72

TRAFFIC FORECASTING FOR COMNAT PHASE II

A Feasibility Study

Telecommunications Economics Branch
Economic Analyses Division
22 February, 1978

TRAFFIC FORECASTING FOR COMNAT PHASE II

A Feasibility Study

Telecommunications Economics Branch
Economic Analyses Division
22 February, 1978

TABLE OF CONTENTS

DRAFT COPY ONLY

TRAFFIC FORECASTING FOR COMNAT PHASE II

A Feasibility Study

1. Introduction

This report has been prepared in response to a request from the COMNAT Review Committee that DEA investigate the possible application of econometric techniques to the forecasting of GTA traffic as a cross check to the GTA "bottom-up" traffic forecast. The forecasting model to be developed should have the capability of producing both forecasts and simulation results based on alternative scenarios. These estimates of future traffic will then be an input into the cost benefit analyses of COMNAT and of the various alternative arrangements to be considered.

In what follows we shall first give a brief description of GTA's forecasting activity for Phase II. We shall then examine the potential contribution that an econometric approach could make to the forecasting activity and review the econometric modelling efforts which have been made so far to forecast traffic. This will be followed by an investigation of the conceptual framework which could be adopted and a discussion of some of the problems which will have to be overcome. Finally, we shall propose an approach for econometric forecasting of traffic and establish a time table for the project.

2. GTA Forecasting Activity for Phase II and Termination Rates Determination

It is our understanding that GTA forecasting activity for Phase II consists essentially in finalizing the 1981 implementation forecast which has been developed jointly by GTA and TCTS. We understand from conversation with GTA staff that this task is now complete and that Bell will use these forecasts to establish on behalf of TCTS the rates to be charged to GTA for the use of COMNAT.

Because of the delays caused by the suspension of the contract it is now expected that COMNAT cannot be implemented before 1983. Bell has been instructed by GTA to establish the rates on two alternative scenarios, (1) a "slow growth scenario" in which it is assumed that the 1983 traffic will be the same as that currently predicted for 1981 in the 1981 implementation forecast discussed above, (2) a "high growth scenario" in which the 1983 traffic is assumed to be 12% higher than the expected 1981 implementation forecast traffic. These traffic forecasts will then form the basis of the cost effectiveness evaluation of COMNAT in 1983.

The traffic forecast is quite crucial for rate determination and for the ultimate cost of the system to GTA because of the 90% commitment provision in the contract. The clause commits GTA to 1,000 switch terminations, or 90% of the switch terminations forecast in the implementation forecast, whichever is greater. Moreover, GTA is committed to 90% of the Centrex or PBX terminations, provided for in the implementation forecast, for each of the telephone companies which are part of the contract.

It is not exactly clear how Bell determines the termination rates but we understand that they are established so as to enable TCTS to recover the cost of the system over the life of the contract. This procedure raises a number of questions:

(a) The expected life of the equipment (digital) is probably much longer than the contract duration (10 years). Should the rates not be established on the expected life of the equipment rather than on the contract duration?

(b) A major determinant of the termination rates will be the expected rate of inflation over the contract duration. What assumptions will be made by Bell in this respect?

(c) What will be the impact of the traffic forecasts on the termination rates? It is expected that the switcher termination rates should be somewhat lower for relatively high traffic forecasts (the high growth scenario) because the fixed costs of the system would be spread over more terminations. However, since under the new COMNAT configuration the switches will be shared with TCTS rather than dedicated to GTA, as previously planned, the fixed cost elements should be relatively small. Moreover, one should not expect traffic forecasts to have an impact on Centrex and PBX terminations. Hence, the impact of traffic on termination rates should be minor.

(d) What is the impact of the 90% rule on traffic forecasts? If, as indicated in (c) above, traffic forecasts have only a minor impact on terminations rates, it is in GTA's own interest to base the system definition on a relatively conservative traffic forecast in order to avoid undue terminations commitment. On the other hand, it is in the best interest of TCTS to use rather optimistic traffic forecasts in order to reduce as much as possible the risk of over-investment. We understand that this difference in objective has become apparent in recent discussions on traffic forecasts between GTA and TCTS.

3. Potential Usefulness of the Econometric Approach

Since GTA has already produced some traffic forecasts as a basis of the implementation forecast, one may wonder what is the potential usefulness of the econometric approach. The purpose of this section is to answer this concern and to formulate more clearly the advantages as well as the limitations of the econometric approach when compared to the bottom-up approach used by GTA and TCTS.

In bottom-up forecasts, the influence of various factors is taken into account implicitly on a judgmental basis, whereas econometric forecasting models explicitly relate traffic to various explanatory variables. This could prove quite useful, not only to better understand the determinants of traffic, but also to simulate alternative scenarios. It must be recognized, however, that the practical usefulness of such models for forecasting and simulation will depend crucially on their proper specification and on the stability of the relationships which have been established. It is not clear at this stage, in light of the data limitation we are facing, whether it will be possible to establish such stable relationships. Moreover, it cannot be over-emphasized that model specification and estimation require considerable time and effort. Finally, even if stable relationships can be established, the accuracy of the traffic forecasts will depend crucially on the accuracy of the forecast of the explanatory variables. It is not clear, *a priori*, that we shall be able to produce good forecasts of these variables.

Traffic forecasts in the bottom up approach appear to be greatly influenced by the most recent past experience. The econometric approach makes a more systematic use of historical data. This may be an important advantage since telephone traffic tends in general to be characterized by a high degree of inertia. If this is the case, it may be quite useful to adopt a time series approach and relate future traffic to current and past behaviour.

Finally, econometric models may provide better over-all traffic forecasts because, in such models, relationships are established directly at the aggregate level. In the bottom-up approach, on the other hand, aggregate traffic forecasts are built up from individual link forecasts. This is based on the implicit assumption that traffic can be forecast for each link in isolation of what happens on other links. This assumption may not necessarily be valid. Indeed, informal discussions with Bell Canada personnel suggest that bottom-up forecasts tend, in general, to be overly optimistic.

Despite the potential advantages of econometric models which have been described above, it is clear that they cannot provide the detailed traffic forecasts required for the implementation forecasts. At best, only aggregate econometric forecasts for major links will be obtained as cross-checks of the bottom-up forecasts.

