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ECONOMIC RESEARCH
AND ANALYSIS

Ben Johnson®
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November 22, 1996

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, NW, Suite 222
Washington, D.C. 20554

Re: *Ex parte* filing
CC Docket 96-98

Dear Mr. Caton:

In accordance with the Commission's rules, this filing will provide notice that Ben Johnson Associates, Inc. has transmitted to the Commission Staff copies of its proprietary software *The Telecom Economic Cost Model*, along with its user documentation. The model is provided on a 3.5" diskette; the documentation is provided on paper.

Pursuant to Commission Rule 1.1206(a)(1), two (2) copies of this letter, the software and the documentation are being filed for inclusion in the public record.

Sincerely,

Ben Johnson, Ph.D.
President

cc: Chairman Hundt

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REPORT

Ben Johnson® Associates, Inc

Telecom Economic Cost Model

USER DOCUMENTATION

November 22, 1996

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Getting Started

Overview

The Telecom Economic Cost Model estimates the economic cost of local telephone networks. A user can estimate the costs of unbundled network elements as well as the costs of major network services like local exchange and switched access.

A wide variety of economic costs can be estimated: Long Run Average Cost (LRAC), Total Service Long Run Incremental Cost (TSLRIC), Total Element Long Run Incremental Cost (TELRIC), Long Run Marginal Cost of a Service (LRMCS), and Long Run Marginal Cost of an Element (LRMCE).

The user can analyze and compare costs under both monopoly conditions and competitive conditions by specifying the percentage market share served by the modeled network—from 100% for an incumbent monopolist down to 5% or less for a minor competitive carrier. Since the model's planning horizon assumptions are long run and forward looking, almost complete variability is possible in the size and design of the cable plant serving the central office. However, the model is

normally run with the loop length data of existing wire centers (a "scorched node" rather than "scorched earth" approach).

The model also allows the user to isolate and separately analyze the economic costs of serving several specific types of customers (e.g., single line and/or multi-line, business and/or residential) and of a wide variety of geographic areas.

The Telecom Economic Cost Model is an "open" model: the user can study all the algorithms used to develop the cost estimates; the user can also trace from each input to each output, or vice versa, by studying the formulas in each cell or by using the "auditing" function in Microsoft Excel.

Computer Requirements

The Telecom Economic Cost Model was developed for Microsoft Excel 7.0, running on a Windows 95 operating system, but it can operate with earlier versions of Excel and Windows. The minimum hardware requirements are a 486 computer with 16 megabytes of RAM. However, we recommend 32 megabytes of RAM for the processing speed to view most results within a few seconds after a wire center is selected or an assumption is changed.

Operating Instructions

To use the model, first locate its file containing the model. While the file name may vary, it will typically be something like BJTECM.xls. Also locate the file containing the loop database. While the file name may vary, it will typically be something like STATEdata.xls. Either of these files may be contained within a compacted file with a name like NAME.zip which must be "unzipped" using standard software such as WinZip or PKUnzip.

Open both the model file and the loop data file, using Excel. You may then be asked whether to "re-establish links." If the loop data file is available, answer *yes*, allowing the model to read the data file. If a loop data file is not available, answer *no*, allowing you to study a user-defined hypothetical wire center (see below).

License Agreement and Introduction

When the model opens, you will be presented with a License Agreement, which you should read carefully. If you need to engage in activities not authorized by the agreement, contact Ben Johnson Associates, Inc. at (904) 893-8600. If you reject the agreement, the model will automatically close. If you accept the license terms, you will be taken to an introductory page, *Intro*. To begin working with the model, click the "Control" button in the upper portion of the screen, using the left button of the mouse (or other pointing device). This will take you to the *Control* page, allow you to specify the type of economic cost to study, and give you access to the remainder of the model.

