FINAL REPORT TO THE DEPARTMENT OF COMMUNICATIONS,

OTTAWA

AN ECONOMIC EVALUATION OF THE 1981 RATE REQUEST BY BELL CANADA: MODEL DEVELOPMENT, SIMULATION AND DOCUMENTATION

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ABSTRACT

This contract concludes with the submission of two reports. Report #1, entitled "Simulation of Bell Canada's Rate Request" develops and simulates an econometric model of the real and financial structures of Bell Canada. A variety of regulation scenarios are examined in detail. Report #2, entitled "Direct and Indirect Effects" designs and simulates a general equilibrium model of the Quebec-Ontario regional economy in order to analyze the direct and indirect (general equilibrium) price effects of proposed Bell Canada rate changes. Additional support documentation including data employed (and definitions); a worked simulation example; computer software manuals and a tape copy have been forwarded to the scientific authority.

1981 BELL CANADA
RATE REQUEST ANALYSIS

Report #1:
Simulation of Bell Canada's
Rate Request

CHAPTER 1 INTRODUCTION

The model described in this report is the outcome of over four years work by faculty in the Department of Economics at Concordia University. The model was developed in order to describe, econometrically, the Bell Canada production process. Demand and financial modules were also estimated, and the complete model has been used, in various forms, to predict the behaviour of Bell Canada under a number of scenarios.

This model is not, of course, the only model of Bell Canada; two other models are currently in use - the model developed by M. Denny et al. (4) at the IPA in Toronto, and the Bell internal model, developed by F. Kiss et al. (7). In many important respects, these models are quite different; it is not that one model is better than another, rather the econometric and behavioural assumptions entering into the model are different.

The purpose of this exercise is to investigate the effect of the rate increase requested by Bell Canada and heard before the CRTC in May and June 1981. The "bottom line" in this investigation is the rate of return on capital, and the method that will be followed is to compare, line for line, the estimates derived by Bell with those derived in this study, using in some cases very different modelling techniques.

In chapter 2 the data base is presented, along with the forecasts for the exogenous variables. The demand system, the cost system, the financial module and the income statement module are presented in chapters 3 to 6 respectively. A historical validation is undertaken in chapter 7, and the simulation under three price scenarios in chapter 8, followed by a conclusion in chapter 9.

CHAPTER 2

DATA BASE

Following the introduction of various interrogatories as well as the Bell Annual Charts, 1980, into the public record, the complete model has been reestimated to 1980. The complete data base, with description and sources, is shown on BELLIB. A more detailed discussion of some of the variables is given in Breslaw [1] and Breslaw and Smith [2].

A number of variables are exogenous to the system, and values for these variables are required for the forecast period. The values used for these variables is shown in the LOAD section of SIMU81E. These values are derived, as far as possible, from Bell's forecasts; in this sense the difference in assumptions between Bell's predictions and those of this study is minimized. For 1983, the 1982 figure is increased by the rate of change existing between 1981 and 1982. For those variables for which no forecasts are available from Bell, an ARIMA process was estimated, identified and used for prediction.

The specifications of the various processes used are shown in Table 2.1.

The following data sources were used for 1952-1980:

Bell Annual Charts 1980, 1981 issue

BELL (NAPO) 30 MAR 81 - 612

CANSIM vectors: D 31600, D 31614, B 14031.

