Telecommunications Demand Analysis in Transition

Lester D. Taylor
Department of Economics
University of Arizona
LTAYLOR@bpa.arizona.edu

Abstract
This paper focuses on the problems and challenges to applied demand analysis in the telecommunications industry that have been posed by technological change, deregulation and competition. Challenges discussed include the development of new sources of data, estimation of price elasticities which apply to firms and users, the modelling of choice of carrier, and the emergence of the Internet.

1. Introduction

While the upheavals that have occurred in world telecommunications markets have generated many benefits, few of these have been bestowed on telecommunications demand analysts. Twenty years ago, the boundaries of the telecommunications industry were stable and well-defined, as were the services provided and telephone companies were either state-owned or regulated monopolies, which made for a readily available body of data on a consistent and comprehensive basis. Today, industry boundaries are rapidly changing, markets are increasingly competitive, and company-based data have become increasingly fragmented and proprietary. The upshot is that estimation of telecommunications price and income elasticities was easier 20 years ago than it is today.

Twenty years ago, telecommunications demand analysts did not have to deal with a rapidly changing and expanding mix of telecommunications services, did not have to contend with emergent substitutes and complements, did not have to deal with firm demand functions as opposed to industry demand functions, and did not have to collect and organize primary data. Today's telecommunications demand analysts must contend with all of these issues and problems.

The purpose of this paper is to provide an overview of the current state of telecommunications demand analysis and to describe both the problems that are being faced and what is being done to solve them.

2. Background: Telecommunications Demand Analysis in the 1970’s and 1980’s

As perspective on current tasks and challenges, a brief overview of the roles that telecommunications demand analysis has played in the past (with a focus on the US and Canada) may be useful. The first substantive use of telecommunications price elasticities appeared in the early to mid-1970’s, largely as a consequence of inflation and the slowing of technological change in long-distance transmission. During the 1950’s and 1960’s, technological change had materially reduced the cost of intercity transmission, which resulted in a steady reduction in long-distance rates. Demand analysis played no role in the setting of rates. While rates were decreased, they were not reduced as much as the decrease in costs because of a desire on the part of regulators to maintain artificially low local rates.

The 1970’s saw things differently. The slowing of technological change in reducing the cost of long-distance transmission coupled with inflation caused the pressure on long-distance rates to be upward, rather than downward. Despite a strong desire on the part of regulators to keep local rates low, pressures were mounting to increase local rates as well. In this situation, the importance of price elasticity became apparent. With decreasing rates, telephone companies have little incentive to take price elasticity into account, since (with inelastic demand) revenues will be higher if price elasticity is ignored than if it is taken into account. The incentives clearly change, however, with upward adjusting rates, since revenues will be lower if price elasticity is ignored than if it is not. As a consequence, the long-distance companies (AT&T in the US and the Trans Canada Telephone System in Canada) began to use econometrically based price elasticities in their filings for rate increases before the their respective regulatory commissions.

During the 1970’s, the focus was almost entirely on the estimation of toll elasticities, as this was where the action was in rate hearings. Access elasticities received
little attention, as local rates were set residually to make up the difference between an agreed-upon revenue requirement and the revenues that would be projected to be forthcoming in the toll and other ‘actively priced’ markets. By the late 1970’s, sophisticated toll demand models for the interstate US market existed at AT&T and the FCC and for the Canadian interprovincial market at Bell Canada, and intrastate models had been used in rate hearings in more than three-quarters of the US states. [See Taylor (1994, Appendix 2).] In great part because of the role played by demand modellers at AT&T, a generic toll demand model emerged in the (then) Bell System, in which a measure of toll calling activity (usually calls or minutes) was related to income, price, a measure of market size (typically the number of telephones), and ‘habit’ (as usually measured by the value of the lagged dependent variable).

