PAPER No. 511

Author: A H ELLDIN

Question by E BÖHM

It is stated in the paper that the monetary value of a tariff component decreases because of increased standard of living and inflation. Both effects are expressed by the parameter \( D \) in the term \( e^{-t} \). - Would it not be preferable to take account of inflation separately from economic growth, namely by considering real instead of nominal prices (real price = nominal price/index of cost of living)? The cost of living increased in many countries by accelerating rates. Economic growth is one of the causes of the so-called "natural increase". Therefore it should be included in the parameter \( D \).

Answer

This paper only presents an idea which has not been checked on any statistical data. All suggestions are therefore mostly welcome.

We have two types of changes with time. One is that the same price will be considered as cheaper with time. For this is used \( e^{-t} \), so \( D = e^{-t} \) in fact the real price in year \( t \) at the price level for year \( t = 0 \). The other change is the so-called natural growth of the traffic volume - or number of subscribers. This is expressed in \( e^{\text{pc}} \) (which in most cases equals the forecast, since most forecasts are made under the assumption of unchanged rate and unchanged price level). I gratefully accept your explanation of this natural growth as an effect of increased rates and increased cost of living.

Question by H Y KRAEPELIEN

Par. 4 refers to my study (read at the second ITC congress) as "short term study". This is incorrect. I stated on p. 110 that equation (3.5), the basic formula, applies "after the subscriber has adopted himself to the new rate". I am convinced that the subject matter must be approached by:

A. Estimating the number of subscriber lines at the new rate by applying traditional price theory with monthly rates, Gross Domestic Product etc., as parameters.

B. Estimating average calling rate per subscriber line by applying a theory where the demand is governed by the dimensionless ratio of message unit rate over monthly rates. This is consequently not true price elasticity.

How does the author reconcile following two statements?

Par. 4: "For a telephone tariff change of this type the immediate reaction should not be visible after one year". (A statement that is not borne out by my empirical data.)

Par. 8: "--- an exceptionally high tariff reduces the demand to zero".

Answer

This is quite familiar with your paper 15 years ago, but I admit that I may have reread your paper a little carelessly. Your approach may very well apply on long term effects as well. I suggest further studies of this matter. Price checks, short term effects and long term effects from change of telephone tariffs must be studied more.

As regards the direct question, the assumption of \( V = 0 \) when \( D = \infty \) is in no way contradictory. We have only to understand the concept of infinity as greater as anything we can think of in practice. If you change one number to zero, this may be what in practice corresponds to \( D = \infty \).

Question by K RAHKO

In your simple mathematical model you do not consider the influence of gross national product and its development. Is it not an important factor?

Answer

Yes, the expected change in the gross domestic product per capital is usually used to roughly estimate the future subscriber density for a whole country. Since there are different definitions of the gross domestic product or the gross national income it seems best to use the gross domestic product at factor costs (UN statistics' terminology) for this estimation. This has been studied by a Working Party in CCITT (ref. No. 4, as well as an addition to this book, published late 1972) as well as the influence of other economical factors on the use of telecommunication services. The gross domestic product is, however, only available for a whole country. It seems questionable if it can be applied to a certain country. Other measures have to be used in the forecast.

As an answer to your question I say that it is quite clear that the gross domestic product per capital indicates the economic standard of living in a country. If the telephone density is high it can be used as a measure of the degree of price sensitivity towards a telephone tariff change. On the other hand, if the telephone penetration is low this measure may not be so good, since most subscribers are business subscribers and only a few rich people can afford to subscribe on a telephone in their residence. Other measures have then to be used in the parameter estimation.

Question by A R VAN DER WEG

In section 5, page 2 of your paper you write that a study of the effect of changes in \( I \) and \( R \) on \( \Delta N \) can give no sensible results if the waiting list exceeds the annual production of new subscriber lines. I ask you if you agree with the following line of thought. A change in the production capacity \( P \) in the case that the production capacity in \( t \) exceeds the production capacity in \( t+1 \), etc. are affected by the tariff change. On the other hand the tariff policy of the Administration will clearly affect future revenues and therefore most probably the amount of money disposable for future investments. This amount on its turn will restrict the possible annual production of subscriber lines. Concluding, we can say that tariff-changes on the one hand affect the waiting list, the length of which determines \( \Delta N \) in the case that the production capacity is bigger than the waiting list, the disposable money for investment purposes will in fact determine \( \Delta N \) in the opposite case.