TABLE 2.1

METHODOLOGY USED FOR PREDICTING EXOGENOUS VARIABLES

Symbol	Description	Methodology
APER	Average P/E ratio	1980 value
CONVS	Local conversations - Bell	ARIMA (0,1,0)
CONTAX	Taxes charged construction	(1)
CPI	Consumer price index	B81-250 , p5
CRTC7801	Effect of Decision 7801 on expenses	(2)
DECC	Composite depreciation rate	1980 value
EXTRIX	Extraordinary items	B-81-1
FXLTD	Foreign exchange - long term debt	B-81-1
GPPONT	Gross provincial product - Ontario	(3)
GPPQUE	Gross provincial product - Quebec	(3)
MNET	Miscellaneous revenue - Net	B-81-1
NICOME	Net income - contract	B-81-1
OLDACCESS	% telephones access to DDD	(4)
OTHIX	Other income	B-81-1
PK	Telephone plant price index	BELL (NAPO) 81-612 Table 7
POPB	Population Bell territory	ARIMA on log(POPB) (0,2,0)
QMIS	Output, miscellaneous service	BELL (NAPO) 81-612 Table 2
QTPL	Output, toll private line	BELL (NAPO) 81-612 Table 2
r	User cost of capital	Same rate as PK
ROTH	Revenue, other toll service excl. WATS	(5)
SPI	% SPI and DMS central office	(6)
UNCOL	Uncollectable revenue	BELL (CRTC) 501
v	Cost of materials, etc.	(7)
w	wage rate	BELL (NAPO) 81-612 Table 6
YIELDMYB	50 bond-yield averages (Canada) (McLeod Young Weir)	B-81-153

Notes to Table 2.1

1. Taxes charged construction will change because of CRTC 78-01 Decision 13; An Increase of 4% p.a. is assumed, but until 1981 results are published, there is little change of knowing the effect of the decision. The item is small; about \$5 m in 1980.

2. A number of new accounting rules were imposed on Bell by the CRTC. These effects are described in B-81-257 and B-81-258. The incremental effect for 1980-1 is \$61.2 m, and for the rules that come into force in 1981-2 the incremental effect is \$51.6 m. These changes are not captured in the existing total operating expenses function. Thus:

   Effect 78-01, Dir. 13 1981 = 61.2 m

   $$1980 = 61.2 \cdot \frac{2390.3}{2805.0} \cdot .25 = \$13.0 \text{ m}$$

   $$1982 = 61.2 \quad \frac{3258.9}{2805.0} \cdot \quad = \$71.0 \text{ m}$$

   (weightings are total operating expenses, B-81-1; .25 for 1980 as effective Oct. 1). Effect of 78-01 Dir. 11, 13 + 16, 1982 = \$51.6 m.

Total effect:	1980	13.0
	1981	61.2
	1982	51.6 + 71.1 = 122.7
	1983	(growth of TOE 81-82)

3. Assumed to growth at same rate as GNP; rates from Bell B-81-250 p.5.

4. Assumed growth of .5% p.a..

5. Calculated from values for total other toll and WATS revenues, BELL (NAPO) 81-612 Tables 1 and 1a. For the requested price increase, see Table 8.1.

6. From BELL (CRTC) 9 Jan. 81-312, the growth of capacity is most striking for DMS, increasing from .1% in 1979 to an expected value of almost 9% in 1982. The share of analogue electronic remains approximately constant 1980-1982. Thus the growth of SP1 + DMS is approximately

1980	.14	1982	.23
1981	.18	1983	.26

7. Rate taken for index as the same as for cost of materials BELL (NAPO) 81-612, Table 3.

CHAPTER 3

THE DEMAND SYSTEM

The system of demand equations (DEML, DEMM) is estimated for two services - local (primary and contract auxiliary) and message toll (a divisia index of Inter, Trans-Canada, U.S. and Overseas, and WATS service). As can be seen, the double log formulation has been used. - Taylor [8] has shown that this formulation is very suitable for telecommunications demand systems.

The main problem in the double log specification has been a lack of robustness of the parameter estimates to slight changes in the specification, and also serial correlation. Neither of these problems occurred. To some extent, this is due to:

a) Use of per capita data for the dependent variable

b) Use of GRP (gross regional product of Ontario and Quebec) as the choice for the income variable.

The functional form and variable definitions are shown in Table 3.1. The per capita output of each service is postulated as a function of the real price, per capita income, and, in the case of local service per capita conversations, as well as three dummy variables as described in Table 3.1.

The two demand equations were estimated as a system (SURE), thus allowing for cross correlation between residuals of the two equations. In fact there was very little cross correlation, and essentially identical results were obtained using OLS on each equation separately. The results are shown in Table 3.2.

From these results, it can be seen that, with the exception of RATI for message toll, all coefficients are statistically significant.

