in one year. Note that the credit demand only includes loans received and not loans applied for but not approved.

The independent variables are basically the same as those in budget share equations, except LOGE, CLDUM, and NPDUM are excluded, and TRAILER is added (Table 33). For the input equations, the distance variables are the distances in kilometers to the nearest fertilizer, seed, and credit service centers, rather than distance to the nearest bus stop.

Interpretation of Regression Results. From the estimated regression coefficients for paddy farms (Table 34), it is evident that the amount of land owned has a positive effect on fertilizer, seed, and credit demand, with statistically significant t-scores for the fertilizer and seed equations. The education level of the household head has a positive and statistically significant impact on demand for seed. For seeds and credit, the distance to the nearest service centers providing these inputs does not significantly affect the demand for them. But it does have a statistically significant effect on fertilizer demand—the distances to fertilizer and credit services have negative effects on fertilizer demand. The regression result shows that for a 1-kilometer increase in the distance to the nearest fertilizer shop, there will be a

Table 33—Description of key variables included in input and output regressions, by type of household

Variable	Description	Paddy Farm Operator	Nonpaddy Farm Operator
Dependent		(Rs)	
SEEDS	Value of HYV seeds purchased	75.93	25.24
FERTILIZ	Value of fertilizer purchased	76.82	10.18
CREDIT	Value of credit borrowed	623.76	161.00
GVPAG	Value of marketed crop production	1,770.51	72.86
Independent			
LANDOWN	Owned land (hectares)		
N	Household size		
SEX	Sex of head of household (male = 1, female = 0)		
ED	Education of household head (1 = above elementary)		
PNADULT	Nonadults as percent of household members		
PCH_HH	Young child as percent of household members		
AGEHH	Age of household head (years)		
SEEDDIS	Distance from village to nearest seed market (kilometers)		
FERTDIS	Distance from village to nearest fertilizer market (kilometers)		
CREDTDIS	Distance from village to nearest credit services (kilometers)		
OUTPDIS	Distance from village to neareast output market (kilometers)		
TRAILER	Percent of households in village owning tractor trailers		
CYCLE	Percent of households in village owning bicycles		
CAR	Percent of households in village owning cars		
MOTORCYC	Percent of households in village owning motorcycle/mopeds		
IRRIDUM	Better irrigated village (yes = 1, no = 0)		
PPDUM[a]	Farm type (paddy = 1, nonpaddy = 0)		

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
[a]Only used for sample including paddy and nonpaddy farms.

Rs 24.70 decline in the value of the fertilizer purchased (a 4.3 percent decline for a 1.0 percent increase in distance). And there will be a Rs 25.97 decline for a 1-kilometer increase in the distance to the nearest credit source. For modes of transport, an increase in the percentage of households owning bicycles in a village will have a positive and statistically significant effect on demands for fertilizer and credit, because bicycles help farmers to reach services and to transport inputs more easily. However, the coefficient for the car ownership variable in the fertilizer demand equations was inexplicably negative and statistically significant. Finally, owning a motorcycle increases the demand for seeds just as bicycle availability increases the demand for other inputs.

Nonpaddy farm regressions are not significant; results for the weighted aggregation of paddy and nonpaddy farms conform to the separate paddy farm results. Approximately three-quarters of the farms are paddy farms. The inclusion of a dummy variable in the regression model did not reveal any statistically significant differences between paddy and nonpaddy farms (see Appendix 2, Table 47).

Demand Regression for Output Marketing Services

Dependent and Independent Variables. One final regression model was estimated in order to identify the effect of access to agricultural marketing on revenue from marketed crops. The independent variables include those used in the input

Table 34—Ordinary least squares regression coefficients for input demand equations, paddy-farm operators

Independent Variable	Dependent Variable		
	Seeds	Fertilizers	Credit
Constant	151.380 (0.839)	-239.860 (-1.877)*	0.36884 (1.189)
N	-2.041 (-0.412)	4.390 (1.255)	-0.00165 (-0.196)
LANDOWN	9.847 (3.055)*	8.570 (3.759)*	0.00544 (0.986)
PNADULT	-23.217 (-0.246)	29.635 (0.445)	-0.18483 (-1.143)
PCH_HH	-45.954 (-0.402)	-6.810 (-0.084)	-0.04034 (-0.206)
AGEHH	-0.497 (-0.405)	1.230 (1.419)	-0.02310 (-0.105)
SEX	-8.717 (-0.148)	-22.575 (-0.542)	-0.15493 (-1.534)
ED	62.561 (2.048)*	32.264 (1.497)	0.02714 (0.519)
SEEDDIS	-16.440 (-0.990)	12.400 (1.059)	-0.03473 (-1.223)
FERTDIS	-24.809 (-1.390)	-24.700 (-1.962)*	0.00678 (0.222)
CREDTDIS	23.294 (1.519)	-25.974 (-2.401)*	-0.00579 (-0.221)
TRAILER	-457.278 (-0.487)	401.106 (0.606)	-0.46238 (-0.288)
CYCLE	69.062 (0.748)	134.352 (2.064)*	0.27237 (1.725)*
CAR	697.364 (0.439)	-2,064.799 (-1.841)*	-2.66704 (-0.981)
MOTORCYC	7,922.825 (2.084)*	-2,223.880 (-0.829)	1.27653 (0.196)
IRRIDUM	64.461 (0.753)	1.648 (0.027)	0.13734 (0.938)
Adjusted R^2	0.20552	0.17385	0.02966
F	3.6215	2.9498	1.3111

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Notes: See Table 33 for definitions of the variables. The numbers in parentheses are t-ratios.
*Significant at the 0.10 level (one-tailed test).

demand equations, but the distance to the nearest output market replaces the other distances in the model (Table 33). The agricultural produce sold consisted of paddy and paddy straw, groundnuts and groundnut straw, ragi and ragi straw, and pulses and pulse straw.

Interpretation of Regression Results. For paddy farms the estimated regression coefficients are, as expected, positive and statistically significant for land owned and the percentage of households owning bicycles in the village, and the coefficient is negative and statistically significant for the distance to the nearest market center where farmers sell crops (Table 35).

As in the results of the input demand regressions, the output marketing regression shows that distance is an important factor influencing the revenue from the sale of crops. Thus, for a 1-kilometer increase in distance to the nearest output market, the revenue from marketed crops to the farmer is reduced by Rs 124.53, or 0.62 percent for a 1.00 percent increase in distance.

These results hold true for the weighted aggregation of paddy and nonpaddy farms. Land owned, distance to nearest market, and percentage of households owning bicycles remain statistically significant when nonpaddy farms are included (see Appendix 2, Table 48).

Household Patterns of Service Use and Regional Patterns of Distribution of Services

The foregoing analysis of household patterns of service use demonstrates the importance and significance of access to services in the determination of household use of these soft infrastructural services, whether consumer- or production-oriented. These findings, together with the analyses of regional and locational gaps, of the relationship between hard and soft infrastructural services, and of population thresholds of services presented in the previous chapter, could well form a useful basis for sound planning of the distribution system for production- and consump-

Table 35—Ordinary least squares regression coefficients for output market equation, paddy farm operators

Independent Variable	Marketed Output	
	Coefficient	t-Ratio
Constant	-3,816.50602	-1.182
N	66.71802	0.536
LANDOWN	336.33847	4.179*
PNADULT	671.11516	0.286
PCH_HH	1,774.05735	0.618
AGEHH	6.73866	0.222
SEX	115.26107	0.078
ED	538.09349	0.701
OUTPDIS	-124.52978	-2.449*
TRAILER	-10,865.84322	-0.499
CYCLE	4,225.46497	2.917*
CAR	-3,091.80798	-0.229
MOTORCYC	63,427.65031	0.741
IRRIDUM	2,514.55126	1.228
Adjusted R^2	0.24116	
F	3.22450	

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: See Table 33 for definitions of the variables.
*Significant at the 0.10 level (one-tailed test).

tion-oriented goods and services in the study region. Three examples taken from input marketing, output marketing, and health services illustrate this point.

Input Marketing. This example relates to fertilizer shops. The household-level analysis shows that the value of fertilizer purchased by a farmer would increase by Rs 24.70 if the shops providing fertilizer were 1 kilometer closer to the farmer's village. The regional findings presented in Table 13 indicate that the median population size at which these establishments appear in the regional settlement system is 5,340 persons. The regional results in Table 15 indicate that there are 4 settlements in the study region that have reached this median population threshold but do not have the service. It is therefore reasonable to recommend that investment in new fertilizer shops should be in these settlements. The regional findings in Table 9 show that in 7 of the 17 middle-order subregions that provide input services for the rural population, provision of these services is below average. Also, 1 of 7 high-order subregions has below-average provision of input services (Table 11). This suggests that new locational investment in fertilizer establishments should, as far as possible, be aimed at these 7 middle-order subregions or at Arni, the deficient high-order subregion. In selecting among the subregions for investment, however, the *least* poorly developed of the deficient subregions should be chosen first, in accordance with the efficiency approach discussed in Chapter 4, because this approach is the most cost-effective and least time-consuming way of reducing disparities in rural infrastructural development in the study region.