4. Conceptual Issues

To develop an econometric model for forecasting voice traffic demand raises a number of important conceptual problems. The purpose of this section is to examine these issues in order to lay the foundation for the proposed approach which will be described below. The issues to be considered here pertain to the definition of voice traffic demand and to the relationships which could conceivably be established between this demand and a number of possible explanatory variables. Let us first consider the problem of defining voice traffic demand.

Ideally the definition of traffic demand should reflect the multi-dimensional nature of telephone services and be useful for tackling the problem at hand, namely the cost-benefit evaluation of COMNAT and alternative arrangements. Let us consider these questions in more detail.

Traffic has four major dimensions which may have a bearing on the optimal network configuration: (a) number of messages; (b) duration of messages; (c) direction of traffic flows; (d) geographical distance covered. For a proper cost effectiveness study one should probably try to build a traffic index reflecting all four dimensions.

The number of messages statistics are not directly available from GTA files because traffic is measured in average busy hour centum call seconds (ABHCCS) for system management purposes. One CCS is a measurement of traffic volume equivalent to 100 call-seconds. Under certain assumptions, it is possible to establish a relationship between traffic measured in CCS and total messages. It is not clear, however, whether this relationship is likely to remain constant over time, or how it can be expected to change.

Another important related point is that demand for voice traffic should really be measured in terms of "offered traffic" i.e. attempted calls on the network (whether successful or unsuccessful) rather than in terms of "carried traffic" (successful calls). Most of the data available unfortunately pertains to carried traffic rather than offered traffic. This could be a major stumbling block in the analysis. However, we understand that GTA is attempting to recreate offered traffic estimates. If successful, this effort could be very valuable for our analysis.

Although no information is available on message duration, the data available provide detail on direction of traffic and geographical distance covered. These dimensions of traffic demand may have a major impact on network configuration. The creation of a switched network such as COMNAT is cost effective if the increased switcher costs are more than offset by the reduced line costs. This will not be true for all traffic flow configurations. In the case of GTA one could conjecture that the hierarchial functional relationship of the Public Service should be reflected in tree-like traffic flow patterns. In this configuration, the "trunk" of the tree is the traffic flow between the Ottawa headquarters and the regional office while the "branches" are represented by the traffic flows between the regional offices and the various district offices. If such a tree-like flow pattern is a good representation of GTA traffic (i.e. heavy traffic between selected nodes) the creation of a switched network becomes much less attractive from a cost effectiveness point of view since the switching requirements are not very high and the potential for reduced line costs is limited.

It is apparent from the above discussions that to be useful for the cost benefit evaluation, traffic demand forecasts should take into consideration (even if only in the form of explicit assumptions) the four dimensions of traffic which have been identified above. Failure to do so could seriously bias the analysis based on these traffic forecasts. Let us now turn to the various potential explanatory variables which could be used in the analysis.

It is useful from an analytical point of view to treat the demand for telephone services in the public service as a derived demand. Telephones are used by public servants as a tool in the production of services (public output) provided ultimately to the population at large. The telephone services input can be expected to vary with the nature and quantity of services provided, the other inputs used in the production process and possible substitution between telephone services and other potential inputs.

The difficulties involved in defining and measuring the output of public servants are well known. However, it must be recognized that the nature, as well as as the level, of the output will affect the input mix and the total input requirements. Some types of public output may be more "communication-intensive" than others. For instance, the delivery of social services such as welfare, UI and manpower programs may require relatively more voice communication than for, say, services. It may therefore be useful for analytical purposes to break public output into homogeneous groups of services based on their degree of communication intensity. As a first cut, a breakdown of public output (however it is measured) by Department could be done in order to determine if significant differences can be found in the output to voice traffic ratios obtained for each Department.

As pointed out above, in addition to the kind of services provided by public servants, the level of public output is another important determinant of traffic demand. However, since in most cases, it is not possible to measure directly the volume of public output, indirect measurement is required. Indices of public output can be built from input information such as the quantity of human resources used in production or the level of government expenditures. Another possible index could be the size of the population served.

The geographical distribution of the output is another key factor. Depending on the nature of the service and on the population served, the delivery of the output will require a more or less decentralized delivery system. For instance the delivery of UI benefits require a very decentralized delivery system. This may result in significant communication requirements. It follows that any forecast of traffic demand should attempt to take into consideration what can be expected with respect to the future geographical distribution of output and the delivery systems which will be used to do so.

Telephone services are used in combination with other inputs in the production of public output. *A priori* one would expect telephone services to be complementary to labour input, the major input in the production of public output. Hence human resource could be used as an explanatory variable of traffic demand on two grounds; first because it may be a good index of public output, as discussed above; and also because it is complementary to telephone services.