TABLE 3.1

DEMAND SYSTEM

Period of Estimation: 1952-1980

Method: SURE (seemingly unrelated regression estimation)

```
COMMENT        ******  DEMAND EQUATIONS  ********          $
FRML DEML LQLOCP =
          (A0+A1*LOG(PLOC/CPI)+A3*LYD+A4*LCONVF+RL1*RAT1+RL2*RAT2
          +RL3*RAT3) $
FRML DEMM LQTOLP =
          (B0+B2*LOG(PTOL/CPI)+B3*LYD+RT1*RAT1+RT2*RAT2+RT3*RAT3)$
```

Dependent Variables:

LQLOCP	Logarithm of per capita local service revenue (primary and contract auxiliary) in constant $1967.
LQTOLP	Logarithm of per capita message toll revenue in constant $1967. This is a divisia index of Intra, Transcanada, U.S. and Overseas, and WATS service.

Exogenous Variables:

LPLOC	Logarithm of local price, deflated by CPI
LPTOL	Logarithm of message toll price, deflated by CPI
LYD	Logarithm of per capita regional product, deflated by CPI. This is a proxy for income.
LCONVP	Logarithm of conversations per capita. This is a proxy for the changing telecommunications environment.
RAT1	Step variable for introduction of DDD in 1959.
RAT2	Step variable for introduction of the one minute charged call in 1971.
RAT3	Step variable for the change in the Toronto EAS in 1976.

TABLE 3.2

DEMAND SYSTEM ESTIMATION

LOG OF LIKELIHOOD FUNCTION = 147.165

RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
A0	-3.64130	.553596	-6.578
A1	-.521054	.851831E-01	-6.117
A3	.289273	.665882E-01	4.344
A4	.626159	.150518	4.160
RL1	.725322E-01	.150718E-01	4.812
RL2	.259902E-01	.134299E-01	1.935
RL3	.575026E-01	.139962E-01	4.108
B0	-3.57085	.932360	-3.830
B2	-1.35326	.135268	-10.004
B3	.609001	.886441E-01	6.870
RT1	.232691E-01	.243420E-01	.956
RT2	.106280	.227195E-01	4.678
RT3	.816166E-01	.295005E-01	2.767

EQUATION DEML
****

DEPENDENT VARIABLE LQLOCP

MEAN OF DEPENDENT VARIABLE = 3.55895
STANDARD DEVIATION OF DEP. VARIABLE = .413431

SUM OF SQUARED RESIDUALS = .521961E-02
STANDARD ERROR OF THE REGRESSION = .134159E-01
R-SQUARED = .9989
ADJUSTED R-SQUARED = .9989
NUMBER OF OBSERVATIONS = 29.
SUM OF RESIDUALS = .341061E-12
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) = 1.7651

EQUATION DEMM
****

DEPENDENT VARIABLE LQTOLP

MEAN OF DEPENDENT VARIABLE = 2.95903
STANDARD DEVIATION OF DEP. VARIABLE = .679190

SUM OF SQUARED RESIDUALS = .231356E-01
STANDARD ERROR OF THE REGRESSION = .282450E-01
R-SQUARED = .9982
ADJUSTED R-SQUARED = .9983
NUMBER OF OBSERVATIONS = 29.
SUM OF RESIDUALS = .611067E-12
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) = 1.9442

Local price is inelastic (-.52) while message toll price is elastic (-1.35). The income elasticity of toll (.61) is greater than that of local (.29) as would be expected. Similarly, the coefficient for the conversation variable (A4) is positive, as expected, and statistically significant. Also note that the value of the Durbin Watson statistic implies that there is little serial correlation.

The system was also estimated using level quantities as opposed to the per capita values; this resulted in little change in the income and price elasticities.

We note, in passing, that there are theoretical problems involved in estimating the MTS equation without taking into account the supply side - price effectively is an endogenous variable. To evaluate the sensitivity of the forecasts to changes in values of ε_M, the simulations are repeated with a cost function evaluated at ε_M : -1.2, opposed to -1.35, which is the base model discussed.

As discussed in Breslaw [1], no attempt was made to estimate demand functions for either toll private line services, nor miscellaneous services. In the scenarios, the values predicted by Bell for 1981 and 1982 for miscellaneous revenues have been used.