Output Marketing. It can be seen from the household-level analysis that revenue for the farmer from marketed crops would increase by Rs 124.53 if marketing establishments (such as market centers) were brought 1 kilometer closer to the farmer's village. The main crops grown in the study region are paddy and groundnuts. From regional findings summarized in Table 14, it is known that the median population size at which paddy marketing centers appear in the regional settlement system is 8,730 persons, and 8,890 persons for groundnut marketing centers. Table 15 indicates that 4 settlements in the study region have the median population thresholds but do not have one or the other of these marketing establishments. Moreover, 9 of the 17 middle-order subregions providing marketing services have below-average provision (Table 9), and 2 of the 7 high-order subregions have below-average provision (Table 11). Therefore, new locational investment in marketing establishments should be aimed at these subregions, again investing in the least poorly developed of the below-average subregions first.

Health Services. Using allopathic clinics as an example, the household-level analysis shows that expenditure on allopathic services would increase by Rs 0.82 if bus service were brought 1 kilometer closer to the household's village. The median population size at which an allopathic clinic appears in the regional settlement system is 3,470 persons (Table 14). There are 12 settlements in the study region that have the median population threshold but do not have the allopathic clinic (Table 15). Nine of the 17 middle-order subregions that provide health services have below-average provision (Table 9), and 1 of the 7 high-order subregions, Wandiwash, has below-average provision of health services (Table 11). Consequently, new locational investment in private hospitals should be aimed at some of these subregions. And, since 7 of these 9 middle-order subregions have below-average provision of transportation services as well, they might benefit from

simultaneous improvement of bus service to hospitals, keeping in mind that it is most efficient to bring the least poorly developed regions up to standard first.

It is important, from the point of view of planning for the provision of these consumption and production services, that the suggested new locations not only be closer to the service-deficient regions, but also that most be located within these regions.

The Public and Private Sectors and Service Provision. These examples demonstrate how the results from household and regional analyses could be used to arrive at locational priorities for the development and improvement of distribution systems for goods and services. They also raise an important issue: the roles of the public and private sectors in this new investment. To facilitate the participation of the private sector in rural areas, the government would have to provide inputs such as land, electricity, water, and credit to potential entrepreneurs. This report shows that potential exists for improving the distribution systems of goods and services in the study region. This potential can be realized if both the public and private sectors work to fill in the subregional locational gaps through policy intervention and direct investment in the regional settlement system. (This aspect is discussed further in Chapter 6.) Hazell and Ramasamy (1991) have addressed the issue as follows:

> The rapid and geographically dispersed growth of the nonfarm economy suggests an elastic structure, which is of course essential if the agricultural growth multipliers are to realize their full potential. Government policy has been generally conducive to this pattern of growth. The government actively supports small businesses through an array of direct assistance programs. It has also invested heavily in basic infrastructure over the years, and there is now a well-developed transport, telecommunication, postal, banking, water, and electricity system throughout the region, as well as a legal and institutional setting that encourages the private sector. Government has also been active in providing a range of producer and consumer services itself, for example, foods and general provisions through ration shops, agricultural marketing, and bus and financial services. These activities compete directly with the private sector, and this may help to keep costs down. The government may also have played a lead role in providing these services in the more remote areas where provision by the private sector was less adequate.

Central Place Theory and Households in the Study Region

Central place theory has always recognized the importance of demand for central functions (services) as a basis for the emergence of central places (service centers). It also recognizes the importance of access to these central functions and the central places that provide them so that potential demand can be converted into actual demand. However, classical central place theory does not analyze the impact of access to central functions or the demand for them at the household level.

As this chapter has shown, when there is better access at the household level to central functions (services), there is greater demand for (expenditure on) them. Higher incomes from agriculture tend to shift household consumption—at least for farming households—toward market purchases and away from consumption of own production. In the study region, agriculture's linkages to nonagricultural sectors of the economy are apparent and are reflected in the emergence of new and the strengthening of old central places (service centers) which provide the central functions (services) demanded by the households.

It can also be argued that by incorporating these findings on the access-demand relationship into the analyses of centrality-deficient complementary regions (gaps in the subregions) and deficiencies in the central place structure of the study region (gaps in the settlement system), it should be possible to identify and to fill in these gaps in the provision of central functions. How to accomplish this is addressed in this chapter. In the next chapter, empirical evidence from the study region is used to examine how this process has evolved over time.

6

CHANGING PATTERNS OF SERVICE PROVISION AND USE AT THE REGIONAL AND HOUSEHOLD LEVELS

Comparison of Two Points in Time

As noted in Chapter 2, the 1982/83 field survey also collected data on the availability and use of services in the study region for the year 1973/74, based purely on recall. The universities of Cambridge and Madras had conducted their own survey of the study region in that year, and reference was made to that survey in the 1982/83 questionnaire. At the village level, less ambiguity was found in recalling whether a service was available than about the frequency of use of a service or the number of services available in a settlement. People were better able to remember where they went to avail themselves of a service. Thus, it was clear that the recall data on availability, patterns of use, and distance were somewhat more reliable than those on frequency of use and number of services.

In the following paragraphs an attempt is made to note the changes that have taken place in the patterns of provision and use of services in the study region at both the regional and the village levels, bearing in mind, of course, the above-noted difficulties in the recall of information.

Other changes were also taking place, particularly in the agricultural sector of the economy of the study region. Before noting the changes in the patterns of availability and use of services, therefore, these changes will be mentioned briefly in order to put the changes in rural service infrastructural development in their proper perspective.

Changes in the Agricultural Sector

The changes in the agricultural sector relate to farm size and technology adoption, farm size and yields, employment in agriculture, agricultural incomes, distribution of income and poverty, and regional impact of agricultural growth (Hazell and Ramasamy 1991).

- In 1973/74, only 15 percent of the small farmers had adopted HYV paddy, whereas among the large farmers the adoption rate was about 66 percent. In 1982/83, however, adoption of HYV paddy was more widespread; more than 90 percent of the paddy area was consistently planted with HYVs, with no systematic difference by farm-size group.
- There is a positive but statistically insignificant relationship between farm size and yields. Yields on small farms are not significantly different from the

yields obtained by the large farms. It appears, therefore, that the new agricultural technology has achieved "scale neutrality" in the study region.

- Between 1973/74 and 1983/84, there was a 70 percent increase in total adult employment per farm in paddy production, and a 44 percent increase per farm in all other crop production. Changes in employment were due to more intensive cultivation of land, particularly to larger gross areas allocated to paddy.
- In real value, family incomes doubled for large paddy farmers between 1973/74 and 1983/84. Small paddy farmers and landless laborers also doubled their incomes. Nonpaddy farmers and nonagricultural households did less well, increasing the real value of their incomes by about 50 percent over the same period of time.
- There were substantial absolute income gains for all households, and absolute poverty declined. The relative distribution of incomes of households improved in that the small paddy farmers and landless laborers gained relative to other groups.

  A number of factors are responsible for these favorable income changes: (1) since distribution of land did not become noticeably concentrated, there was less scope for concentration of incomes at the top end of the distribution; (2) agricultural employment increased significantly; (3) incomes per hectare were highest for small paddy farmers; (4) nonfarm sources of income and employment increased significantly; and (5) the state government provided more goods and services, such as credit, transport, health, education, communications, agricultural extension, fertilizer and seed distribution, agricultural marketing, electricity, employment, and subsidized food.
- In the region, each rupee increase of value added in agriculture stimulated an additional Rs 0.84 increase of value added in the nonfarm sector (Hazell and Ramasamy 1991). Half of this gain is due to agriculture's demand for inputs and for output marketing, as well as processing, and the other half is due to increased consumer demand as a consequence of increased incomes.

  The agrobusiness sector accounts for Rs 0.31 of this multiplier, the government accounts for another Rs 0.15, and the private sector, apart from agrobusiness, accounts for the remaining Rs 0.38. Thus, interindustry and demand linkages are quite important in the study region. In almost all cases of government intervention, the government is present as a matter of last resort and as a facilitator of development.

Changes in the Settlement System

Given the above changes in the agricultural sector of the rural economy, it should come as no surprise that there would be commensurate changes in the regional distribution of the shops and establishments that provide the goods and services. Since these shops are located in the settlement system of the study region, it is also not surprising that there would be commensurate changes in the regional settlement system. This analysis encompasses changes between 1973/74 and 1982/83 in the distribution of population among settlements, the distribution of

service provision among settlements, the spatial features of middle-order service centers, and the index of service provision.