Control

The *Control* page allows you to specify the type of economic cost to be estimated, selecting from five categories: Long Run Average Cost (LRAC), Total Service Long Run Incremental Cost (TSLRIC), Total Element Long Run Incremental Cost (TELRIC), Long Run Marginal Cost of a Service (LRMCS), and Long Run Marginal Cost of an Element (LRMCE).

After selecting the appropriate economic cost category, push the "Establish Parameters and View Results" button. This takes you to a page where you can precisely define the type of economic costs to be studied, along with certain related parameters.

Changing Assumptions

You can modify numerous other input values and assumptions by pushing the "Financial Assumptions" and "Technical Assumptions" buttons that appear at the bottom of the *Control* page and at the top of various other pages. Pushing these buttons takes you to the pages containing the key assumptions used by the model, all of which can be easily verified or modified. The financial assumptions include income tax rates, debt/equity ratios and cost rates, economic lives, plant-specific expense ratios, and various unit investment amounts (e.g., labor rates per hour). The technical assumptions include facility utilization and sharing factors, average calling characteristics, technical characteristics of the network, cable splicing and placement times, and various other assumptions.

Studying Individual Wire Centers

While the Telecom Economic Cost Model can analyze costs for entire states or regions, it accomplishes this one wire center at a time. This reduces the minimum computer hardware required to run the model. It also allows you to study each wire center in full detail. For instance, you can modify key assumptions to better fit the characteristics of particular wire centers, if you need this higher level of precision for a particular study.

To operate the model, you must select a specific wire center for which the model will estimate costs. Three types of wire centers can be selected:

- A hypothetical wire center with typical characteristics, such as a rural area, a small town, an urban business area, or an urban residential area.
- An actual wire center with characteristics specified in a data file. If the required data file is not available, you can gather the data and

prepare the required file, or contact Ben Johnson Associates, Inc. (904) 893-8600.

- A hypothetical wire center with characteristics that are user-established. Selecting this choice and pushing the "Establish characteristics" button takes you to the *Hypothetical Wire Center* page. You can then define a wire center with appropriate characteristics for the study in question, by specifying the average loop length, number of households, and number of business loops within each of four geographic quadrants served by the wire center.

Studying Large Areas

If you want to study costs for an entire state or other large geographic area, you can do so by studying each of the wire centers within the specified area. As each wire center is studied in turn, you simply accumulate the resulting cost estimates, which you can then list, total, or average, as you choose.

Illustrative Pages

Appendix A contains illustrative excerpts from the model, replicating on-screen displays that you will see as you use the model.

Specifying the Type of Economic Cost

Types of Economic Cost

A key feature of the Telecom Economic Cost Model is its versatility in allowing users to compare and contrast a wide variety of different economic cost concepts. The model can develop five broad categories of long run economic cost estimates: Long-Run Average Cost (LRAC), Total Service Long-Run Incremental Cost (TSLRIC), Total Element Long Run Incremental Cost (TELRIC), Long-Run Marginal Cost of a Study (LRMCS), and Long Run Marginal Cost of an Element (LRMCE). Within each of these broad categories, a variety of different specific long-run cost estimates can be developed.

Average cost is the total cost of producing a given quantity of output, divided by the total number of units produced. In contrast, *marginal cost* is the rate of change in total cost resulting from changes in output. In a sense, average cost and marginal cost lie at two ends of a spectrum, with incremental cost ranging between these two extremes, depending upon the defined increment.

Incremental cost is the change in total cost resulting from a specified increase or decrease in output. In mathematical terms, incremental cost equals total cost assuming the increment is produced, minus total cost assuming the increment is not produced. Because a wide variety of different increments (changes in output) can be specified, incremental cost can be very similar to (or equal) average cost, or it can be very similar to marginal cost, depending upon the specific increment being studied.