Answer

The model in its present form is not advanced enough to take into account the existence of a non-negligible waiting list of subscribers. Your suggestion is, however, interesting and I am anxious to see how you can extend the model. I think, however, that it might be unrealistic to connect disposable capital for investments and revenues
without taking account that there is generally a decision function on a political level in between them.

Question by A R VAN DER WEG
In section 6 on page 2 of your paper where you are formulating the mathematical model you write that the real value of D increases with time because of inflation, etc., the consequence of which is that according to formula (1) V increases. In other words: the subscribers have no money illusion. Then you say that the parameter \( B \) must be determined from periods when D has not been changed. Supposing that you have in mind an unchanged real value of D, my question is if there are in fact periods in which the real value of D is unchanged. In other words: estimation of \( B \) feasible in such question which statistical method will you use when you are going to estimate the parameters of formula (1)?

Answer
It would be easier to understand a \( B \) as the increase given by the forecast, since the forecasts in most cases assume unchanged price level and unchanged tariff. The price of D at time t is \( \hat{D}_t \) expressed in the price level of \( t = 0 \). Before one starts to think on methods of parameter estimation it is desirable to study statistical data to see if it agrees with the general idea of the presented model. There are several possible methods for estimation of the parameters but it would be desirable to have as few parameters as possible so as to make the model more simple and reliable. A certain revision of (1) may possibly simplify the parameter estimation.

Question by I MOLNAR
As a substitute of a controlled experiment, this paper suggests to derive the law of dependence of traffic on the rate structure by comparing the results of prolonged observations of "normal" traffic growth during epochs when the rates for telephone service remain unchanged, as against traffic growth during such epochs when rates have increased (or decreased?). Now, telephone traffic, as all manifestations of socialities, is affected by a great variety of factors, concurrently or shifted in time, and which may or may not be correlated with each other to some degree. The problem to face then is to centrifuge out of this melange the rate ingredient by some special technique of correlation analysis, or even more so by analysis of variance techniques, particularly as applied to time series.

My question is whether you have investigated any of these approaches, or some other for this purpose? If so, it would be interesting to know your experience.

Answer
I refer to my answers to Dr. Böhm and to Mr. van der Weg. The method has not yet been tried on any statistical data. The problem of estimating the parameters therefore remains unsolved. Modifications of the model may be necessary to simplify the parameter estimation.

Question by J E FULENIWIDER
This is a very interesting model study particularly since we are now studying alternatives to flat rate service and any views on the relationship between traffic (and hence revenue) and tariff is sought.

What led you to the general form of equations (3), (4) and (5)? Are they based on a feedback effect?

Answer
The basic function is given in expression (1) and explained in section 6.2. The idea is that a very low rate - or no rate at all (D=0) - still gives a limited traffic demand. On the other hand a very high rate reduces the demand to only a few very important calls, so we can put \( V=0 \) for \( D=\infty \). As regards the shape of the curve between these two extremes we know that we get different reactions if a high and if a low rate is changed. Therefore it was necessary to find a function that had an inflexion point in the working area of D and expression (1) satisfied this condition if \( D \approx 0.5 \). The constant \( q \) (which should be >0) serves to adjust the reaction to suitable strength.

The expressions (3), (4) and (5) are then built up as products of expression (1), one for each tariff component, the influence of each being adjusted to its reasonable influence by mainly its constant q.

The model presented here does not consider flat rate cases or tariff systems with free local calls. When applying it on these type of tariff a certain caution is recommended.

Question by J A BURGESS
I would like to ask Mr. Ellidin if he has any data comparing subscriber calling rates for "flat rate" and "message rate" tariff structures. By "flat rate" I refer to a system of charging where the subscriber pays only a rental and is allowed free calls over a wide area (long distance trunk and international calls of course are charged for) and by message rate where subscribers pay a rental and for each call on either a timed or untimed basis, I have made a few limited investigations on this subject and have found that in general business calling rates are similar for the two tariff structures but for residential lines wide differences occurred. If the order of 3 or 4/1, flat rate versus message rate can occur.