Distribution of Population in Settlements

Over the years 1973-83, the settlement system has become relatively less top heavy. The middle segment (settlements with populations of 2,500-9,999) has grown from about 25 percent of the total population to just above 30 percent. This strengthening of the middle segment also means that there are more locational choices for service provision in 1983 than there were in 1973 (Table 36).

In the context of the overall policy of development of rural service infrastructure followed by the state government through decentralization in the study region, it can be seen that the large urban centers in the study region have not been the sole recipients of public and private sector investment in rural service infrastructure. Small urban centers and large villages are also being chosen for such investment.

Distribution of Service Provision in Settlements

Service provision, compared with the distribution of population, has become even more balanced, with a remarkable increase in the percentage of services provided by the middle segment of the settlement system (service scores between 40.01 and 100.00), rising from about 25 percent in 1973 to just above 40 percent in 1983. The highest segment (with service scores of 130.01 and above) no longer dominates the study region. Thus, large towns and cities are not the only major providers of services; many small towns and larger villages are assuming that role, having emerged as service centers during 1973-83 (Table 37).

Spatial Features of Service Centers

During the years 1973-83, the number of service centers in the study region increased from a mere 75 to 473 at the low order of the service hierarchy (out of a total of 535 settlements). The number of middle-order service centers rose from 16 to 22, but the high-order centers did not increase at all. Given that just over three-fourths of middle-order service centers and just under two-thirds of high-order service centers are from within the study region, it is clear that the centers within the study region most significantly influence the patterns of provision of

Table 36--Distribution of settlements by population size group, 1971 and 1981

	1971			1981		
Population	Number of Settlements	Total Population	Percent of Population	Number of Settlements	Total Population	Percent of Population
Less than 1,000	58	52,085	4.73	3	2,584	0.21
1,000 - 2,499	399	611,141	55.49	422	640,908	51.77
2,500 - 4,999	58	193,201	17.54	87	277,589	22.42
5,000 - 9,999	14	93,695	8.51	15	99,021	8.00
10,000 or more	6	151,146	13.73	8	217,851	17.60
Total	535	1,101,268	100.00	535	1,237,953	100.00

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Table 37—Scores of service provision and distribution of settlements, 1973 and 1983

Year/Score	Number of Settlements	Percentage of Settlements	Total Score	Percentage of Total Score
1973				
Less than 10.00	1	0.19	7.14	0.03
10.00 – 40.00	420	78.50	12,490.42	59.75
40.01 – 70.00	89	16.64	4,204.35	20.11
70.01 – 100.00	15	2.80	1,216.98	5.82
100.01 – 130.00	2	0.37	212.76	1.02
130.01 or more	8	1.50	2,774.72	13.27
Total	535	100.00	20,906.37	100.00
1983				
Less than 10.00	0	0.00	0.00	0.00
10.00 – 40.00	334	62.43	10,686.95	46.52
40.01 – 70.00	169	31.59	7,970.84	34.69
70.01 – 100.00	15	2.80	1,230.24	5.35
100.01 – 130.00	9	1.68	1,085.68	4.73
130.01 or more	8	1.50	2,000.80	8.71
Total	535	100.00	22,974.51	100.00

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

services in the study region. The changes in the number of service centers at the middle-order level, together with their spatial features, best reflect the changes in the regional distribution system of services for the study region.

As noted above, the 16 middle-order service centers in 1973 increased to 22 by 1983. Of the original 16, 2, namely Tindivanam and Vellore, had become high-order service centers, which means that 8 new middle-order centers emerged during the period. With the emergence of these new centers and the strengthening of the old centers, it is expected that the average area covered by a service center would decline (Table 38). The number of villages served by each center would also decline, but the population served by each center could either increase or decrease depending upon the base from which the population grew during 1973-83.

This is what seems to have happened. Of the 14 centers for which comparison can be made, Chetpet, Nemili, and Kaveripakkam gained in service area, but the rest either remained constant or declined. Only Kaveripakkam gained in the number of villages served; the rest remained either the same or declined. Some have gained and others lost service population, with those losing being the more important and older centers—Arkonam, Arni, Tiruvannamalai, Wandiwash, and Thiruvathipuram (Cheyyar). The declining size of the service areas indicates that distances to the service centers themselves have also declined, making them more accessible to the rural population. This is in agreement with earlier findings that both population and service provision are becoming less top heavy with the emergence of new centers, which cut into the service areas and populations of the existing centers.

Index of Service Provision

The index of service provision is calculated for the entire study region and not for its individual subregions. This is a spatial index in that it first measures the

Table 38—Spatial features of middle-order service centers, 1973 and 1983

Service Center and Subregion	1973 Service Area	1973 Service Population	1973 Settlements Served	1983 Service Area	1983 Service Population	1983 Settlements Served
	(square kilometers)			(square kilometers)		
Arkonam	316.23	111,953	48	201.87	108,085	33
Arni	505.79	183,251	70	420.18	154,661	59
Chetpet	85.23	31,134	17	87.37	35,226	17
Desur	...	...	...	6.59	4,301	1
Kalasapakkam	...	...	...	2.08	2,443	1
Kancheepuram[a]	...	...	...	140.78	40,599	21
Kannamangalam	...	...	...	9.98	5,026	...
Kaveripakkam	21.08	9,732	3	32.68	14,141	5
Kilpennathur	...	...	...	24.66	10,471	2
Nemili	12.28	5,279	3	14.77	6,498	3
Peranamallur	...	...	...	14.96	4,256	1
Panapakkam	...	...	...	9.94	8,748	2
Polur	232.59	77,961	44	192.86	79,585	37
Solingar[a]	49.58	11,849	8	42.73	12,846	7
Thellar	...	...	...	14.70	5,513	1
Thiruvathipuram (Cheyyar)	198.46	67,046	38	194.09	71,806	37
Tindivanam[a]	2.93	1,130	1	...	...	...
Tirukovilur[a]	2.89	1,265	1	2.89	1,482	1
Tirutani[a]	34.32	10,301	4	34.32	12,376	4
Tiruvannamalai	616.45	222,202	104	431.02	192,970	81
Uthramerur[a]	6.25	1,069	1	6.25	1,061	1
Vellore[a]	55.12	26,882	8	...	...	...
Vettavalam	...	...	...	23.46	12,121	3
Wandiwash	396.32	118,144	66	290.67	91,150	47

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Note: Information about the service centers outside the study region is incomplete.
[a]These service centers are outside the study region.

provision of services per square kilometer. The percent change in this index over 1973-83 is calculated with 1973 scores as a base. As shown in Table 39, the level of total service provision has gone up. Considered individually, all services have shown a positive change, except banking, which has remained constant. Further, when the entire service provision is categorized as public or private sector, the values are marginally better for the public sector, but both show a steady improvement in service provision over the period.

The role of both the government and the private sector in providing these services seems to be equally important, given that the values in Table 39 are almost the same. In that table, the private sector is assumed to provide only retail services and the government sector is assumed to provide the rest of the services. In 1973, this was broadly the case. Since then, the private sector has moved rapidly to provide other services. What the table conceals is the extent of involvement of the private sector in provision of all services except the communication services in 1983.

Other studies have shown that the relative importance of the roles of government and private sectors in providing these services depends upon and varies with

Table 39—Index of service provision, 1973 and 1983

Service	Index of Service Provision[a]		
	1973	1983	Change
	(score/square kilometer)		(percent)
All services	7.56	8.44	11.64
Education	0.38	0.39	2.63
Health	0.14	0.16	14.28
Communication	0.52	0.64	23.07
Banking	0.08	0.08	0.00
Transportation	0.14	0.16	14.28
Agricultural inputs and implements	1.32	1.71	29.54
Animal husbandry	0.03	0.06	100.00
Marketing	0.87	0.90	3.44
Retail	4.08	4.34	6.37
Public sector	2.20	2.46	11.81
Private sector	5.36	5.99	11.75

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
[a]The index is the mean score per square kilometer for the study area.

the stage of agricultural development in that rural region (Wanmali 1983b). In an earlier stage of development, the government plays a leading role; in an intermediate stage, both government and the private sector are equally important; and in a later stage, the private sector plays a leading role.

Similarly, in the earlier stage, the government not only makes policy but also executes it, with the help of its own institutions; at an intermediate stage, its involvement in execution is greatly reduced by the entry of the private sector; and in the later stage, the government only formulates policy, leaving its execution entirely to the private sector.

The study region has been at the intermediate stage since 1973, when the new agricultural technology of improved seeds, chemical inputs, and irrigation was introduced. It now appears to be entering the later stage of agricultural development, where the role of government is to formulate policies to facilitate agricultural and rural development.

Changes at the Regional Level

It should be noted that the figures in Table 39 indicate the change in the densities of provision of services and not their volume of business. Thus, for example, when banking shows no change, it means that between the two points in time, for the study region as a whole, the density of banking services has remained constant. This does not take into account the volume of loans made available by the institutional banking sources and the services provided by the noninstitutional banking sources, both of which appear to have grown.