Long Run Average Cost (LRAC)

Average costs can sometimes be useful in evaluating barriers to entry, and the likelihood that a new carrier will find it profitable to build a network to serve a particular geographic area. Unless the carrier anticipates generating total revenues in excess of its total costs, it is not likely to enter a market. In making this evaluation, a comparison of average revenues to average cost may be useful, particularly where market segmentation and/or price discrimination are not significant factors. Where they are significant in a market, however, an average cost analysis should be supplemented with a marginal cost analysis, or a precisely focused incremental cost analysis, in order to fully evaluate the prospects of the carrier recovering its total costs.

Similarly, if a new entrant's expected average costs is less than the average costs it would incur using the services or unbundled elements of another carrier, it may not choose to install its own network, unless the carrier places sufficient emphasis on the quality control and other benefits of controlling its own facilities. Thus, average cost calculations

can be useful in evaluating the likelihood that facilities based entry will occur in a particular market.

To conduct a Long Run Average Cost study, select this option on the *Control* page, then push the "Establish Parameters and View Results" button. This takes you to the *LRAC* page. Here various choices allow you to precisely define the type of average economic cost you want to estimate. The options are outlined below.

Stand-Alone or Composite Costs

You must choose among single and/or multiline residence and/or business customers. If you select a narrow market category (e.g., residence customers only) the model will produce a "stand alone" cost study for this category of service. For instance, specifying residence customers only or business customers only will cause the model to build a network serving the locations specific to those customers and with facilities scaled to meet their needs alone.

By contrast, if you select both residence and business customers, the model will build a larger, more extensive network serving both residential and business locations and will thus estimate the average cost of serving both types of customers simultaneously. Economies of scope tend to make the latter figure lower than the stand-alone average cost of serving either category separately.

Direct, Joint and Common Costs

You must also decide whether to limit the study to direct costs or to include shared (joint and/or common) costs as well, specifying the amount.

Joint costs are a specific type of shared cost--one incurred when production processes yield two or more outputs in fixed proportions. Put another way, once joint costs are incurred to provide one product or service, they are costlessly available to provide one or more other products or services as well.

A classic example arises in the joint production of leather and beef. Although cattle feed is a necessary input for the production of both gloves and hamburgers, there is no economically meaningful way to separate out the feed costs that are required to produce each. If the quantity of leather and beef is reduced, there will be a savings in the amount of cattle feeding costs, but it is impossible to say how much of this change in cost results from the change in the quantity of leather and how much from the change in the quantity of beef.

The joint cost percentage you select is included in the study output. For a "pure" economic cost study, this would normally be set at 0% for a single service (e.g., local exchange). It would be set at 100% for the entire family of services engaged in the joint production process.

In general, *common costs* are incurred when production processes yield two or more outputs. They may be common to the firm's entire output or to just some parts of its output. An increase in production of any one good will tend to increase the level of common costs; however, the increase will not necessarily be proportional. The costs of producing several products within a single firm may be less than the sum of the analogous costs that would be incurred if each of the products

were produced separately. The savings thus obtained are known as *economies of scope.*

The Telecom Economic Cost model does not analyze common costs in detail; it simply adds a user-specified allowance for them as a percentage of the direct and/or joint costs included in the study.

Network Size

Economies of scale and scope can cause average costs to vary widely with the size of the network. As telecom markets become more competitive, it becomes increasingly important to consider how a carrier's costs are related to its network's market share as well as to that network's geographic scope. The model will build a network sized to optimally serve whatever portion of the market you specify. Thus, for example, if you specify 100% market share, the model will build a network of optimal size to serve all of the (business and/or residence) customers in the specified geographic area; if you select a 25% market share, the model will build a smaller network, just large enough to serve one-fourth of the total market.

To provide for cost variation within individual wire centers, the model gives each wire center two geographic zones--zone 1 covering the highest density portions (assumed to be in the immediate vicinity of the wire center or end office switch) and zone 2 covering a much larger area, with greater loop lengths and a lower concentration of customers.

The LRAC cost estimates are displayed at the bottom of this page for the selected wire center. The total cost per line is shown, and the costs are disaggregated into functional

categories. If you have chosen to include joint or common costs, these appear, as well.