By the late 1970’s, things were again in a state of flux in telecommunications markets. Competition had emerged in the US in the intercity toll market and the historic toll-to-local subsidies that had sustained artificially low local rates were being eroded as a consequence of the competition driving toll rates towards cost. The result was substantially increased upward pressure on local rates, together with an extensive exploration of the possibilities of replacing flat-rate local service with measured service. Amid widespread concern that increased local rates and/or the substitution of measured for flat-rate local service would cause large numbers of households to give up telephone service—and therefore jeopardize universal service—attention in the early 1980’s shifted to the estimation of access price elasticities.

The estimation of access demand models required the use of different modelling strategies from that of estimating toll models. Whereas the 1970’s toll models were usually estimated by conventional regression methods using market data, access demand models were usually specified in a probit or logit discrete choice framework and estimated from data referring to individual households. Moreover, interest was not only on the overall magnitude of access price elasticities, but how access elasticities differed between and among low- and high-income households, black, hispanic and white households, and single-parent households headed by females. [For a discussion of the access demand models that were estimated in the 1980’s for the US and Canada, see Taylor (1994, Chapter 5).]

The divestiture of AT&T which went into effect on January 1, 1984 was a significant event not only for the restructuring of the telephone industry in the US, but for telecommunications demand analysis as well. Historically, data relating to the telephone industry had been conveniently collected and made freely available to the public by AT&T. With the divestiture, however, this was no longer the case, as AT&T (which still formed the overwhelming bulk of the intercity toll market) quickly came to view its data as proprietary. Demand analysts accordingly now had to expend a great deal more effort in collecting and organizing data sets.

Not only did the divestiture eliminate AT&T as a primary source of the data, but it underscored the fact that the Bell System was no longer co-terminous with the telephone industry, that no single company, even if it were so willing, could be a provider of data for the entire industry. In short, by the mid-1980’s, not only had data in the telephone become proprietary, but it had become severely fragmented as well. Moreover, with competition and fragmentation, firm elasticities became distinct from industry elasticities, and care had to be used in interpreting elasticities that had been estimated with the data of a single company.

An additional consequence of the divestiture was that it restructured the intercity toll market into three markets in place of the two which had previously existed. Pre-divestiture, there was an intrastate market and an interstate market. Rates in the intrastate markets were regulated by state public utility commissions, while interstate rates were regulated by the FCC. With divestiture, the interstate market remained intact, but the intrastate market was split into two parts, an intralata market that was restricted initially to local exchange companies and an interlata/intrastate market that was open to any long-distance company, but was closed to the local exchange companies. The FCC continued to regulate interlata/interstate rates, while intralata and interlata/intrastate rates remained under jurisdiction of the individual states.

With competition in the intralata markets, the need to distinguish between firm and industry elasticities was immediately evident. Initially, this was not a problem in the intralata market, but in time competition emerged in that market as well, both as a result of policy and benignly through the use of 1-0-XXX dialing. The XXX refers to the unique three-digit code that was assigned to each of the long-distance carriers. Thus, 1-0-XXX for AT&T was 1-0-ATT (or 1-0-288). Dialing this number would connect the dialer directly to the AT&T toll switch, through which an intralata call could then be placed as though it were an interlata call. As this occurred, the same problems of analysis emerged as in the intralata markets. In fact, the problems were even more insidious with intralata data because analysts, using data obtained from the local exchange
companies, were often not even aware that the data did not pertain to the entire intralata market.

Objectively, there is really no way of knowing just how much the intralata price elasticities estimated using data from the billing records of local exchange companies may have been affected as estimates of the industry elasticity for the intralata market. Using data that will be described in Section III, it is now possible to take the presence of multiple carriers into account in estimating intralata price elasticities. These data, however, are obtained directly from households, rather than from the billing records of the local exchange companies.

The only study using billing records of local exchange companies of which I am aware that attempt to take into account the presence of competitive intralata carriers is Taylor and Rappoport (1994). This study finds a competitive effect on the size of the price elasticity that is statistically significant. However, the strong stability in the magnitude of the intralata price elasticity obtained in a diverse array of studies using local exchange company data which do not account for competitive effects suggests that the bias involved using pre-1994 data (say) has not been severe. Included in the studies in question are Duncan and Perry (1992), Hausman (1991), Taylor and Rappoport (1994), and Zona and Jacob (1990).