On the basis of the evidence presented so far in this and other chapters, it is clear that the growth of the study region's economy was a consequence of the technology-induced development of agriculture, which was responsible for increases in incomes in the farm and nonfarm sectors of the rural economy. Com-

pared with the mid-1970s, this development in agriculture was facilitated by the greater availability of rural infrastructural services, which was itself also stimulated by the higher demand for services. Further, as agriculture prospered, incomes from it were spent on increasingly diversified but mostly locally produced and distributed goods and services, which, in turn, augmented the patterns of regional income and employment and strengthened the regional settlement and service systems. It appears that such multiplier effects are indeed a part of the basis of growth of the region's economy.

Unmistakably, the evidence also points to a process of decentralization of urban functions into the rural areas, where the emergence of new service centers at all levels of the service hierarchy has been fairly widespread in response to the demand for these functions from the households of the study region.

The central place theory has always recognized the importance of the existence of and increases in demand for central functions (goods and services) in the process of emergence and growth of central places (service centers). But being deductive in nature, the theory never provided any proof of this process, except to mention that population increases in settlements (as a proxy for household demand increases) will result in emergence and growth of central places.

What the present study has been able to demonstrate, not only on the basis of analysis of population at the settlement level, but also and more importantly on the basis of analysis of expenditure patterns at the household level, is how these increases in population and household demand influence the emergence and growth of nonfarm employment through and in the shops and establishments selling goods and services throughout the region. This gives rise to the establishment of new service centers and strengthening of old service centers. This inductive analysis of the emergence and growth of a central place system in the study region represents the unique methodological contribution of this study.

7

CONCLUSIONS AND POLICY IMPLICATIONS

Settlement Systems

Analyzing the settlement system within the framework of Christaller's ([1933] 1966) central place theory, modified by earlier studies in India (Wanmali 1970, 1983a, 1985; Sen et al. 1971) has enriched understanding of the demographic, functional, and spatial characteristics of North Arcot's regional settlement system and its provision and use of services. Demographically and functionally, the settlement system has become less "city" dominated during the years 1973-83. Goods and services have become more widely available in large villages and small towns, not in its major urban center alone. Spatially, there has been an increase in the number of service centers, most markedly at the low end of service provision, but also at the middle and high levels.

Most of the principles of central place theory are upheld in the settlement system of the study region (Christaller [1933] 1966). There is a hierarchy of services that underlies the hierarchy of settlements, and the high-order service centers provide more complex services to a greater number of people who live in a more extensive region than do the low-order service centers. However, no hexagonal service areas were encountered. Service areas were of all shapes and sizes and were mostly governed by local topography, such as rivers, forests, and hills, and by the existing transportation networks. The influences of the three principles of spatial organization of settlements—marketing, transport, and administration—were mixed. Marketing and transport principles were influential at the low level of the service hierarchy and all three principles at the middle and high levels.

In analyzing service provision within and between the subregions of the study region, it was possible to identify those services and subregions that have above- and below-average service provision. Those with below-average service provision were considered to have gaps in their service structure. This identification of gaps in the regional service provision was extended to settlements themselves by indicating those settlements that have the necessary threshold population to sustain a service but do not have the service. Along with the analysis of service provision at the subregional level, this analysis of population thresholds of services applies and extends research on the central place theory for developing countries.

The regional analysis was also helpful in identifying the effects of the availability of hard infrastructure, such as roads and road networks, on the development of soft infrastructural services, such as education, health, communication, banking, agricultural inputs, animal husbandry, agricultural marketing, and retail services. Where hard infrastructure was lacking, the probability of soft infrastructural services being available in a settlement declined.

The household-level analysis of effects of access to goods and services and modes of transport on expenditure patterns and budget shares is unique among the geographical analyses conducted on demand for services in general and on the growth and emergence of central places in particular. It also adds to the understanding of dynamics of distribution systems for goods and services in rural India.

Planning for the Provision of Rural Service Infrastructure

The results of the analyses help in identifying imbalances in the provision of services among the subregions in the study region. These, together with the results of the household analysis of the impact of access on expenditure, can help the development administrator set priorities for the provision of these services. An example of how this could be achieved is given below.

The budgetary allocations for the development of these services and similar allocations for special development projects are known for the study region.[20] These resources are made available by the government to local development administrators at both the district and the *panchayat union* level for investment in the rural areas. The time horizon for spending them is five years in India. When the results of the regional and household level analyses and the pattern of budgetary allocation are put together, a list can be drawn up of locational priorities for the provision of rural service infrastructure. For example, if resources are available for the provision of one marketing center for agricultural output over a period of five years, then, based on the results of the study, the settlements capable of supporting this service are known. One of the settlements in the least poorly developed subregions should be chosen for the center. When additional resources are available to the development administrators, they can continue to choose from the settlements on the list of priority locations. Thus, this list can provide a spatial basis for the planning of services until all the identified locational service gaps in the regional settlement system are filled.

Household Use of Services

In considering the conclusions drawn from the analysis of household use of services, one must keep in mind the major qualification that this report includes no information on prices of goods and services, nor does it analyze prices of inputs and outputs because these prices are administered by the government.

What becomes apparent from the household-level analysis is the potential for improving the design of the distribution system for goods and services. Some services demanded by households appear to be negatively and significantly influenced by a lack of access to bus service. Bus stops, accordingly, need to be brought nearer to consumers to realize the potential of household demand linkages. Some input and

[20]The budgetary allocations for government expenditure on current account and special projects are given in Appendix 2, Table 49.

output marketing services demanded by the households were found to be negatively influenced by lack of access to them, suggesting that these services should be brought nearer to consumers. The gaps in the provision of these services are indicated, as well as the effects of lack of access to services on patterns of expenditure. The study demonstrates that, when available and accessible, these services help improve the total production and the productivity of agriculture and also help strengthen the linkages to nonagricultural sectors of the rural economy. The influence of factors such as ease of access to various modes of transport, which help conquer distance, is also estimated in household demand for various goods and services. Policies that influence direct access to these modes of transport (such as liberal credit for purchase of the modes of transport, cooperative ownership of certain modes, and so forth) should be devised and implemented. Thus, the results of the study could be useful in developing policies for improving the distribution system for those services and for tapping the potential market for them.

Generalizing and Applying the Results

Because it is based on central place theory, it can be argued that certain elements of this study would be common even if it were conducted elsewhere in India or in other parts of the Third World: settlements, service availability, service use, population of settlements, and area of settlements. These elements are amenable to analysis of the type noted in Chapters 4, 5, and 6. Of course, the details will vary with the geographical contexts, but the framework of analysis will remain almost the same.

Therefore, it can also be argued that the policy implications emanating from such studies will be similar, although differences in geographical contexts are likely to influence them differently. For example, settlements of smaller population sizes and densities in southern Africa would result in a similar policy implication about the effects of access on demand for consumption and production goods and services, but perhaps the manner of providing services in that part of the Third World would be different. For example, in southern Africa, locations of services might be more mobile than fixed as in southern India, because of the high per capita cost of providing them in regions of low population densities. Above all, results specific to a region are necessary for policymakers in Third World countries, because the gaps, the thresholds of services, and the estimates of effects of access on expenditure patterns, and through these, the linkage effects to the rest of the economy, will vary from country to country and from region to region.

The Development of the Regional Economy

The analysis also indicates that new agricultural technology, rural service infrastructure, and rural institutions appear to go hand in hand in reducing the polarization effects that were feared in the rural areas of the study region following the introduction of the new agricultural technology (Farmer 1977). From the beginning, the state government actively supported the establishment of rural institutions such as *panchayat unions* below the district level, as well as plans for the diffusion and decentralization of public-sector rural service infrastructure in the study region. This

resulted in greater and better access to goods and services over a period of time and widespread decentralization of urban functions to the rural areas. This institutional and infrastructural development has enhanced the household and regional linkage effects for the rural population in a variety of ways, thereby improving the quality of rural life in the study region.

APPENDIX 1: REDUCED-FORM DETERMINANTS OF HOUSEHOLD EXPENDITURES

The results of an estimated reduced-form model are presented to substantiate the findings derived from the two-stage least-squares model estimated for the main text. Because, in the second stage, expenditure shares are estimated as a function of the natural log of total expenditure and the variables that determine the natural log of total expenditure, multicolinearity is likely to be a problem. Multicolinearity could affect the accuracy of parameter estimates. Although the reduced-form model does not allow for the separate examination of the effects of income level and the direct influences of household and village factors on expenditure behavior, the final impact of each factor may be more accurately estimated.

Household and village characteristics are expected to determine a household's level of income and to influence expenditure patterns. The household characteristics include the following variables:

Size of household (N),
Per capita land owned by household (LANDPER),
Nonadults as a percent of household members (PNADULT),
Young children as a percent of household members (PCH_HH),
Age of household head (AGEHH),
Sex of household head (SEX),
Education of household head (ED),
Paddy farm operator household (PPDUM),
Nonpaddy farm operator household (NPDUM),
Cultivation laborer household (CLDUM), and
Noncultivator household (NCDUM).