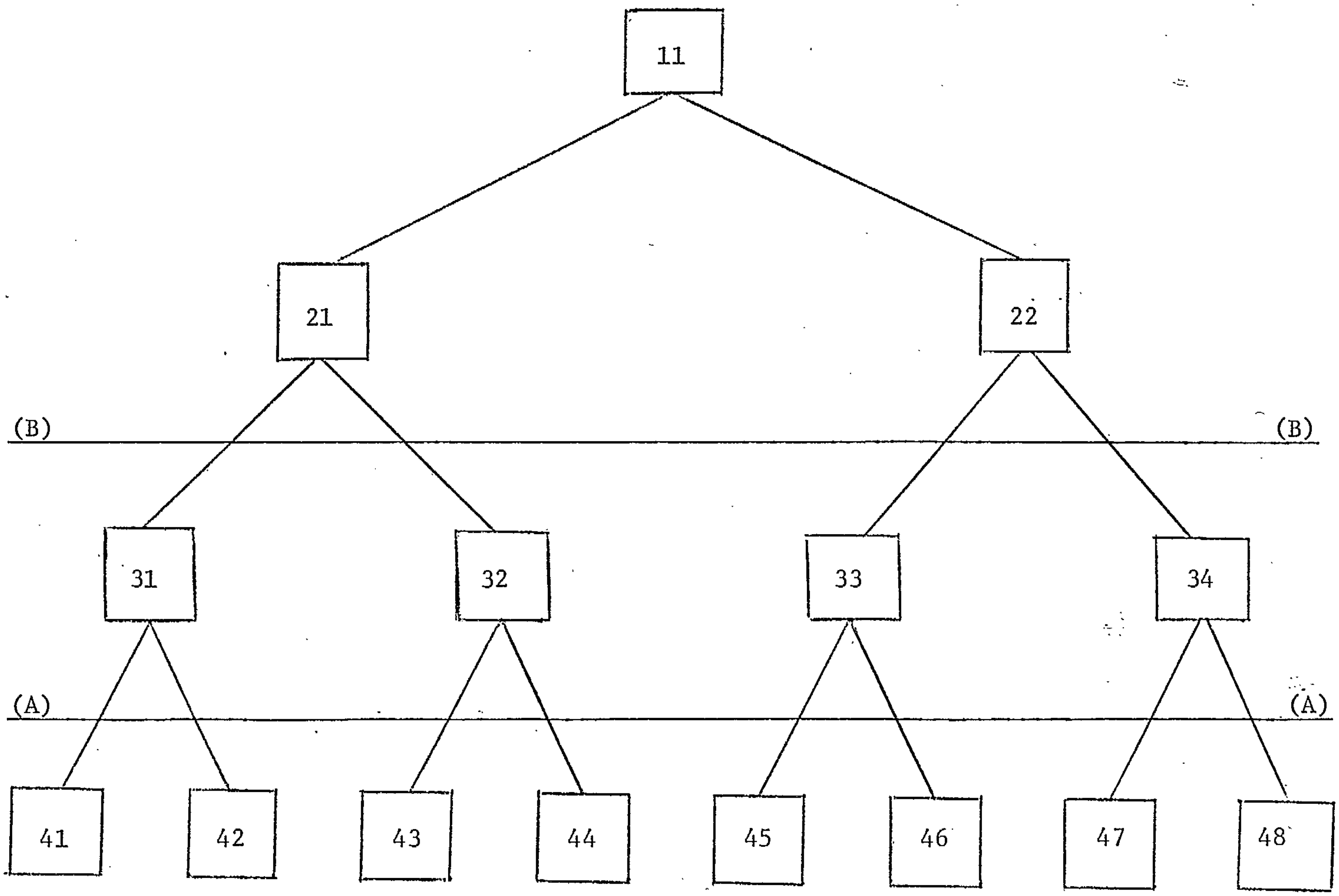
Telephone service can be expected to be a substitute for other means of communication (mail, telex, courier service, travel). One would therefore expect, other things being equal, a negative relationship between the demand for telephone service and the demand for other means of communications. For instance, if the mail service keeps deterioriating and the cost of travel keeps increasing, public servants may have to rely more on the telephone for communication needs. On the other hand, new developments such as video transmission, electronic mail and the creation of data banks accessible on-line nationwide, may result in some reduction in the demand for voice service.

The demand for telephone services can also be affected by administrative factors. The decentralization of the Public Service may be an important consideration in this respect. However, if one accepts the hierarchial description of the Public Service, it is not clear what the net impact of decentralization will have on traffic demand. Figure 1, below, is useful to analyse the issues involved. In this graph each circle represents an administrative unit. The number in each circle represents the place of the unit in the organization. The first digit in each circle represents the unit in the hierarchy (vertical position) and the second digit represents the horizontal position of the unit. For instance, unit 32 is the second unit of the third hierarchial level. It is assumed for simplicity that, for each unit of any hierarchial level, there are always two reporting units at the next lower level. For instance, units 43 and 44 report to unit 32. The lines between circles represent reporting links along which communication flows are channelled. Let us assume further that there is only one region to be served, say Ontario.

Suppose that before decentralization the dividing line between the responsibilities of the headquarters (Ottawa) and the regional office (Toronto) is along (A). It follows that units 11 (senior management) to 34 are in

FIGURE 1

The Impact of Decentralization on
Intercity Traffic with no Increase in Personnel



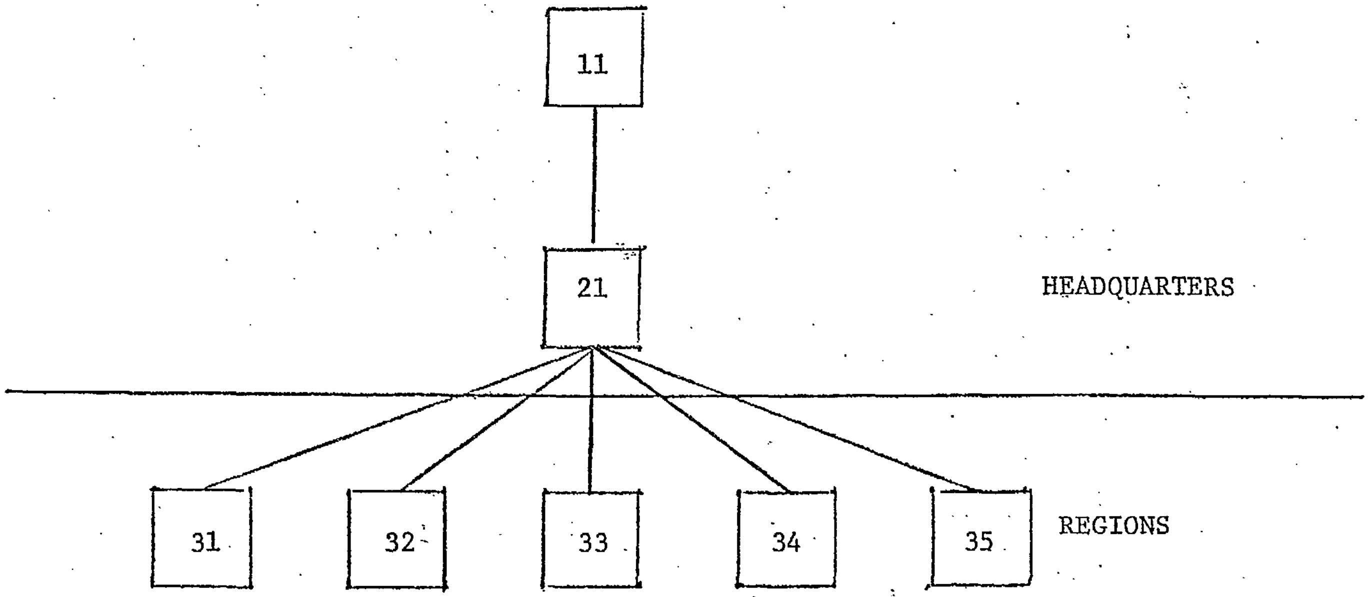
Ottawa while units 41 to 48 are located in Toronto. This implies that all communications between units 11 to 34 are local Ottawa calls while all communications between the third and fourth level of the hierachy are trunk calls between Ottawa and Toronto.