Answer
Unfortunately I have no such data, but your observation is very interesting since it shows that residential subscribers are more price sensitive than business subscribers.

Question by H Y KRAPELIER
I believe telephone administrations will have difficulty when preparing their budgets in estimating the effect of tariff changes on the telephone traffic, and the resulting effect on the revenue, unless a better understanding is obtained regarding what kind of elasticity we are confronted with in the case of demand for local message units per subscriber line.

Attached Figure T-1 illustrates the effect of the Tariff Structure on Local Telephone Traffic, it contains usage data for 94 cases from 55 cities in 17 countries on all continents except Africa. The number of subscriber lines in those cities varies from about 10 000 to over 1 000 000. The time span is half a century (1922-1972). Cases studied include business subscribers, residence subscribers as well as cases with a common tariff for both classes. The chart covers Flat Rate cases as well as Measured Tariff cases with and without message allowance.

The usage data, M, representing average number of completed outgoing local message units per subscriber line per month, has been plotted against a traffic reduction coefficient \( m \). The formula for \( m \) contains a few parameters. Among them three tariff parameters - basic recurring charge, message unit rate and mass message unit allowance - plus parameters for intensity in subscriber reaction, and others.

For comparison with reported usage data, \( m \) is also presented as three regression lines, each representing a typical subscriber class definition. As expected, the points in the chart show a certain dispersion, because there are innumerable factors, besides the tariff structure, which influence local telephone traffic. (Most of the major deviations in the chart are due to explainable reasons, however.)

1. There is a definite pattern in the influence of tariff structure on traffic.

2. The tariff structure has a very strong influence on the traffic.

Certain parameters in the formula for \( m \) have been estimated rather approximately for the purpose of establishing a reasonable general fit between reported and computed usage figures.

It is desirable to collect additional and more precise data in order to determine the proper values of some of the parameters used and to determine the effect of a few other major factors influencing the traffic. In line with this, the study should be extended to cover also cities with less than 10 000 subscriber lines.


**Fig. T-1.**

Answer

Mr. Kraepelien has studied these problems during a period of more than 20 years and it would be very useful if he could publish his work to the benefit of all who work with traffic problems.

PAPER No. 512

Authors: G MASETTI and G MIRANDA

Question by K RAHKO

In your paper there is presented a very useful computer-aided forecasting method. It would be useful also in international network planning if it takes into consideration the 24-hour traffic profile and the variations of traffic interest ratio. Which are the authors' opinions?

Answer

The 24-hours traffic profile has been considered in our model only for the choice of network busy hours at different hierarchical switching levels, on the base of which the Italian toll network is planned, without considering the possibility of any dynamic management actions in routing strategies, which are not allowed at present. The computing procedure illustrated in the paper can be applied to every network - national or international - based on the same management principles and being at our disposal input traffic data of the same type as ones described; otherwise the computing program must be modified accordingly.

As to the second part of the question, in case of variations - during the forecasting time interval - of the traffic interest coefficients, which are foreseeable at the time the forecasting are made but are not expressed by trend of historical data, the operator must put them manually into the computer, and then the computing procedure will readjust automatically the output traffic of the forecasted matrix.

PAPER No. 514

Author: S S KATZ

Question by G MATIGNON

How do you improve the robustness of the network under random load variations?

In particular, do you use dual service criteria?

Answer

There are three methods that may be employed in the Network Planning Programme to deal with load variations.

1. I mentioned in my talk that both peak and normal busy-hour loads may be specified to the Network Design Programme.

Dual service objectives may be specified for final trunk group blocking probabilities to offer different levels of service protection under Busy Season Busy Hour and peak traffic load levels.

2. Multiple busy-hour loads may be specified to reflect non-coincidence of busy season traffic throughout the day.

3. A third method of including robustness in the selection of a network routing plan is to subject the network configuration for each plan, corresponding to the same point in time, to random variations of the engineered loads. These random variations (which should be replicated a sufficient number of times) may reflect uncertainties in load forecasts or load measurements.

Using a service evaluation program, such as that described in reference 1, one can calculate point-to-point service for each set of load variations and produce distributions of point-to-point service, representing the robustness of each routing plan to deal with variations from engineered load levels. This may provide the basis for selecting a network routing plan from alternatives, if the costs are comparable.