The village characteristics include the following variables:

Quality of village's irrigation capacity (IRRIDUM),
Bicycle-owning percent of village's households (CYCLE),
Car-owning percent of village's households (CAR),
Motorcycle or moped-owning percent of village's households (MOTORCYC),
Distance from village to nearest bus stop (TDIS), and
Distance from village to nearest center for low-order services (LDIS).

The estimated coefficient for each variable includes the indirect effect on expenditure behavior through the variable's influence on income level, as well as the direct effect on expenditure behavior. The direct and indirect effects can be in opposite directions—the coefficient captures the net effect.

The reduced-form model was estimated for a weighted sample of all household types and separately for each type. The results for paddy farm operators are presented in Table 40, nonpaddy farm operators in Table 41, cultivation laborers in Table 42, and noncultivators in Table 43. The results for the weighted sample of all household types are given in Table 44.

Table 40—Ordinary least squares regression results for budget shares of paddy farm operator households

Independent Variable	Dependent Variable						
	LOWSHR	MIDSHR	HIGHSHR	FPSHR	CDSHR	TRANSHR	HEALSHR
Constant	94.179	6.400	-1.103	89.149	5.936	2.773	0.022
	(10.253)*	(0.933)	(-0.994)	(9.754)*	(0.854)	(2.201)*	(2.449)*
N	-0.867	0.305	0.070	-0.899	0.336	-0.043	0.001
	(-1.910)*	(0.901)	(1.279)	(-1.991)*	(0.980)	(-0.701)	(2.601)*
LANDPER	-6.239	1.437	0.318	-6.760	1.674	0.224	0.005
	(-3.845)*	(1.187)	(2.640)*	(-4.187)*	(1.363)	(1.008)	(2.923)*
PNADULT	0.436	-10.534	-0.834	-0.075	-11.242	-0.201	0.004
	(0.051)	(-1.639)	(-0.801)	(-0.009)	(-1.726)*	(-0.171)	(0.471)
PCH_HH	10.005	15.997	9.285	7.605	21.926	-1.285	0.095
	(0.181)*	(0.387)	(1.388)	(0.138)	(0.524)	(-0.169)	(1.603)
AGEHH	0.003	-0.023	-0.012	0.016	-0.029	0.010	-0.000
	(0.033)	(-0.267)	(-0.885)	(0.141)	(-0.327)	(0.676)	(-2.705)*
SEX	-0.445	2.279	0.798	0.172	2.941	-0.935	0.002
	(-0.083)	(0.568)	(1.229)	(0.032)	(0.723)	(-1.269)	(0.482)
ED	-3.811	3.158	-0.369	-4.687	2.597	1.576	-0.003
	(-1.289)	(1.431)	(-1.034)	(-1.593)	(1.161)	(3.885)*	(-1.119)
IRRIDUM	-4.806	0.880	0.241	-4.191	0.892	-0.625	-0.005
	(-1.342)	(0.329)	(0.558)	(-1.176)	(0.329)	(-1.273)	(-1.060)
CYCLE	-52.940	2.324	1.220	-49.402	2.398	-1.024	-0.026
	(-7.674)*	(0.462)	(1.497)	(-7.366)*	(0.470)	(-1.108)	(-2.989)*
CAR	69.984	-20.590	7.958	47.118	-12.101	8.393	0.692
	(1.476)	(-0.582)	(1.389)	(0.999)	(-0.337)	(1.291)	(3.906)*
MOTORCYC	97.348	-45.403	-6.802	137.667	-41.570	-26.198	-1.954
	(0.735)	(-0.459)	(-0.425)	(1.045)	(-0.415)	(-1.442)	(-3.731)*
TDIS	2.365	-0.457	-0.112	2.249	-0.521	0.134	-0.001
	(3.303)*	(-0.856)	(-4.301)*	(3.157)*	(-0.963)	(1.366)	(-1.789)*
LDIS	-0.275	4.285	-0.318	-1.185	3.442	1.964	-0.016
	(-0.072)	(1.499)	(-0.688)	(-0.311)	(1.188)	(3.739)*	(-2.870)*
Adjusted R^2	0.34299	0.02967	0.02956	0.33678	0.01821	0.22204	0.24449
F	7.14396	1.35988	1.35852	6.97629	1.21833	4.35901	4.53650

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Notes: The sample size of paddy farm operators is 154. The numbers in parenthese are t-ratios. The variables are defined in Table 25.

*Significant at the 0.10 level (two-tailed test).

Net Effects of Household Characteristics

Household Size

Larger households tend to allocate a greater part of the household budget to middle-order and high-order services at the expense of low-order services. The findings with regard to the increase is statistically significant for the weighted

Table 41—Ordinary least squares regression results for budget shares of nonpaddy farm operator households

Independent Variable	Dependent Variable					
	LOWSHR	MIDSHR	FPSHR	CDSHR	TRANSHR	HEALSHR
Constant	112.942	11.181	114.500	13.758	0.261	-0.118
	(5.468)*	(1.277)	(5.569)*	(1.654)	(0.070)	(-2.118)*
N	1.091	-0.135	0.221	-0.213	0.704	0.004
	(0.470)	(-0.138)	(0.096)	(-0.228)	(1.684)	(1.323)
LANDPER	-28.112	3.838	-32.342	2.985	0.116	0.052
	(-1.886)*	(0.607)	(-2.180)*	(0.497)	(0.043)	(2.513)*
PNADULT	-39.942	6.092	-25.205	4.272	-7.856	-0.032
	(-1.553)	(0.559)	(-0.984)	(0.412)	(-1.695)	(-0.949)
PCH_HH	156.148	-26.684	71.805	-25.019	15.347	0.796
	(1.161)	(-0.468)	(0.536)	(-0.462)	(0.633)	(4.393)*
AGEHH	0.293	-0.178	0.333	-0.186	-0.046	0.001
	(1.066)	(-1.528)	(1.215)	(-1.684)	(-0.940)	(1.427)
SEX	-17.010	6.025	-18.580	5.159	-0.128	0.016
	(-1.664)	(1.390)	(-1.826)*	(1.253)	(-0.070)	(1.190)
ED	-2.499	-2.767	-4.856	-2.867	2.581	0.023
	(-0.249)	(-0.649)	(-0.485)	(-0.708)	(1.425)	(1.264)
IRRIDUM	-20.222	2.152	-21.457	0.825	1.095	0.038
	(-1.942)*	(0.487)	(-2.070)*	(0.197)	(0.584)	(2.044)*
CYCLE	-1.921	-26.709	-2.733	-27.560	2.449	0.095
	(-0.099)	(-3.243)*	(-0.141)	(-3.522)*	(0.700)	(1.358)
CAR	-688.864	652.392	-690.215	649.361	-1.592	-1.684
	(-4.303)*	(9.611)*	(-4.332)*	(10.070)*	(-0.055)	(-1.525)
MOTORCYC	521.721	327.714	619.410	373.476	-58.106	4.133
	(1.138)	(1.686)	(1.358)	(2.023)*	(-0.704)	(1.342)
TDIS	2.915	-0.358	2.711	-0.126	0.005	-0.004
	(1.684)	(-0.489)	(1.574)	(-0.181)	(0.017)	(-1.328)
LDIS	-0.621	-5.362	-0.856	-6.258	1.731	0.008
	(-0.070)	(-1.418)	(-0.096)	(-1.942)*	(1.078)	(0.636)
Adjusted R^2	0.65236	0.8938	0.64275	0.90319	0.31719	0.50698
F	4.31997	15.88960	4.18319	17.50538	1.82188	2.68938

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Notes: The sample size of nonpaddy farm operators is 24. High-order regressions were not included in this table because the F-tests were not significant. The numbers in parenthese are t-ratios. The variables are defined in Table 25.