Total Service Long Run Incremental Cost (TSLRIC)

Total service long run incremental cost is equal to the firm's total cost of producing all of its services assuming the service (or group of services) in question is offered, minus the firm's total cost of producing all of its services excluding the service (or group of services) in question. TSLRIC has also been defined as the change in total cost resulting from adding the entire amount of a service to the company's total output, with the output of all other services remaining constant. In effect, TSLRIC measures the difference between producing a service and not producing it.

TSLRIC can be useful in public policy and pricing decisions. For example, TSLRIC estimates can indicate the presence or absence of subsidies for a service in the aggregate. Similarly, incremental costs can be useful in developing or examining regulatory or pricing policies applicable to a particular service or group of customers. For instance, the Telecom Economic Cost model can compute the additional cost incurred when a network is expanded to serve a specified block of customers (e.g., all residential customers, or the most price-sensitive portion of the market, or the low-income customers eligible for a special program, etc.). Incremental cost is a key consideration in evaluating the price charged the specified block of customers.

To conduct a TSLRIC study, select this option on the *Control* page, then push the "Establish Parameters and View Results" button. This takes you to the *TSLRIC* page, where you may

precisely define the type of incremental cost to estimate. A wide choice of cost studies is available.

Defining the Increment to be Studied

Since incremental cost is the change in total cost associated with a specified increase or decrease in output, it is fundamentally a comparison between two alternative scenarios (one with and one without the output increment). Accordingly, the model estimates TSLRIC by building two networks of different size and scope, then comparing the resulting costs.

You can specify whether the increment is added to or removed from the alternative network. This decision may affect the way you interpret or describe your study, but it generally doesn't affect the cost estimates in a long run context, where sunk costs are not involved, and all costs can vary. If you decide to proceed by adding the increment, the network will be modeled excluding the service in question in the first configuration and including it in the second. If you decide to proceed by removing the increment, the order of the configurations will be reversed. In either order, the model simultaneously calculates the costs associated with these two alternative networks, compares them, and computes the difference, which is equal to the TSLRIC of the specified increment.

For most purposes TSLRIC is usefully stated on a per unit basis. In fact, it is common practice to report and refer to TSLRIC per unit, without including the term "per unit." In the model, aggregate TSLRIC is computed for each wire center, and this aggregate amount is then divided by the change in output (incremental volume), resulting in TSLRIC per unit. It is

the latter figure (TSLRIC per line) which is reported at the bottom of the TSLRIC page.

The model can produce a wide variety of different TSLRIC studies, depending upon the defined increment. For example, you can choose to study the incremental costs of serving residence customers assuming business customers would be served in any event. Conversely, you can choose to study the incremental costs of serving business customers assuming residence customers would be served in any event.

You are not limited to these basic choices, however. By specifying the percentage of customers (market share) in various categories, you can develop a wide variety of different TSLRIC studies. For example, you can estimate the TSLRIC of adding a specific group of residence customers to a network that would otherwise serve business customers and all other residence customers. Do this by specifying the percentage of residence customers served in the two configurations (with a larger percentage in the configuration including the specified group).

Similarly, you can estimate the incremental cost of expanding the network to serve zone two (farther from the central office), by "adding" these customers to a network that would otherwise only serve customers in zone one (nearest to the central office). Such an estimate can be useful in a situation where competitive "cream skimming" is a possibility and the analyst wants to determine the TSLRIC of providing service to customers in the outlying portions of the service area, assuming the carrier would provide service to close-in customers in any event.

Direct, Joint and Common Costs

You must also decide whether to limit the study to direct costs or to include shared (joint and/or common) costs as well. If joints costs are included, you must specify their amount.

Joint costs are a specific type of shared cost--one incurred when production processes yield two or more outputs in fixed proportions. An alternative way of describing joint costs is that, once they are incurred to provide one product or service, they are costlessly available to provide one or more other products or services as well.