Let us assume now that as a result of decentralization the line dividing responsibility between Ottawa and Toronto is moved from (A) to (B). The first effect will be a reduction in local calls in Ottawa and an increase in local calls in Toronto. The traffic between the third and fourth levels of the hierarchy which were trunk calls before decentralization are now local Toronto calls. On the other hand, the calls between the second and third levels which were local Ottawa calls before decentralization are now trunk calls (see Figure 2).

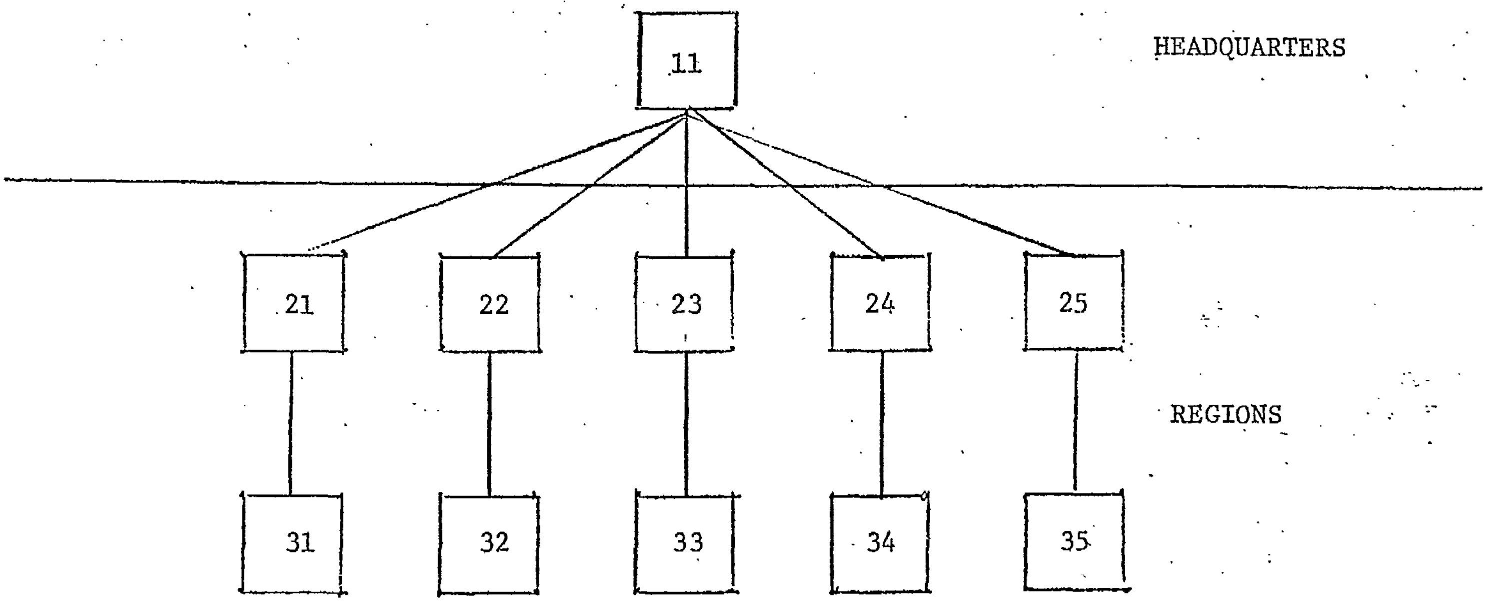
FIGURE 2

The Impact of Decentralization on
Intercity Traffic with a 5-Fold Increase in Personnel

(a) Before Decentralization



(b) After Decentralization



Given the pyramidal nature of the organization which results from its hierarchical structure, fewer people and fewer reporting links (4 instead of 8) are involved in trunk calls after decentralization than before decentralization. It follows that, unless typical communication flows between the second and third level units are significantly higher (double in our example) than communication flows between third and fourth level units, decentralization should result in a net decline in intercity traffic.

These results can readily be extended to a multi-region situation even if decentralization entails a net increase in personnel. To show this, let us consider an extreme case. Suppose that the functions of one unit at headquarters are transferred to the regional level in such a way that five units of a size equal to the original unit are now required (one in each Region). It is clear from Figure 2 that the total number of intercity reporting links will remain the same. Hence, unless more traffic takes place at higher echelons, there should not be a net increase in total intercity traffic even in this extreme case.

Although the discussions have been based on a rather simplistic representation of the Public Service administrative structure it points to a very important conclusion with respect to the impact of decentralization on traffic: decentralization will <u>not</u> necessarily lead to increased intercity traffic as is often assumed, it may indeed very well result in a <u>reduction</u> of intercity traffic if our representation of the structure of the Public Service is correct.

There are other administrative factors which may affect traffic. The Treasury Board guidelines on the use of telephones, as well as the introduction of Traffic Data Analysis (TDA), may result in significant shifts in traffic demand. The internal pricing policy for telephone services could also have an impact.

If, for instance, a usage sensitive pricing scheme is introduced, traffic demand would probably be lower than if telephone services are free to the users or if a fixed fee structure is used. Changes in administrative procedures of the nature described above will probably be reflected in shifts of the traffic growth curve.

Supply considerations could also have a significant effect on the traffic demand. A "bad" network could have a negative effect on traffic demand (the discouraged caller effect akin to the discouraged worker effect in labour economics). On the other hand a "good quality" network may generate additional traffic demand as better service may induce substitution of telephone service for other forms of communication. This is the "stimulation factor" used in GTA's implementation forecasts.

Finally, major political changes, such as for instance a redistribution of power between the federal and provincial jurisdictions could have a major impact on traffic. If important responsibilities which are now under federal jurisdiction such as for instance manpower, communication, regional expansion, welfare, consumer and corporate affairs, environment were transferred in part or in total to the provinces, this would result in a major change in traffic demand. However, predictions in this respect are hazardous to make, to say the least.

5. A Review of Previous Modelling Efforts:

Most forecasting activities carried out for GTA so far have used the "bottom-up" approach. In this section we intend to give a brief review of the limited "top-down" econometric modelling efforts which has been made over the past few years. This review, together with the discussion of conceptual issues in the previous section will set the scene for our own proposed approach which will be outlined in Section 6.