Other toll service, excluding WATS, consists of toll private line, telex and other data services. Toll private line is by far the largest component. This series was predicted using an autoregressive scheme in the previous study, and, at that time, it was pointed out that Bell's predictions appeared low. A summary is shown in Table 3.3. In the present application, Bell predicts an increase of 16.9% for private line services revenue 1980-1981, assuming no rate increase (BELL (NAPO) 612, Table 1a), but only 5% for 1981-1982.

To maintain consistency, the Bell predictions for toll private line and other revenue will be utilized. However, it seems likely that, as in the previous case, Bell's predictions will be biased low.

TABLE 3.3

PREDICTION OF OTHER TOLL (EXCL. WATTS)

	1980	1981
BELL (NAPO)-612 (a)	242.9	279.7 1) 289.1 2)
Predictions Made in 1980 (b)		
Bell:		
No price increase	212.8	223.8
With price increase	221.8	247.0
Breslaw:		
Autoregressive	243.1	282.1

(a) 1980 Delivered value
1981 Estimated value - 1) No rate increase; 2) Rate increase

(b) Breslaw [1] Table 20.

CHAPTER 4

THE COST SYSTEM

In Breslaw [1], a cost model based on data from 1968 to 1978 was utilized. This made estimation and simulation quite simple, since over that period capital and labour shares remained approximately constant - a range of 1% was the extent of the variability of the shares. However, there were problems with this model - in particular the profit maximization conditions were not satisfied for message toll.

The addition of the data periods for 1979 and 1980 suggested that the hypothesis of constant shares could no longer be maintained (see Graph 4.1), and consequently the cost model was re-estimated for the period 1956-1980 (thus excluding the Korean war period). The full cost system consists of the cost function (trans log.), two factor share equations (capital and labour), and two profit maximization equations (MTS and toll private line). The details of the theory behind the system is discussed in Breslaw and Smith [2]. However, there are some important differences:

a) Period of estimation 1956-1980

b) Measure of technology. In this model, two separate measures of technology are used concurrently -

TLN - % telephones with access to DDD

ULN - % of COE which are SP1 or digital.

The rationale for the introduction of a second measure of technology is that the first measure has effectively plateaued by the late 1970's.