*Significant at the 0.10 level (two-tailed test).

sample of all household types; the decrease is statistically significant for the sample of paddy farm operators. For the paddy-farmer sample, the noncultivator sample, and the weighted sample, larger households spend higher portions of their total expenditures on health services (represented by allopathic clinics). The results from the weighted sample indicate that larger households also expend a greater

Table 42—Ordinary least squares regression results for budget shares of cultivation laborer households

Independent Variable	Dependent Variable						
	LOWSHR	MIDSHR	HIGHSHR	FPSHR	CDSHR	TRANSHR	HEALSHR
Constant	97.847	3.058	1.636	96.369	5.194	0.628	0.010
	(15.270)*	(0.967)	(1.330)	(14.734)*	(1.360)	(0.811)	(1.892)*
N	0.272	0.241	0.026	0.307	0.251	-0.026	0.000
	(0.416)	(0.746)	(0.214)	(0.460)	(0.643)	(-0.334)	(0.244)
LANDPER	0.754	-4.749	-0.709	0.750	-6.015	-0.541	0.014
	(0.076)	(-0.969)	(-0.372)	(0.074)	(-1.016)	(-0.451)	(1.907)*
PNADULT	-6.207	2.458	0.507	-4.507	2.339	-0.992	-0.005
	(-0.798)	(0.641)	(0.340)	(-0.568)	(0.505)	(-1.056)	(-0.827)
PCH_HH	34.216	-18.478	-7.413	36.017	-28.049	1.748	0.002
	(0.867)	(-0.949)	(-0.979)	(0.895)	(-1.193)	(0.366)	(0.065)
AGEHH	-0.110	-0.001	0.001	-0.078	-0.008	-0.018	-0.000
	(-1.111)	(-0.033)	(0.076)	(-0.774)	(-0.144)	(-1.560)	(-1.177)
SEX	4.139	0.719	0.171	3.234	1.034	0.496	0.004
	(1.299)	(0.458)	(0.281)	(0.994)	(0.545)	(1.289)	(1.783)*
ED	-1.280	1.366	-0.319	-2.072	1.332	0.561	-0.003
	(-0.409)	(0.885)	(-0.532)	(-0.649)	(0.714)	(1.484)	(-1.235)
IRRIDUM	-1.407	-0.275	-1.012	-2.455	-1.212	0.543	0.001
	(-0.456)	(-0.181)	(-1.708)*	(-0.780)	(-0.659)	(1.457)	(0.279)
CYCLE	-4.789	-2.745	-2.527	-5.996	-5.383	1.643	-0.011
	(-0.784)	(-0.911)	(-2.153)*	(-0.961)	(-1.477)	(2.224)*	(-1.966)*
CAR	0.655	-15.280	9.273	6.785	-3.234	-5.702	0.065
	(0.015)	(-0.687)	(1.072)	(0.148)	(-0.120)	(-1.047)	(0.645)
MOTORCYC	-277.761	41.413	15.362	-267.922	49.931	-11.266	-0.248
	(-2.770)*	(0.837)	(0.798)	(-2.618)*	(0.835)	(-0.929)	(-0.848)
TDIS	-0.080	-0.052	0.130	0.050	0.078	-0.105	0.000
	(-0.137)	(-0.179)	(1.156)	(0.084)	(0.223)	(-1.478)	(0.263)
LDIS	-11.582	4.868	-0.376	-13.358	2.809	3.298	-0.001
	(-3.666)*	(3.123)*	(-0.620)	(-4.142)*	(1.491)	(8.634)*	(-0.281)
Adjusted R^2	0.18752	0.10999	0.03486	0.21121	0.02007	0.5164	0.06127
F	3.14816	2.15030	0.68647	3.49200	1.19100	10.93900	1.56400

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District. Tamil Nadu, India, 1982-84.
Notes: The numbers in parenthese are t-ratios. The variables are defined in Table 25.
*Significant at the 0.10 level (two-tailed test).

share on consumer durables (including clothing and cloth). The paddy-farm households reduce the share allotted to food and personal services.

Larger households are expected to contain more members who can engage in income-generating work. This should allow the household to have a higher per capita level of expenditure. At higher expenditure levels, it is expected that consumption shifts in favor of the more cosmopolitan services represented by the

Table 43—Ordinary least squares regression results for budget shares of noncultivator households

Independent Variable	Dependent Variable						
	LOWSHR	MIDSHR	HIGHSHR	FPSHR	CDSHR	TRANSHR	HEALSHR
Constant	101.565	3.932	0.900	98.603	5.221	2.104	0.009
	(16.120)*	(0.938)	(0.797)	(15.156)*	(1.162)	(2.333)*	(1.450)
N	-0.666	-0.083	-0.016	-0.748	-0.084	0.030	0.001
	(-1.492)	(-0.280)	(-0.204)	(-1.621)	(-0.266)	(0.472)	(1.896)*
LANDPER	-10.544	3.191	3.132	-11.695	5.390	0.517	0.014
	(-3.155)*	(1.435)	(5.228)*	(-3.389)*	(2.261)*	(1.083)	(4.930)*
PNADULT	-5.425	2.939	0.290	-2.072	2.739	-2.782	-0.003
	(-0.781)	(0.636)	(0.233)	(-0.289)	(0.553)	(-2.798)*	(-1.370)
PCH_HH	28.546	-18.892	-1.606	28.260	-22.463	1.352	0.027
	(0.742)	(-0.738)	(-0.233)	(0.711)	(-0.818)	(0.245)	(0.864)
AGEHH	-0.130	-0.017	0.006	-0.064	-0.015	-0.051	-0.000
	(-1.413)	(-0.280)	(0.382)	(-0.681)	(-0.241)	(-3.890)*	(-1.625)
SEX	2.872	2.181	0.210	1.877	2.420	0.677	0.004
	(0.936)	(1.068)	(0.382)	(0.592)	(1.105)	(1.541)	(1.396)
ED	-0.850	0.332	-0.492	-2.328	0.022	1.280	-0.000
	(-0.300)	(0.176)	(-0.969)	(-0.795)	(0.011)	(3.156)*	(-0.158)
CYCLE	0.951	-2.764	-1.439	0.138	-4.570	1.833	-0.010
	(0.149)	(-0.650)	(-1.257)	(0.021)	(-1.003)	(2.005)*	(-1.433)
CAR	-80.562	-0.127	-0.189	-73.846	4.083	-8.861	-0.008
	(-2.193)*	(-0.005)	(-0.029)	(-1.947)*	(0.156)	(-1.685)*	(-0.061)
MOTORCYC	-380.152	60.851	17.397	-375.927	70.988	-4.336	0.038
	(-3.625)*	(0.872)	(0.925)	(-3.472)*	(0.949)	(-0.289)	(0.108)
IRRIDUM	0.085	-0.650	-1.275	-1.492	-1.868	0.972	0.004
	(0.027)	(-0.312)	(-2.271)*	(-0.461)	(-0.836)	(2.167)*	(0.993)
TDIS	-0.385	-0.026	0.139	-0.217	0.121	-0.154	0.000
	(-0.599)	(-0.061)	(1.212)	(-0.328)	(0.265)	(-1.673)	(0.002)
LDIS	-10.294	4.838	-0.113	-11.939	3.049	3.145	0.000
	(-3.116)*	(2.201)*	(-0.192)	(-3.500)*	(1.294)	(6.651)*	(0.172)
Adjusted R^2	0.40532	0.01395	0.12872	0.41492	0.01839	0.41543	0.27294
F	9.28391	1.17194	2.79556	9.61920	1.22768	9.63720	5.23660

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
Notes: The numbers in parenthese are t-ratios. The variables are defined in Table 25.
*Significant at the 0.10 level (two-tailed test).

middle- and high-order services. The positive signs associated with household size for middle-order, high-order, consumer durables, and health services supports the hypothesized effect of household size on expenditure through the income effect.

Not only do larger households have more hands to engage in productive activities, they also have more mouths to feed. Holding productive assets constant, this could limit the income available for less basic expenditures. However, for the

Table 44—Ordinary least squares regression results for budget shares of a weighted sample of households