Two econometric models will be reviewed here. The first model is a toll forecasting model which was presented in a March 1973 progress report prepared by the Economic Policy Planning Division of the Planning Branch. The second model was built as part of a feasibility study done for GTA.(1) Let us first examine the March 1973 toll model.

The stated objective of the March 1973 toll modelling exercise was to prepare a medium-term forecast for toll traffic broken down by four major sectors on a regional basis. The four sectors were the product sector (raw materials producers, manufacturers, wholesalers, retailers) the service sector (personal services, professional services, hotels and restaurants), the government sector (federal, provincial and municipal), and the public sector public coin telephones. The data used to estimate the models were obtained from a Special Toll Analysis Sample (STAS) produced by Bell Canada. The sample provided monthly data on toll traffic over the period April 1967 to June 1972 broken down for the four major sectors (product, service, government, coin) by two origins (Ontario and Quebec) and nine destinations (ontario, Québec,

---

(1) Feasibility of Central Management Guideline for Local Telephone Expenditures; Economic Policy Division, DOC, March 1976.

British Columbia, Alberta, Saskatchewan, Manitoba, New Brunswick, Newfoundland, Maritimes). Two types of models: gravity and econometric, were used in the analyses. The gravity models were built for analyzing the traffic of the four sectors described above (product, service, government and public). It is not clear, however, whether GTA traffic was included in the government sector model. In addition to these gravity models an econometric model was built specifically for GTA traffic. In what follows, we shall first make a short assessment of the gravity model then turn to the GTA traffic econometric model which is of greater interest for our purpose.

Two types of gravity models: a population, and an employment variants, were used in the analysis. In the population model the total monthly number of toll calls between two provinces was related to the population level in the two provinces and the distance between the two provinces. In the employment model the population variables were replaced by employment variables for the two provinces. The employment model was expected to be more sensitive to the underlying economic conditions.

From a goodness of fit (R squared) point of view, it appears that the employment model performs better in most cases with a R squared above .70. However, no other statistical test is given in the report.

Although not enough information is given in the report to analyze fully the empirical results obtained from the gravity models, two methodological comments are in order. First of all, gravity models suffer from well known limitations. In particular, it is hard to give an interpretation of the coefficients obtained. Moreover, to use gravity models for time series analysis in which the distance variables remain constant over time as is done here, appears unwarranted. In most analyses, the reason why gravity models are chosen is to study the impact of distance on traffic. If distance is not allowed to vary (as in this case) one may wonder what is the purpose of using a gravity model in the first place. Another limitation of the analysis results from the nature of the data used in the estimation. Only data on traffic originating in Ontario and Quebec is used, hence only outgoing traffic is analyzed, and no information is provided on ingoing traffic.

The report also provides an econometric model for GTA traffic. There is, however, some confusion with respect to the data used. On the one hand, the number of calls statistics given on pages 6 and 4 and reproduced on page 29 suggest that only GTA traffic originating in other provinces is also considered. Moreover, the source of the GTA traffic data is not clear, whether obtained as part of Bell STAS toll sample, or from some other source.

The estimated equations of the GTA econometric model are given on page 30 of the report, which has been reproduced in Appendix I. Four equations are estimated for traffic originating in Ottawa, Montreal, Toronto, and Quebec expressed in CCS. The explanatory variables used included lagged unemployment rates, cheques cleared, and government expenditures. No explanation is given why these variables were used. Over-all, the statistical fit is very good with R squared ranging between .88 and .94. Moreover, the Durbin Watson statistics show no sign of auto-correlation and the coefficients of the explanatory variables are significant. The results are, nevertheless, somewhat puzzling. For instance, why is traffic positively related to both unemployment and cheques cleared? These two variables are probably negatively correlated yet positive coefficients are obtained for both variables. The lagged structure used for the unemployment rate is probably the reason for this surprising result. But the interpretation which can be given to the equations is not obvious. Moreover, the estimated equations for Toronto suggest that the gains in goodness of fit obtained by using the unemployment rate as a separate explanatory variable in addition to cheques cleared may be rather marginal. Finally, the estimated traffic appears to behave more erratically than the actual traffic, as can be seen on page 33. This is certainly not a very good feature for forecasting. From this point of view, a simple trend curve could have probably done a better job.

In the March, 1976 study, (Appendix II) pertaining to local telephone expenditures of federal government departments, while not directly related to toll, our main area of interest, is, nevertheless, of interest from a methodological point of view.

The main objective of the study was:

"To examine the feasibility of developing cost effectiveness directions and guidelines by a central management authority to assist departments/agencies to acquire and utilize efficiently local telecommunications services".

For this purpose, a model relating local telephone costs to various explanatory factors was built. Among all the factors considered, four variables were selected as providing the best explanation of the observed variation in local telephone cost per employee across departments. These variables were as follows:

1) number of employees;

2) the proportion of professional employees;

3) operational expenditures on plant and facilities (a proxy for floor space);

4) the degree of budgetary control over telephone expenditures.

The equation was estimated from cross-section data on the telephone expenditures of 27 departments which were obtained from a survey conducted by GTA in May 1974. This data only pertains to local telephone expenditures in the National Capital Region. The result of the estimation is reproduced in Appendix II. The statistical fit (R squared) is surprisingly good (.71) for cross-section data, but no information is given on the statistical significance of the coefficients. Two interesting results which may extend to toll traffic stem from the analysis. First of all, total local telephone expenditures per employee appear to be negatively related to the total number of employees (a 10% increase in the number of employees results in an increase of only 7% in telephone expenditures). Another interesting result is the positive relationship between telephone expenditures and the proportion of professional employees (a 10% increase in this proportion results roughly in a 4% increase in telephone expenditures).

This completes our review of the rather limited efforts which have been devoted in the past to the econometric modelling of GTA traffic. In the following section we shall present our own approach which will build mainly on the results of this section and on the discussion of conceptual issues in Section 4 above.

6. A Proposed Approach

On the basis of the discussion of conceptual issues, and the review of previous work made in the last two sections, we are now in a position to propose a possible approach to the modelling and traffic forecasting exercise. In what follows recommendations will be made with respect to the definition to be adopted for traffic, the explanatory variables to be used in the estimation procedure, and to the data required in the analyses. Let us first turn to traffic definition.

It was pointed out in Section 4 that traffic has four major dimensions: number of messages, duration of messages, direction of traffic flow, and geographical distance covered. It was also shown in that section that all four dimensions can have a bearing on network configuration and network cost. It is, therefore, essential that they all be considered in the analyses, even if only in the form of explicit assumptions.