The joint cost percentage you select will vary. For a "pure" economic cost study, it would normally be set at 0% for a single service (e.g., local exchange). It would be set at 100% as part of the economic cost of the entire family of services engaging in the joint production process.

In general, common costs are incurred when production processes yield two or more outputs. They are often common to the firm's entire output but can be common to just some parts of it.

The Telecom Economic Cost model does not analyze common costs in detail; it simply adds an allowance for these costs as a percentage of the direct and/or joint costs included in the study. The percentage selected by the user specifies the allowance for common costs which will be added to the direct and/or joint costs which are estimated by the model.

Network Size

The model will build two networks, each sized to optimally serve the applicable share of the market. Thus, for example, if

the user decides to "add" residence service to a network serving business locations, the model will not include any facilities for residence customers in Configuration One, in effect setting the residence market share at 0%. However, you must specify what fraction of the business customers will be served in both configurations and what fraction of the residence customers will be served in Configuration Two. If the user is studying an incumbent monopoly carrier, this would typically be set at 100%, as would the business market shares in both configurations. Of course, when studying the costs faced by a new entrant, a lesser percentage share of the market would normally be appropriate.

You should ensure that the selected percentages are appropriate to the issues being studied, since economies of scale and scope can influence the TSLRIC estimates, although the impact tends to be less dramatic and less predictable than with LRAC estimates (where costs tend to consistently and substantially decline as network size increases).

Total Element Long Run Incremental Cost (TELRIC)

The FCC developed its own version of economic cost for purposes of implementing the 1996 Telecom Act, coining the term TELRIC (total *element* long run incremental cost) to describe the method of economic cost calculation it believes is most appropriate.

> 672. *Overview.* Having concluded in Section II.D., above, that we have the requisite legal authority and that we should establish national pricing rules, we conclude here that prices for interconnection and unbundled elements pursuant to sections 251(c)(2), 251(c)(3), and 252(d)(1), should be set at forward-looking long-run economic cost. In practice, this will

> mean that prices are based on the TSLRIC of the network element, which we will call Total Element Long Run Incremental Cost (TELRIC), and will include a reasonable allocation of forward-looking joint and common costs...

By coining its own term, TELRIC, the FCC has highlighted certain distinctions between its approach to costing network elements and the TSLRIC concept generally applied to telecom services. First, in its Implementation Order, the FCC required that certain shared or common costs be included in TELRIC, even if they do not vary with the presence or absence of the element in question. Since the FCC's requirements in this regard are not consistent with the standard definition of TSLRIC in its pure form, by coining a distinct term (TELRIC) the FCC has avoided some potential confusion in this regard. Second, when the TSLRIC concept is applied to elements (rather than services), the magnitude of the joint and common cost problem tends to be reduced.

TELRIC and TSLRIC are identical in one respect: they are both long run economic cost concepts, using a theoretical planning horizon where most inputs are variable, including the scale and type of plant used by the firm.

To conduct a TELRIC study, the user selects this option on the *Control* page, then pushes the "Establish Parameters and View Results" button. This takes the user to the TELRIC page. Here the user is offered various choices. The user may select an element from a list of several different elements (loops, excluding CPT; loops, including CPT, except NID; customer premises termination (CPT), except NID; network interface

devise (NID), port (non-traffic sensitive end office switching); traffic sensitive end office switching; other end office features). The user estimates the incremental cost of adding the element to a network containing all other elements necessary to provide bundled service.

Direct and Common Costs

You must also decide whether to limit the study to direct costs or to include common costs as well. If you wish to include an allowance for common costs (rather than analyze them separately), you must specify the amount. A "joint" cost percentage factor is not required, since the costs in question are directly attributable to specific elements. For instance, a distribution cable jointly used for toll and local service is exclusively attributable to the loop element. It is not jointly used in the production of end office switching.
The Telecom Economic Cost model does not analyze common costs in detail; it simply adds an allowance for these costs as a percentage of the direct and/or joint costs included in the study. The percentage you select specifies the allowance for common costs added to the direct and/or joint costs estimated by the model.