Independent Variable	Dependent Variable						
	LOWSHR	MIDSHR	HIGHSHR	FPSHR	CDSHR	TRANSHR	HEALSHR
Constant	107.026	3.322	0.807	104.619	4.195	1.598	0.0161
	(29.954)*	(1.475)	(1.901)*	(29.177)*	(1.840)*	(3.496)*	(3.919)*
N	-0.218	0.306	0.051	-0.253	0.343	0.001	0.0005
	(-0.960)	(2.132)*	(1.887)	(-1.106)	(2.359)*	(0.020)	(2.539)*
LANDPER	-5.492	2.816	0.619	-6.320	3.071	0.607	0.0052
	(-5.923)*	(4.818)*	(5.622)	(-6.791)*	(5.190)*	(5.123)*	(5.511)*
PNADULT	-4.568	0.778	-0.433	-3.437	0.259	-0.409	-0.0080
	(-1.340)	(0.362)	(-1.069)	(-1.005)	(0.119)	(-0.938)	(-2.300)*
PCH_HH	61.860	-5.118	0.754	55.188	-2.650	-3.473	0.0980
	(3.349)*	(-0.440)	(0.344)	(2.977)*	(-0.225)	(-1.470)	(5.159)*
AGEHH	-0.024	-0.020	-0.008	0.003	-0.025	-0.019	-0.0005
	(-0.565)	(-0.762)	(-1.606)	(0.079)	(-0.927)	(-3.560)*	(-3.262)*
SEX	2.938	0.835	0.174	2.298	0.928	0.363	0.0018
	(2.061)*	(0.931)	(1.033)	(1.608)	(1.022)	(1.994)*	(1.239)
ED	-3.400	1.709	-0.131	-3.786	1.437	0.670	-0.0012
	(-2.679)*	(2.136)*	(-0.871)	(-2.972)*	(1.775)*	(4.129)*	(-0.967)
IRRIDUM	-4.694	1.774	-0.185	-5.185	1.360	0.449	-0.0044
	(-2.829)*	(1.696)*	(-0.941)	(-3.113)*	(1.285)	(2.115)*	(-1.712)*
CYCLE	-31.983	3.845	-0.345	-31.385	2.588	0.908	-0.196
	(-9.936)*	(1.895)*	(-0.902)	(-9.716)*	(1.260)	(2.206)*	(-4.393)*
CAR	49.657	-13.598	6.072	46.412	-3.333	-7.318	0.3744
	(2.239)*	(-0.973)	(2.304)*	(2.086)*	(-0.236)	(-2.579)*	(4.680)*
MOTORCYC	-50.941	-3.962	3.389	-32.258	-3.004	-5.825	-1.0000
	(-0.831)	(-0.103)	(0.465)*	(-0.524)	(-0.077)	(-0.743)	(-4.510)*
TDIS	1.368	-0.423	-0.006	1.345	-0.377	-0.010	0.0001
	(5.937)*	(-2.913)*	(-0.219)	(5.816)*	(-2.570)*	(-0.351)	(-0.478)
LDIS	-5.627	3.807	-0.270	-6.622	2.376	2.419	-0.0089
	(-3.031)*	(3.253)*	(-1.227)	(-3.554)*	(2.006)*	(10.185)*	(-3.461)*
PPDUM	-27.210	-2.066	-0.609	-27.821	-2.330	0.210	0.0027
	(-14.913)*	(-1.796)*	(-2.811)*	(-15.200)*	(-2.002)*	(0.903)	(1.456)
NPDUM	-4.788	-1.312	-0.541	-6.489	-1.520	0.040	0.0159
	(-2.087)*	(-0.907)	(-1.983)*	(-2.818)*	(-1.038)	(0.136)	(6.738)*
CLDUM	1.094	-4.195	-0.270	1.878	-4.161	-0.791	-0.0013
	(0.642)	(-3.904)*	(-1.337)	(1.098)	(-3.825)*	(-3.628)*	(-0.781)
Adjusted R^2	0.61254	0.13509	0.05402	0.63222	0.12559	0.28617	0.21173
F	86.68944	9.46581	4.09524	94.17642	8.78503	22.72917	14.70290

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Notes: The numbers in parentheses are t-ratios. See Table 25 for definitions of the variables.

*Significant at 0.10 level (two-tailed test).

sample households the effect of having more workers clearly offsets any population pressure on the allocation of total expenditures.

Per Capita Land Ownership by Household

The most important productive asset for households in rural areas is land. The results show that households owning more land per person budget more of total expenditure to the more sophisticated services. The shift is particularly striking for health services, for which greater ownership of land has a positive effect across household types.

Households with more land per capita are expected to generate more income per capita and to spend more of that income on the less basic services. Also, since more land can be used to meet subsistence food needs, the ownership of more land is expected to reduce the need to purchase food. In the case of land, the direct and indirect effects are both expected to result in a smaller share of total expenditure being allocated to basic necessities. The econometric results are compatible with this hypothesis.

Nonadult Household Members

Households that have a higher proportion of members who are not adults spend less on health. Negative effects are also observed on transportation (bus service) for noncultivators, consumer durables for paddy farmers, and low-order services for nonpaddy farmers.

The effect that household size has on expenditure patterns through increased income is expected to be mitigated when a greater percentage of the household members are not adults. Nonadults are assumed to be less productive. Also the needs of nonadults are expected to be lower in terms of expenditure. In households where adult needs dominate, budgeting for food might increase to satisfy larger appetites but might also decline in favor of more sophisticated services. Empirically, the results are not clear across households.

Young Children in Households

The findings are only a little clearer with regard to the effect of young children. For the weighted sample, the higher the percentage of household members who are young children the greater the expenditure share for low-order services, food and personal services, and health services. The effect on health services is also found for nonpaddy farmers separately. The income effect seems to be overridden by young children's needs for greater health care.

Age of Household Head

Older heads of households appear to be reluctant to allocate higher portions of total expenditure to purchased health care. This holds for paddy farmers, as well as for the weighted sample. For noncultivators, as well as for the weighted sample, age seems to reduce the propensity to use transportation services. Although older household heads might have had the time to accumulate more income-generating assets, the empirical results suggest that an age-related traditionalism counteracts any indirect effects of age on expenditure patterns through income. Of course, traditionalism could also limit the adoption of improved production technologies, but, since the negative effect is only associated with transportation and health, the

tendency being observed is more likely to be the result of a direct association between age and expenditure preferences.

Gender of the Household Head

While it is typically believed that female-controlled budgets are more likely to have higher allocations for food, female heads of household are also more likely to have income constrained by discrimination in access to production inputs. Both effects should lead to a greater allocation of expenditure to the less sophisticated services, although female-headed households might show a preference for health services.

According to the regression results for the weighted sample, male-headed households are actually more inclined to purchase low-order services than are female-headed households. But the budget share for transportation is indeed larger if the household is headed by a man. The share allocated to health care is higher for cultivation laborer households that are headed by males. Nonpaddy farm households that are headed by men conform to the expectation of less budgeting for food and personal services.

Education of the Household Head

The more educated household heads allocate larger shares of total expenditure to middle-order services, consumer durables, and transportation at the expense of low-order services and food and personal services. The more educated paddy farmers and noncultivators, separately, show a greater tendency to allocate expenditures to transportation services.

Greater education should lead to higher incomes and to more cosmopolitan tastes. The regression results confirm that education does lead to more sophisticated consumption patterns.

Irrigation in the Village

Because the survey took place after a period of severe drought in which the area's catchment basins had not been adequately replenished by the monsoon rains, it is expected that the village's capacity for irrigating crops would have a significant effect on household income. Also, since the availability of water would affect cropping patterns, irrigation capacity could directly alter the need to purchase foods not grown by the household.

For the weighted sample of households, better irrigation is shown to encourage smaller allocations of total expenditure to low-order services, food and personal services, and health services, and a larger allocation to middle-order services. The paddy farms are expected to be the most directly influenced by the quality of village irrigation, but the irrigation variable did not prove to be statistically significant. Nonpaddy farmers in better-irrigated villages allocate less of total expenditure to low-order services and food and personal services but more to health services. Better irrigation is associated with lower expenditure shares being allocated to high-order services by cultivation laborers and noncultivators. Also, noncultivators spend more on transportation if they reside in better irrigated villages. It appears that the effect of irrigation on the overall welfare of a village influences household expenditures more than the quality of irrigation affects the consumption patterns of the primary users of irrigation water.

Bicycle Ownership in the Village

If a greater percentage of a village's households own bicycles, then both the bicycle-owning households and the other households have a greater opportunity to avail themselves of this mode of transportation. Bicycling can be useful for carrying a person with a small load for a slightly longer distance than can be covered on foot. The empirical results suggest that villagers, particularly cultivation laborers and noncultivators, use bicycles to reach bus services for traveling to places where middle-order services are available. The bicycle can also be used to reach input and output markets, and thus help in generating additional income, which could encourage consumption of middle-order services and transportation services at the expense of low-order services and food and personal services.

Car Ownership in the Village

The availability of cars encourages consumption of low-order services, high-order services (including fuels), food and personal services, and health services. And the relative accessibility, even if low in absolute terms, reduces the proportion of total expenditure going to bus service. Cars are a more convenient mode of transport than are buses. However, the regression results are not consistent for each class of household.

Motorcycle Ownership in the Village

Slightly better access to motorcycles appears to encourage noncultivators to shift consumption away from low-order services and food and personal services. Like cars, the results are not consistent across household types.

Distance from Village to Bus Service

The farther household members have to travel from their village to reach bus services, the greater the share of total expenditure they allocate to low-order services at the expense of middle-order services. A shift to food and personal services and consumer durables is also observed. For noncultivators a longer distance to the bus stop translates into a reduction in the share of total expenditure allocated to bus service.

Distance from Village to Nearest Center for Low-Order Services

The greater the distance from a village to the nearest center for any low-order service, the larger the share of total expenditure that households in the village allocate to bus service. The shares decline for food and personal services and health services. The expenditure share for low-order services is reduced in favor of middle-order services. It seems that if greater travel is required, households have a preference for middle-order services over low-order services.

Primary Household Occupation

Holding the other variables constant, it appears that a household's primary occupation influences its expenditure pattern. During the drought, nonpaddy farmers consumed more per capita than did noncultivators, paddy farmers, and cultivation laborers, in that order. In contrast to noncultivators, nonpaddy farmers' expenditure

shares are higher for health services and lower for food and personal services, low-order services, and high-order services. Paddy farmers have lower shares for low-order services, middle-order services, high-order services, food and personal services, and consumer durables. Cultivation laborers have lower shares for middle-order services, consumer durables, and bus service. For households that are directly employed in crop cultivation, it seems that household consumption is more related to consumption from own production at the expense of expenditures on outside services, at least during a time of drought.