As mentioned earlier the traffic data available to us is in ABHCCS for each major link of the network. Under certain assumptions, (notably with respect to average call duration), ABHCCS can be translated into total messages. Several alternative definitions of traffic could be tried. The simplest and crudest way of measuring traffic would be to use CCS data directly. Another total traffic index could be built by making assumptions with respect to average call duration and by multiplying total calls by average duration and distance. Such an approach has been proposed by Dobell.

The direction of traffic could be taken into account in several possible ways. First of all, one could make separate estimations for each major link. This is feasible and could provide valuable insights on the evolution of traffic overtime since, as a rough approximation, the 10-15 major links account for about 40% of total traffic. Another approach would be to break traffic so as to reflect the hierarchical structure of the Public Service. Three kinds of traffic would be considered, that between headquarters and regional offices (Level 1 traffic), that between regional offices and district offices (Level 2 traffic), and other traffic. Level 1 and Level 2 traffic could be either estimated on the aggregate level or broken down by region. This approach, if feasible, could be very useful to analyze the impact of decentralization on traffic, ant to test our hypotheses of Section 4 in this respect. One must be aware, however, that the data available only provide traffic information between geographical locations. The functional nature of the call is, therefore, not clear. For instance, it is not known if a call made from Ottawa to Toronto will terminate on-net or off-net and, even if it terminates on-net, whether its destination will be the regional office or any other agency on the government network. The seriousness of this problem could probably be tested with TDA data. However, we have not been able so for to ascertain fully what use can be made of these data. Let us now turn to the functional relationship to be examined.

As a first cut at the problem, trend analysis is probably the best and simplest approach. Based on the definitions described above, various trend functions reflecting alternative assumptions with respect to growth over time could be tried to obtain a preliminary range of traffic forecast estimates. These results could be used for preliminary cross-check of GTA's own forecast.

The second proposed step is to introduce various explanatory variables in the estimation, in light of the discussion of Sections 4 and 5. If one can assume, as we have done in Section 4, that the demand for voice traffic is a derived demand from the demand for public services, then the introduction of three kinds of variables can be explored and substitute input variables.

As was pointed out in Section 4, public output cannot be measured directly in most cases, and the use of proxy variables is required. One such proxy, human resource, is also expected to be a complementary input to telephone services. Such data are available quarterly from Statistics Canada (SC72-004) on the number and regular earnings of federal government employees by occupational category, by province, by function and by department. Moreover, similar data are available by metropolitan areas on an annual basis. Several estimations could be made using total number of employees and total earnings or by building an index which would take into account the occupational distributions of the public servants. In this respect, it is worth keeping in mind the result of the March 1976 study (Appendix 2) which suggests that local telephone expenditures increase at a slower rate than the total number of employees, but are positively related to the proportion of professional employees. These results may very well extend to toll traffic.

It is also interesting to note that federal government employment forecasts have been made by DPW and GTA. The GTA forecasts were produced in 1975 for the automated notice system of the PSC. They provide future annual employment estimates by regions and by metropolitan areas up to 1985.

We understand that DPW has also produced employment forecasts using Delphi techniques. However, the current status of these forecasts is not clear at this time.

Another possible proxy for public output is the level of government expenditures. Such data are available from Statistics Canada on a regular basis by department as well as by function. The functional breakdown appears particularly interesting since it would enable us to explore whether telephone usage is more sensitive to some government functions than others (i.e. we could test if public output is homogeneous with respect to telephone usage or whether some government activities are more "communication intensive" than others). Finally, expenditures on other forms of communication, (such as mail) and transportation, could be used to ascertain the degree of substitutability between various means of communication. The proper specification of such relationships would require careful examination. A cost function or a production function approach may be useful in this re
respect, although one must be aware that the basic assumption of cost minimization may not hold in a public environment.

The impact of decentralization could be taken into consideration by relating changes in traffic patterns to changes in the geographical and occupational distribution of public servants. Another useful variable in this respect would be the level of public investment in each major metropolitan area. Such investment can be expected to act as a leading indicator to traffic flow changes (i.e. heavy public investment in one particular metropolitan area in a particular year is probably reflected in increased in and out traffic in the following years). Useful information on current and past decentralization experiences and future decentralization plans can probably be obtained from DPW, the PSC, or TBS.

In conclusion it is apparent that a considerable amount of effort is required at the data collection and model estimation stage before a satisfactory model can be built. The work is mostly exploratory and in our opinion a considerable amount of time and resources will be required over the next few months before useful results can be obtained. In the short run, one should probably have to contend with trend forecasts. Preliminary results available so far are rather encouraging and suggest that simple functional forms which track past inter-city traffic data rather well can be found. These results will be presented shortly in our first interim report. As more data becomes available in machine readable form over the next few weeks, more sophisticated trend analyses will become feasible. At the same time, preliminary attempts will be made to establish causal relationships between traffic and some of the explanatory variables suggested above. It is highly unlikely, however, that this work will be completed by the end of March in light of the problems involved in the collection of data in machine readable form and of the large amount of experimentation which will be required before satisfactory relationships can be established.

APPENDIX 1

Econometric Model for GTA Toll Traffic

EPPB (March 1973)

GTA ECONOMETRIC MODEL

OTTAWA CCS $= -231{,}762.1 + 584.3\ UNC_{T-8} + 21{,}651.7\ \ln CHC_T$

(2.3) (13.4)

$N = 16 \quad R^2 = .94 \quad D.W. = 2.19$

MONTREAL CCS $= -2716.9 + 64.5\ UNQ_{T-6} + 3703.6\ GEC_T$

(2.4) (12.1)

$N = 13 \quad R^2 = .94 \quad D.W. = 2.14$

TORONTO CCS $= -19{,}878.5 + 2033.9\ \ln CHT_T$

(11.2)

$N = 13 \quad R^2 = .92 \quad D.W. = 2.31$

QUEBEC CCS $= -2753.9 + 40.8\ UNQ_{T-4} + 22.06\ PGOV_T$

(3.1) (7.4)

$N = 13 \quad R^2 = .88 \quad D.W. = 1.79$

WHERE:

UNC = Unemployment rate, Canada

CHC = Cheques cleared, Canada $

UNQ = Unemployment rate, Quebec

GEC = Total Canadian government expenditures per labour force participan

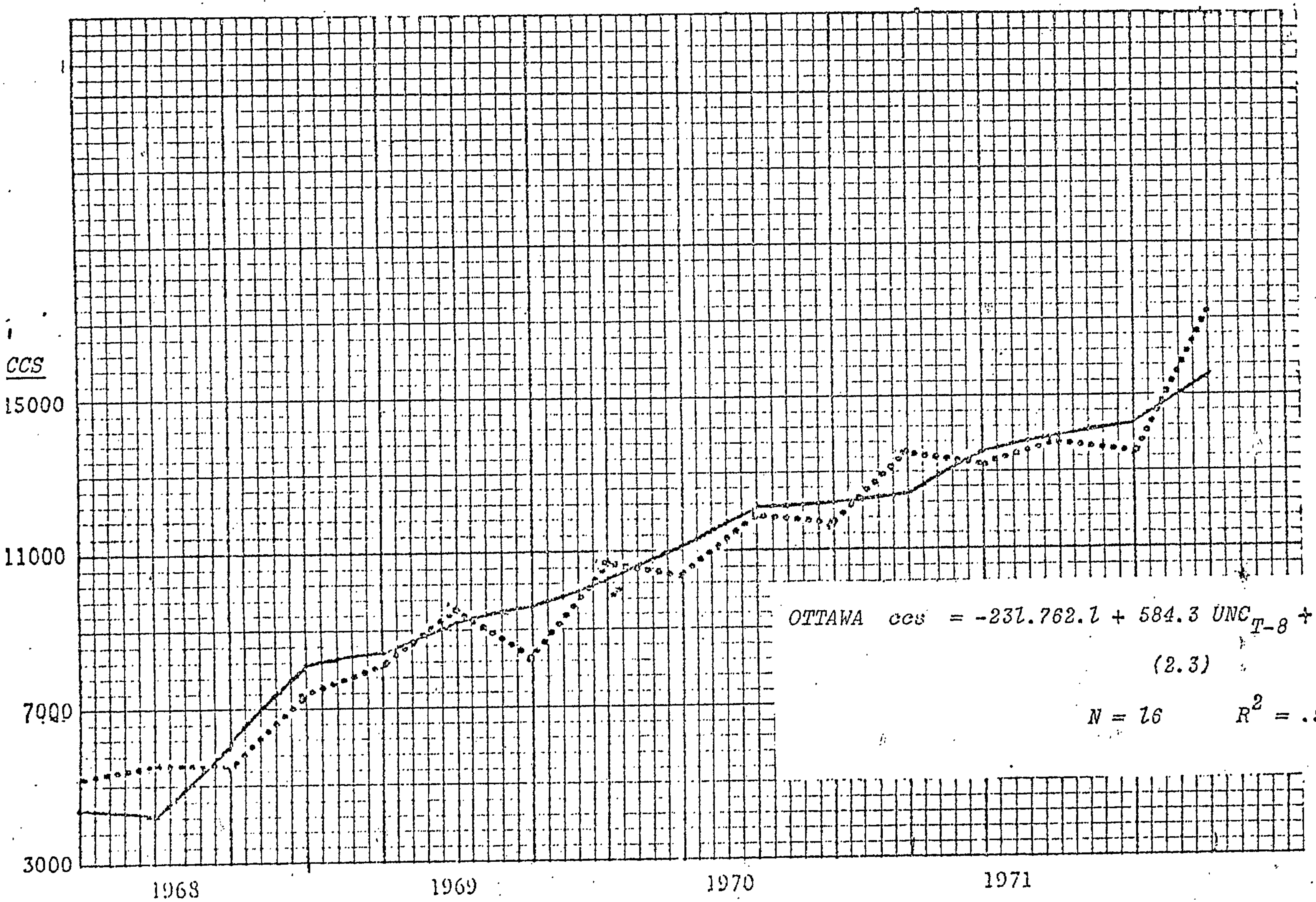
CHT = Cheques cleared, Toronto $

PGOV = Index of real domestic product in government

= employment govt

OTTAWA TO ALL CITIES

ACTUAL & CALCULATED



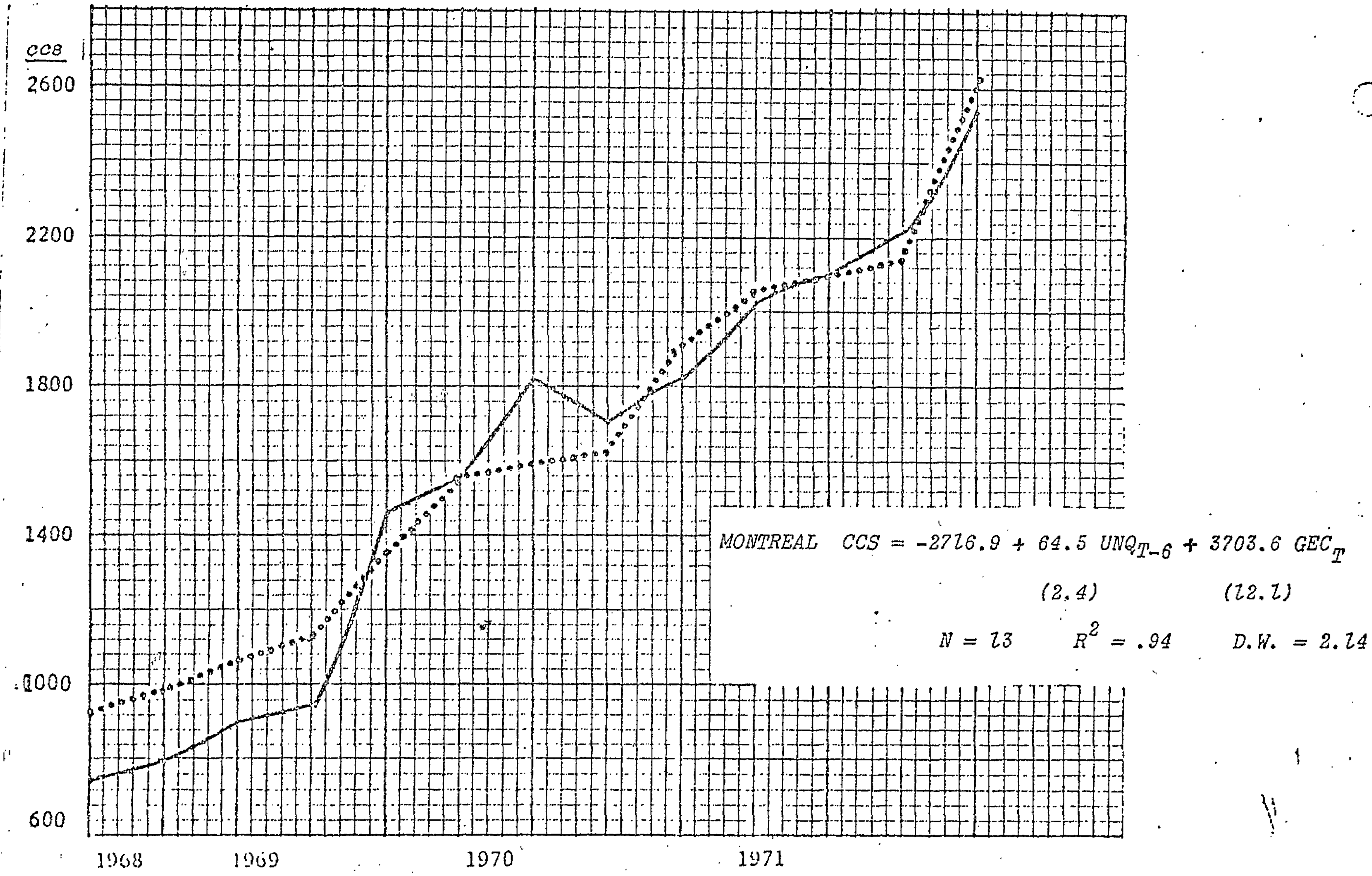
$$\text{OTTAWA } ccs = -231.762.1 + 584.3\ UNC_{T-8} + 21{,}651.7 \ln CHC_T$$