Another demand-modelling matter which emerged after the AT&T divestiture was a need to deal with the so-called custom- and class-calling features offered by the local telephone companies. In practice, services such as call waiting, call forwarding, three-way calling and speed dialing came to be offered individually or in packages of any two, any three, or all four. The bundled (or packaged) price was of course less than the cost had the consumer purchased the items in the bundle individually. In the early 1990's, several approaches to the modelling of the demand for these bundled services were pursued, including regular logit, conditional (or nested) logit, and multinomial probit models. [For a discussion of the underlying microeconomics in a random-utility framework, see Taylor (1994, Chapter 7). See also Kridel and Taylor (1993).] However, as will discussed in the next section, econometric analysis of commodity bundles is still in its infancy.

3. Current and Future Challenges in Modelling Telecommunications Demand

3.1. Data Availability

Let me begin with what is clearly one of biggest challenges currently facing empirical analysis of telecommunications demand, namely, the need for new sources of data. As mentioned in the preceding section, the emergence of competition has led to a drying up of data availability from traditional industry sources, namely, the telephone companies themselves. This has occurred, not surprisingly, because the telephone companies have come to view their data as proprietary and any elasticities that can be estimated from them as important trade secrets.

Even if access to company proprietary data were not an obstacle, fragmentation is. With multiple carriers, data from an individual carrier is restricted to that carrier's customers. Although local exchange companies in the US still do much of the billing for the long-distance carriers, the only information which can in general be made available to outsiders is that which relates to the LEC-supplied services. To get a complete picture of the telecommunications consumption of a household or business, one must tap the household or business itself.

The need for doing this is increasingly being recognized, and telecommunications data bases now exist which are based upon information obtained directly from the records of telecommunications users rather than from the records of service providers. PNR & Associates, for example, an economics and marketing consulting company in Jenkintown, PA, is now in the fourth year of acquiring telephone bills from households and in the second year of doing so from businesses.

The PNR surveys are referred to as Bill Harvesting™ and Business Wave™ for households and businesses, respectively. About 10,000 households and 3-5000 businesses are represented in the surveys. As of fall 1997, toll demand models, together with models describing carrier choice, have been estimated using data from Bill Harvesting I and Bill Harvesting II. See Rappoport and Taylor (1996), Taylor, Rappoport, and Kridel (1996) and Kridel, Rappoport and Taylor (1997a, 1997b). By obtaining data from users rather than from suppliers, it is possible (at least in principle) to construct a complete record of a user's telecommunications usage, rather than the fragmented records that can at best be constructed from the data of carriers.

3.2. Firm, Industry and User Elasticities

When there is just a single supplier in an industry, the firm and industry demand functions obviously coincide. With competition, however, this is no longer the case. Cross-price elasticities appear, and firm
demand functions emerge which are distinct from the industry demand function. Estimation of firm demand functions is far from easy, and existing efforts to isolate separate demand functions for the long-distance companies in the US interlata toll market using aggregate data published by the FCC are unconvincing (at least in my opinion). [My own efforts at estimating firm demand functions using FCC data have so far been determinedly unsuccessful. Other efforts (also problematic from my point of view) include a study by Ward (1995). See also Crandall and Waverman (1996, Chapter 5).]

Just as there is a difference between firm and industry demand functions, one must also take care to distinguish between the demand functions faced by individual suppliers and the demand functions for individual users when users have a choice among competing suppliers. Let me illustrate what I have in mind in this connection by describing the model for intralata toll calling in the US which was estimated by Taylor, Rappoport, and Kridel (1996) using data from the Bill Harvesting II data base of PNR & Associates. Since competition is now present in the intralata market in every state, the model relates toll calling activity not only to the toll price of the incumbent local exchange company, but also to the price charged by AT&T (taken as a surrogate for the other intralata carriers).