Network Size

Economies of scale and scope can cause TELRIC estimates to vary widely with the size of the network. As telecom markets become more competitive, it becomes increasingly important to consider how a carrier's costs will be affected by the share of the market its network serves, as well as by the geographic scope of its network. The model will build a network sized to optimally serve whatever portion of the market you specify. Thus, for example, at 100% market share, the model will build a network optimally sized to serve all of the (business and/or

residence) customers in the specified geographic area. In contrast, at a lower percentage, the model will build a smaller network, one just large enough to serve the specified share of the total market.

To allow for cost variation within individual wire centers, the model provides for two geographic zones: zone 1 covering the highest density portions (assumed to be in the immediate vicinity of the wire center or end office switch) and zone 2 covering a much larger area, with greater loop lengths and a lower concentration of customers.

The TELRIC cost estimates are displayed at the bottom of this page for the selected wire center. The total cost per line is shown, and the costs may be disaggregated into functional categories or sub elements. Any allowance for common costs you have chosen is shown, as well.

Marginal Cost

Marginal cost is the rate of change in total cost resulting from changes in output. In mathematical terms, marginal cost is the first derivative of the total cost function with respect to output, assuming the cost function is continuous and smooth. In practical applications, the cost function is not necessarily smooth or continuous. Accordingly, it is sometimes necessary to estimate marginal cost over a discrete interval, using smoothing or averaging techniques. When properly applied, marginal cost focuses on the effect of very small changes in output occurring at the point in the total cost curve where the firm is operating and decisions are being made.

To estimate the marginal cost of a service, first select the appropriate option on the *Control* page and push the "Establish Parameters and View Results" button, which takes you to the *LRMCS* page. Follow a similar procedure to estimate the marginal cost of a network element.

Stand-Alone or Combined Costs

You must choose what group's marginal costs to study: single and/or multiline residence and/or business customers. For example, if you wish to estimate the marginal cost of local exchange service on a network serving only residence customers, the model will build a network that serves only residential locations and will scale the facilities to meet the needs of these customers alone. To compute marginal cost, the model will resize the network in a series of iterations smaller and larger than this optimum, or midpoint size. In turn, the model will compute the slope of the total cost curve resulting from this series of computations.

By contrast, if you decide to estimate the marginal cost of local loops on a network that includes both residence and business customers, the model will build a larger, more extensive network of appropriate scale and scope to serve both residential and business locations. To compute marginal cost, the model will resize the network in a series of iterations smaller and larger than this optimum, or midpoint size, based upon variations in the number of business and residence customers served. In turn, the model will compute the slope of the total cost curve resulting from this series of computations, thereby estimating the marginal cost of loops used to serve these customers on a combined network.

Direct, Joint and Common Costs

You must also decide whether to limit the study to direct costs or to also include shared (joint and/or common) costs. In the latter case, you must specify the amount to include in the study.

Joint costs are a specific type of common cost--one incurred when production processes yield two or more outputs in fixed proportions. For a "pure" economic cost study, you would normally set joint costs at 0% for a single service (e.g., local exchange) and at 100% for the entire family of services engaged in the joint production process.

A joint cost percentage factor is not required for the marginal cost of elements, since the costs in question are directly attributable to the element in question. For instance, a distribution cable jointly used for toll and local service is exclusively attributable to the loop element. The cable is not jointly used in the production of something like end office switching.

In general, common costs are incurred when production processes yield two or more outputs. They are often common to the entire output of the firm but can be common to just some parts of that output. The Telecom Economic Cost model does not analyze common costs in detail; it simply adds an allowance for these costs as a percentage of the direct and/or joint costs included in the study. The user-selected percentage specifies the allowance for common costs that will be added to the direct and/or joint costs estimated by the model.