(2.3) (13.4)

$N = 16$ $R^2 = .94$ $D.W. = 2.19$

MONTREAL TO ALL CITIES

ACTUAL & CALCULATED



APPENDIX 2

Econometric Model of Local Telephone Expenditures

EPSB (March 1976)

3. Application of the Model and Results

The relationship between the four explanatory variables and the primary dependent variable, total local telephone expenditures per employee, was identified in econometric terms as follows:

$$\ln (LC/E) = 3.13 - .30299 \ln E + .38669 \ln(P/E)$$

$$+ .17176 \ln (B/E) - .193C \qquad R^2 = .71$$

where, in the case of each department

LC = total local telephone expenditures

E = total employees in the NCR

P = total professional employees

B = operational expenditures on plant and facilities

C = variable to account for degree of departmental control over local telephone expenditures

Examining the plus and minus signs in the equation suggests the nature of the relationship between the explanatory variables and total telephone costs per employee as follows:

i) The *negative* relationship between total employees (E) and total local telephone costs per employee (LC/E) suggests that as departments grow larger there is not a proportionate increase in their expenditures on local telephone services.

ii) The *positive* relationship between the explanatory variable (P/E) and the dependent factor indicates that the telephone requirements for professional employees tends to raise the average cost per employee.

iii) The *positive* relationship between operational expenditures on plant and facilities (B/E) (e.g., a good proxy for amount of floor space occupied) and local telephone costs per employee indicates a greater need for telephone facilities.

iv) The *negative* sign in the case of the last variable (C) which accounts for the type of departmental control over local telephone expenditures points to a decrease in cost per employee, given explicit branch or divisional control of the telephone budget.

Application of this equation yielded the estimated cost of local telephone service per employee as seen in Table 5. These *estimated* figures for each department represent the amount per employee each department would be expected to spend on the basis of the model. The residual cost in Column 3 represents the difference between the estimated cost per employee and the actual cost as presented earlier in the paper. Using this approach one observes in Table 5 how much each department either exceeded or fell below the expected cost performance.

Exactly the same procedure was followed for each of the secondary equations (see Appendix E for their specification) in which the dependent variable was costs of main lines and extensions per employee, costs of auxiliary equipment per employee and costs of intercoms per employee respectively. The comparison of expected costs per employee with actual costs for each department for these three components are presented in Tables 6, 7 and 8. Once again the degree to which each department's expenditures either exceeded or fell below the expected level is clearly indicated in Column 3, in absolute dollar terms, and in Column 4, in percentage terms.

Table 5 - Estimated Total Local Telecommunications Expenditures Per Employee - National Capital Region, May 1974

	DEPARTMENT	1 ACTUAL COST $	2 ESTIMATED COST $	3 RESIDUAL COST $	3 ÷ 1 RESIDUAL %
1	Regional Economic Expansion	40.30	23.09	17.21	42.7
2	Urban Affairs	32.61	30.70	1.91	5.9
3	Privy Council	27.43	16.30	11.13	40.6
4	Science & Technology	25.45	37.30	-11.85	46.6
5	Environment	17.37	11.44	5.93	34.1
6	COMMUNICATIONS	17.33	16.91	.42	2.4
7	National Defence	16.27	11.01	5.26	32.3
8	Industry Trade & Commerce	15.70	12.57	3.13	19.9
9	Finance	15.50	21.50	- 6.00	38.7
10	Justice	15.13	14.94	.19	1.3
11	Manpower & Immigration	14.82	14.30	.52	3.5
12	Labour	14.64	14.49	.15	1.0
13	External Affairs	13.89	12.62	1.27	9.1
14	National Health & Welfare	12.09	9.44	2.65	21.9
15	Consumer & Corporate Affairs	12.04	12.64	- .60	5.0
16	Transport	11.88	9.79	2.09	17.6
17	Secretary of State	11.09	14.24	- 3.15	28.4
18	Energy, Mines & Resources	10.69	10.47	.22	2.1
19	Indian Affairs & Northern Development	9.71	13.34	- 3.63	37.4
20	Public Works	9.40	10.34	- .94	10.0
21	Treasury Board	9.38	12.93	- 3.55	37.9
22	Supply & Services	8.73	8.36	.37	4.2
23	National Revenue	8.22	10.49	- 2.27	27.6
24	Veterans Affairs	6.62	10.23	- 3.61	54.5
25	Solicitor General	6.56	7.94	- 1.38	21.0
26	Agriculture	6.51	8.00	- 1.49	22.9
27	Post Office	4.92	5.00	- .08	1.6

TRAFFIC FORECASTING FOR COMNAT PHASE II: A FEASIBILITY STUDY