Substantiated Findings

Whereas the findings presented in the main text of the Engel function analysis relate to the effects of total expenditure and the additional effects of household and village characteristics on expenditure patterns, the results of the reduced-form model relate to the combination of direct and indirect effects of household and village characteristics.

Comparing the findings reported for the two approaches, it is confirmed that for nonpaddy farmers more land per capita results in a smaller share of total expenditure being allocated to food and personal services and a larger share being allocated to health care. It is also confirmed that the larger the nonadult portion of household members, the smaller the portion of per capita expenditure allocated to low-order services by nonpaddy farmers. The larger the proportion of household members who are young children, the greater the share for health. If male-headed, a nonpaddy farm household spends a smaller share on food and personal services. A smaller share of total expenditure goes to low-order services and food and personal services if the nonpaddy farmer resides in a better-irrigated village. Greater accessibility of bicycles encourages nonpaddy farmers to shift consumption toward middle-order services. In villages where cars are more accessible, nonpaddy farmers spend more on middle-order services and consumer durables at the expense of low-order services and food and personal services. For nonpaddy farmers, many of the factors that are hypothesized to affect consumption patterns are proven to be statistically significant, using either the reduced-form approach or the Engel function approach.

Fewer hypothesized relationships are confirmed for paddy farmers. The negative relationship between the household head's age and the expenditure share on health is substantiated by the reduced-form estimation. In villages where bicycles are more accessible, paddy farmers tend to spend a smaller share on low-order services. Paddy farm households located in villages farther from bus stops shift consumption toward low-order services and food and personal services and away from high-order services and health services.

Since estimation of Engel functions did not result in statistically significant F-tests for cultivation laborers and noncultivators, no comparison is made with the reduced-form results for cultivation laborers and noncultivators.

APPENDIX 2: SUPPLEMENTARY TABLES

Table 45—Regression coefficients for budget share equations by service group for weighted sample

Independent Variable	Dependent Variable						
	LOWSHR	MIDSHR	HIGHSHR	FPSHR	CDSHR	TRANSHR	HEALSHR
Constant	-24[illegible]65	424.405	-35.5237	-365.540	254.560	279.830	-20.0520
	(-0.172)	(0.962)	(-0.915)	(-0.252)	(0.798)	(1.218)	(-0.729)
LOGE	86.9451	-57.5231	5.3870	102.400	-33.254	-38.800	3.3315
	(0.420)	(-0.907)	(0.965)	(0.490)	(-0.725)	(-1.175)	(0.842)
N	3.4999	-2.4024	0.2773	4.1650	-1.2631	-1.7827	0.2092
	(0.362)	(-0.809)	(1.061)	(0.426)	(-0.588)	(-1.153)	(1.130)
PNADULT	34.6844	-25.9137	2.3833	44.047	-15.918	-18.359	0.6916
	(0.351)	(-0.856)	(0.895)	(0.442)	(-0.727)	(-1.165)	(0.366)
PCH_HH	18.5703	-5.8919	-0.6106	17.198	-5.5908	-1.0956	1.7640
	(0.437)	(-0.452)	(-0.532)	(0.401)	(-0.593)	(-0.161)	(2.171)*
AGEHH	-0.2684	0.1492	-0.0207	-0.2698	0.0723	0.0870	-0.0274
	(-0.368)	(0.667)	(-1.053)	(-0.367)	(0.447)	(0.752)	(-1.967)*
SEX	10.9638	-3.2644	0.8742	12.040	-0.67900	-3.4132	0.5047
	(0.409)	(-0.397)	(1.208)	(0.445)	(-0.114)	(-0.797)	(0.984)
ED	-28.9626	18.1265	-1.4815	-34.432	11.391	11.857	-0.8179
	(-0.512)	(1.045)	(-0.970)	(-0.603)	(0.907)	(1.312)	(-0.756)
IRRIDUM	-10.5345	4.8922	-0.6745	-12.234	2.5621	3.3654	0.1410
	(-0.432)	(0.655)	(-1.025)	(-0.497)	(0.474)	(0.865)	(0.302)
CYCLE	30.5777	-38.1598	3.1396	43.038	-22.845	-26.508	1.0225
	(0.208)	(-0.848)	(0.792)	(0.290)	(-0.701)	(-1.131)	(0.364)
CAR	180.156	-101.752	15.5327	202.980	-51.869	-69.942	10.2250
	(0.416)	(-0.765)	(1.328)	(0.464)	(-0.539)	(-1.010)	(1.234)
MOTORCYC	-806.901	528.491	-44.6497	-924.590	314.390	337.420	-40.5790
	(-0.407)	(0.869)	(-0.834)	(-0.462)	(0.714)	(1.065)	(-1.070)
TDIS	1.0198	-0.2196	-0.0100	0.9303	-0.2253	0.1113	-0.0326
	(0.347)	(-2.243)*	(-1.826)*	(0.313)	(-3.885)*	(0.237)	(-0.580)
PPDUM	-309.2920	-11.4390	-2.4930	-306.4700	-13.4900	-1.0861	-1.9343
	(-6.489)*	(-0.783)	(-1.938)*	(-6.370)*	(-1.276)	(-0.143)	(-2.122)*
NPDUM	-211.1120	-11.6286	-1.9878	-209.2000	-11.3840	-4.1125	0.1003
	(-5.232)*	(-0.940)	(-1.825)*	(-5.136)*	(-1.271)	(-0.638)	(0.130)
CLDUM	-224.813	-32.8731	-0.4241	-215.740	-26.373	-14.977	-1.1660
	(-4.589)*	(-2.188)*	(-0.321)	(-4.363)*	(-2.427)*	(-1.915)	(-1.245)

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Notes: N = 337. Numbers in parentheses are t-ratios. See Table 25 for definitions of the variables.

*Significant at the 0.10 level (two-tailed test).

Table 48—Regression coefficients for output market equation for weighted sample including both farm types

Variable	Coefficient	t-Ratio
Constant	-2,750.963	-0.987
NPDUM	-192.193	-0.193
IRRIDUM	2,045.966	1.149
PCH_HH	1,808.817	0.704
SEX	79.691	0.065
CYCLE	3,419.611	2.783*
ED	487.540	0.716
N	65.088	0.563
OUTPDIS	-120.251	-2.505*
AGEHH	0.316	0.012
LANDOWN	325.6[illegible]	4.382*
MOTORCYC	47,661.119	0.663
PNADULT	194.704	0.095
CAR	-5,376.116	-0.448
TRAILER	-5,872.524	-0.320
Adjusted R^2	0.24998	
F	3.49910	

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.
*Significant at the 0.10 level (one-tailed test).

Table 49—Government expenditure on current accounts and special projects, 1982/83

Government Expenditure	Account	Share
	(Rs)	(percent)
Current account		
Education[a]	1,610,956	2.66
Health[b]	5,539,067	9.15
Communication[c]	2,055,815	3.39
Credit and finance[d]	25,231,869	41.69
Transport[e]	17,985,274	29.72
Agriculture and agricultural inputs[f]	6,075,420	10.03
Animal husbandry[g]	1,741,301	2.87
Marketing[h]	274,699	0.49
Total in services	60,514,401	100.00
Special project		
Intensive Rural Development Programme[i]	14,926,000	16.16
Self-Sufficiency Scheme[j]	60,860,000	65.59
National Rural Employment Programme[k]	4,998,000	5.41
Drought Relief Programme[l]	11,550,000	12.84
Total in all special projects	92,334,000	100.00

Source: International Food Policy Research Institute/Tamil Nadu Agricultural University, Field Survey in North Arcot District, Tamil Nadu, India, 1982-84.

Note: Government expenditure does not include factor payments and capital accounts, only receipts.

[a]Includes all education services.

[b]Includes all public health and social welfare services.

[c]Includes all postal and telegraphic services.

[d]Includes all cooperative and commercial banking services.

[e]Includes all road and rail as well as department of transport services.

[f]Includes agricultural research, agricultural marketing, oilseeds, seed certification, and agricultural engineering services.

[g]Includes key village centers and animal husbandry services.

[h]Includes all regulated marketing services.

[i]Includes expenditure on agriculture, animal husbandry, minor irrigation, training and extension, agriculture, fishery, and farm forestry.

[j]Includes expenditure on village-to-main-road link roads, culverts, school buildings, rural dispensaries, maternity centers, village pathways, and minor irrigation.

[k]Includes expenditure on afforestation, drinking water wells, minor irrigation, drinking water, transport, and roads.

[l]Includes expenditure on sinking bore and open wells, deepening of wells, drinking water, transport and roads, improvement in minor irrigation, and new ponds.

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