GEOGRAPHY AND THE COST OF NETWORK INFRASTRUCTURE:
THE CASE OF LOCAL TELEPHONE SYSTEMS

DISSERTATION

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Abstract

On February 8, 1996, the U.S. Congress enacted the Telecommunications Act of 1996 to promote competition and reduce regulation in local telephone service, in order to secure lower prices and higher quality of service. The promise of competition in local service, however, has largely remained unfulfilled, and there is still much unknown about the cost structure of the telephone industry at the local level. The question of whether natural monopoly characteristics have ever existed has never been fully answered, and is still a valid one. The purpose of this research is to expand earlier empirical research on telephone costs by accounting for the site-specific (hedonic) characteristics of the service territory. In past research, these characteristics have been approximated by population density, customer density, or service territory area. In order to achieve a better understanding of the cost structure of the telephone industry, both total cost and disaggregate capital investment cost functions have been developed and econometrically estimated while including site-specific physical and geographical characteristics, such as (1) soil, (2) slope, (3) environmental quality, (4) service territory size, (5) street pattern, (6) population density, (7) land uses, and (8) exchange proximity.

A translog total cost function is estimated at the company level, using 1980 data for 41 telephone companies operating within the state of New York. Disaggregate capital investment cost functions are estimated at the local exchange level for five different plant components: central office equipment, buildings, cables, pole lines, and underground
conduits. A separate equation for the share of underground investment in total cable (underground and overhead) investment is also estimated. The size of the samples used in these estimations varies between 65 and 615, depending upon the data availability for the selected variables. Additive, log-log, and Box-Cox functional forms are considered, and the optimal functional form is selected using log-likelihood ratio tests.

The empirical results show that site-specific factors (1) are significant determinants of costs in the telephone industry, and (2) provide substantial advantages (or disadvantages) to telephone companies regarding the output levels where economies of scale or density are exhausted. The results also show that significant cost savings and scale economies are achieved by expansion through densification (fixed service territory size). At the company sample mean, economies of scale are exhausted for a market of 61,543 telephone units. Economies of density, however, are exhausted at 610,836 units, a much higher level. These thresholds vary with the site-specific cost factors. Among the plant components, the strongest economies of density are achieved in pole (e=0.60) and cable (e=0.74) capital investments, followed by central office equipment (e=0.92) and underground conduit (e=0.90) investments. The only component where the exchanges experience diseconomies of density is buildings (e=1.12). The total economies of density are 0.83 at the sample mean, implying that monopoly is the optimal form of production.

It is concluded that monopoly is the optimal form of production for predominantly small to mid-size markets, when the expansion is achieved through densification, which implies a need for mergers among existing small and mid-size companies and exchanges. However, for larger markets and for newly emerging service areas, competitive entry to the market should be encouraged.