The models that are estimated allow for a cross-price elasticity for those households which used multiple carriers during the month covered in the survey. The price elasticities that are obtained are as follows:

- A price elasticity of about -0.25 for those households who use only the local exchange company for their intralata calls;
- A 'LEC' price elasticity of about -0.55 and a 'cross' elasticity of about 0.35 for those households who use multiple carriers for their intralata calls.

How are these elasticities to be interpreted? In view of the size and signs of the estimated elasticities, it is tempting to interpret them as being from the vantage point of the incumbent local exchange company: an 'industry' price elasticity somewhere between -0.25 and -0.30, a 'firm' price elasticity for the local exchange company of about -0.55, and a 'cross' elasticity with respect to a generic competitor of about 0.35. However, this would be a mistake. The data refer to households, so that the vantage point is that of residential users, rather than that of the local exchange company. The proper interpretation, accordingly, would seem to be as follows: For customers who are 'loyal' to their local exchange company, the intralata price elasticity is about -0.25; for customers who are 'disloyal' to their local exchange company, the intralata price elasticity is about -0.30, consisting of a 'LEC' elasticity of -0.55 and a 'cross' elasticity with respect to a generic competitor of about 0.35. [These results, it should be noted, are derived from a model in which the 'own' and 'cross' price elasticities are conditional on the decision to use a non-LEC intralata carrier. The carrier-choice decision is endogenized in Kridel, Rappoport and Taylor (1997b). The elasticities obtained differ somewhat from those just described, but are consistent with an overall intralata market elasticity of the order of -0.4.]

My point in the foregoing is not that the interpretation that has just been given is necessarily the correct one, but that when micro-level user data are used in estimating telecommunications demand functions in markets in which there are multiple suppliers, a great deal of care must be taken in interpreting the resulting price elasticities. Clarifying the issues and questions involved represents a major current challenge.

### 3.3. Choice of Carrier

Since the AT&T divestiture, interlata toll users in the US have had to specify a long-distance carrier that is accessed on a 1-plus basis. (What 1-plus means in this case is that whenever a user who has previously specified a specific long-distance carrier as that user's default carrier dials the number desired preceded by a 1, the local exchange company automatically routes the user's toll calls to that carrier.) Other carriers can still be used, but must be accessed through codes that entail the dialing of additional digits. This has given rise to the need to develop models which explain a consumer's choice of primary carrier.

With competition burgeoning in the intralata market, a similar need is emerging in that market as well. With the increasing availability of microdata bases that derive directly from the bills of telecommunications consumers, the challenge not one of data, but of simply doing the analysis, and then incorporating the results in a relevant way into appropriately specified toll usage models. An obvious framework to use is a two-stage model in which a probit or logit model which explains carrier choice is fed into a regression model which explains usage. A first attempt in doing this for interlata carriers using data from the Bill Harvesting II data base of PNR & Associates is described in Kridel, Rappoport and Taylor (1997a).
3.4. Optional calling plans

Competition in the toll markets in the US and Canada has been accompanied by a proliferation of subscription-based optional calling plans. An optional calling plan is simply a two- or multi-part tariff, in which payment of an upfront subscription fee entitles the user to a discount on usage. The basis for such calling plans is non-homogeneity of tastes and preferences among telecommunications consumers. In effect, what the plans provide are instruments for market segmentation. From a menu of calling plans, consumers self-select into the plans which best serve their needs and circumstances.

The beauty of such plans is that, in situations in which market price elasticities are less than 1 (in absolute value), a carrier can increase its revenues through a decrease in the price of usage, with the consumer as well as the carrier being made better off. This is a well-known implication of a two-part tariff (or more generally of non-linear pricing). For a discussion, see Brown and Sibley (1986). An additional benefit of optional calling plans to the carriers offering them is that members can be made to feel that they are part of community which receives special treatment, thus creating resistance to the blandishments of competitors.