Question by G MATIGNON

Tandem Program Monitor.

How do you adjust the policy of INCAP and MAXCAP to ensure the best rate of convergence?

Answer

The type of adjustments to MAXCAP and INCAP are described qualitatively, as I am sure you have seen, in Section 2.7. The quantitative details of these adjustments (e.g., whether over-relaxation methods are needed to improve convergence) will be based upon extensive experimentation which will begin late this year. These will be documented in detail, as warranted by the success of the experimentation.

Question by G MATIGNON

Tandem Allocation Process.

When you bring a new candidate tandem into the solution of continuous variable problem, can you always choose it with enough confidence? e.g., Is there always a k such that $\sum x_{jk}/INCAP_k$ is close to 1?

Answer

The type of adjustments to MAXCAP and INCAP are described qualitatively, as I am sure you have seen, in Section 2.7. The quantitative details of these adjustments (e.g., whether over-relaxation methods are needed to improve convergence) will be based upon extensive experimentation which will begin late this year. These will be documented in detail, as warranted by the success of the experimentation.

Question by G MATIGNON

Switched Load Process.

What kind of approximation do you use to recompute the number of trunks ($\Delta$ NTK) and the overflow probability ($\Delta$ B)?

Answer

The approximation represents a special case of step 10 of the switched load process (section 2.4), which allows recomputation of $B_{XY}(t)$ and $NTK_{k}(t)$, using the results obtained from the last iteration of step 10. Details will appear in subsequent documentation of the Multi-Stage Tandem Program Switched Load Process (pending validation of the model).
The planning methods presented in your paper for determining the least-cost trunk network configuration for a 5- to 20-year planning interval needs a great amount of computing time. Is the computer program which implements the algorithms now operational so that you could tell us which the computing times are?

Answer

As of now, only portions of the Tandem Program are operational and we have had no computation experience with the program as a whole.

Naturally, computation time is an extremely important consideration in determining the practicality of this program as a planning tool. This is particularly so because I feel it is essential that a network planning study require the synthesis program to be re-run, for many different routing plans and alternative study conditions, as I discuss in the last several paragraphs of the paper.

Our objective is to keep the run time of the Tandem Program within several hours for networks in the range of 100–200 switching machines (local Exchanges + Tandems). Many features of the Tandem Program reflect the minimum computation-time objective.

1. All of the design algorithms were chosen with computation speed in mind. The design parameters used in the algorithms, which are all iterative, permit a trade-off of run time vs assurance of optimality. We will experiment with these parameters to ensure that an appropriate balance is reached, and that no single process has unwarranted precision.

2. Scale reduction methods have been devised to consolidate large number of end-offices into terminal nodes.

3. Run-time may be reduced by careful selection of the planning stages. The time increments between successive stages may be variable, so that there is adequate flexibility in selecting any multi-year profile.

PAPER No. 515
Authors: A TAYLOR and N G BATTY

The question on computing aspects is very large and complicated. You will get a big amount of output data. Have you studied the possibility of using display units together with a man and the lightpen? It might reduce the unnecessary output data.

Answer

Although a display unit was used for a short time during the development of the model, the use of interactive displays with light-pens has not been considered. Instead we keep output data manageable by means of a data extraction program which reduces large output files to histograms, scatter diagrams and can provide statistical information. The use of a standard data file structure in the model has greatly assisted in this task.

PAPER No. 516
Authors: A PARVIALA, M NURMINEN and L HEISKANEN

According to the method presented in your paper it is very easy to calculate the number of lines needed in a new building.

1. Can you tell us how many lines there are needed in an old building?

2. How accurate can you determine the number of PABX-lines in a new business or industrial building?

Answer

The statistical material used to find the regressions is based on samples of existing buildings of different ages. Therefore we can only have a rough estimate of lines needed in a business or industrial building by using the coefficients given in chapter 5 of our paper. We have not done separate investigation in order to find a forecast model for PABX-lines separately in different types of industrial or business buildings.

time to expand the local network well in advance of the need so that when the inhabitants are moving into their apartments in a new or existing building, the well-dimensioned local network with dedicated lines and exchange numbers is ready.