Let me now turn to the problems that optional calling plans present to telecommunications demand analysis. Fortunately, problems of a purely technical nature have largely been solved, as there now exists a substantive literature dealing with both the theory and the econometrics of two- and multi-part tariffs. [See, among others, Taylor (1994, Chapter 3).] Hence, again, it is primarily a matter of obtaining the requisite data and then executing the proper analyses. As with carrier choice, a quantal choice framework provides an appropriate point-of-departure.

3.5. Bundles and packages

As has been noted, local exchange companies in the US and Canada for a number of years have offered a variety of custom- and class-calling features both individually and in packages. Bundled prices are always at a discount over what the cost to the customer would be if each of the services were purchased individually. Bundling clearly can clearly lead to a expansion of markets, for among other things supplying of services in a package can lead to a customer purchasing the package when in its absence none of the services would be purchased. [The papers laying out the relevant microeconomics of commodity bundles include Adams and Yellen (1976), Spence (1980), and McAfee, McMillan, and Whinston (1989). For applications to custom-calling features in telecommunications, see Kridel and Taylor (1993) and Taylor (1994, Chapter 7).]

With the passage of the Telecommunications Act of 1996, which opens the local exchange market to competition, and eventually the interlata market to the Regional Bell Operating Companies as well, the bundling of telecommunications services is certain to become of greatly increased importance. The challenges that this will present to telecommunications demand analysis are obvious.

3.6. Emergence of the Internet

A final challenge confronting telecommunications demand analysis is the Internet. The emergence of the Internet as a social and commercial force is such an amazing phenomenon that one has to be humble in its presence. No one, as far as I am aware, foresaw the Internet's rapid growth during the last half dozen years, and no one I venture to suggest has any real insight as to how it will develop in the next half dozen. In my view, the biggest challenge regarding demand analysis and the Internet is how to model the Internet itself. [For my own initial musings about how to go about modelling Internet demand, see Taylor (1996). See also Rappoport, Taylor, and Kridel (1997) and Rappoport, Taylor, Kridel, and Serad (1997).]

As far as telecommunications is concerned, the only thing that is really clear is that the Internet is currently both a substitute for telecommunications and a complement. It is a substitute in that communication and information retrieval and exchange over the Internet has taken the place of the same over telephone networks. And of course there is the lurking possibility (nay, likelihood) that direct voice communication over the Internet will eventually emerge in a major way. On the other hand, telecommunications and the Internet are also clearly complementary in that use of one frequently gives rise to use of the other, not to mention the fact that the backbone connection system of the Internet is supplied by local and long-distance telecommunications companies.

In the near term, telecommunications demand modellers should probably concentrate on building models to explain the demand for access to the Internet. Information for doing so will need to be collected from households and businesses, as is currently being done, for example, as adjuncts to the Bill Harvesting™, Business Wave™, and Request™ surveys of PNR & Associates. In turn, information on Internet access can
be used as a driver of calling activity in models of toll demand. In the longer term, there will have to be a multifaceted focus on modelling the end purposes for which use of the Internet provides inputs. The only thing that is even reasonably clear at this point is that the telecommunications and the Internet are going to be increasingly intertwined. [Initial analyses of data from Bill Harvesting and Request surveys which focus on Internet and on-line access are given in Rappoport, Taylor, Kridel, and Serad (1997) and Rappoport, Taylor, and Kridel (1997).]

4. Concluding Comments

In this paper, I have attempted to give an overview of the changes that have occurred in telecommunications demand modelling and the problems that face the current generation of telecommunications demand modellers. While the list of problems may be long, they are not insurmountable, and offer a variety of fun-filled challenges for ingenuity and innovation. The two biggest challenges, in my opinion, will be the acquisition and organization of relevant data bases and the development of a framework for modelling the Internet.

Also, I think it is important that telecommunications demand modellers see that the traditional role for the econometric estimation of price elasticities -- namely, for calculating the revenue effects of tariff changes in proceedings before regulatory commissions -- has largely passed. In a competitive environment, applied demand analysis still has an important role to play, ranging from the conventional forms of elasticity estimation to the identification of new markets. In doing this, though, it will need to be recognized that the focus of demand analysis will have to change from revenue requirements to marketing.

References