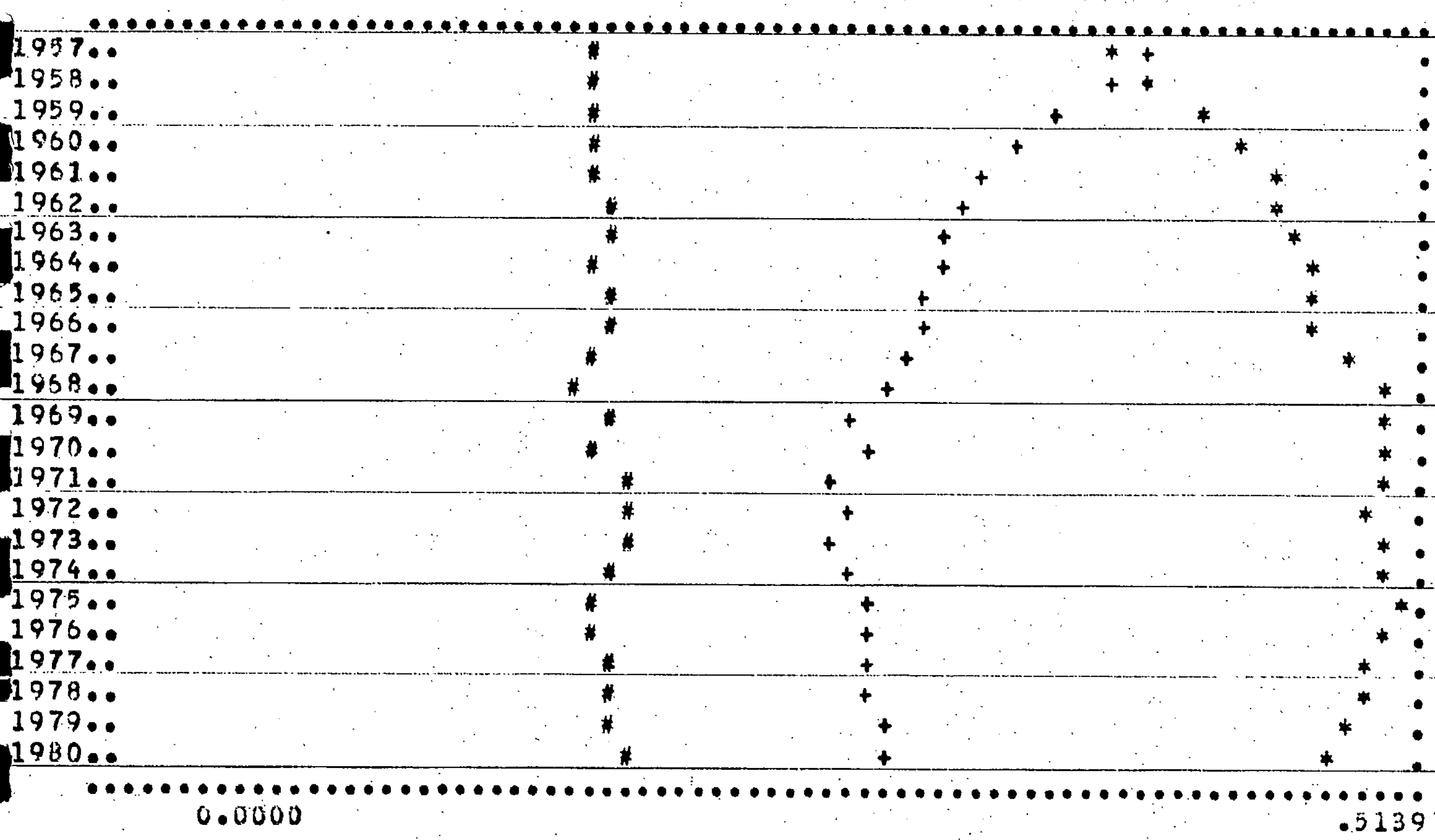
GRAPH 4.1

FACTOR SHARES

TIME SERIES PLOT
****

CHARACTERS	VARIABLES
•	D
#	LHM
+	LHL
*	LHK

SMPL VECTOR
6 29



Although DDD does act as a proxy for the technological improvements (in particular microwave) made during the 1960's a second phase of technology (electronic) is not captured by DDD. Hence the introduction of SP1 as a measure. The main gain from this additional variable is a far better fit for the share and profit maximization equations.

c) The price elasticity for message toll was taken for the demand equation (-1.35, and for the sensitivity analysis -1.2). The price elasticity for toll private line was taken as -2.0 (see Breslaw and Smith [2] for discussion as to the effect of changing the value of this parameter).

d) The material share hardly varies over the period and is assumed constant.

e) The cost function is assumed homogeneous of degree 1 in factor prices. Coupled with a constant share for materials imply the following restrictions:

$$C_w + C_r + C_v = 1$$

$$C_{ww} = -C_{wR} \qquad C_{wT} = -C_{rT}$$

$$C_{rr} = -C_{wR} \qquad C_{wv} = -C_{ru}$$

$$C_{wQL} = -C_{rQL} \qquad C_{wv} = C_{rv} = C_{vv} = 0$$

$$C_{wQM} = -C_{rQM} \qquad C_{vQM} = C_{vQL} = C_{vQP} = C_{vT} = C_{uT} = 0$$

$$C_{wQP} = -C_{rQP}$$

The cost function is shown in FRML COSTFN and the two share equations in SCL and SCK. The derived profit maximizing conditions (MR = MC) are assumed to exist for QTOL and QTPL. These are shown in FRML TOLPRM and TPLPRM; the left hand side terms (MRM, MRP) are the respective marginal revenues, $P(1+1/\varepsilon)$, where P and ε are the respective prices and elasticities. The equations are shown in Table 4.1.

TABLE 4.1

COST SYSTEM

Period of Estimation: 1956-1980

Method: SURE

```
COMMENT        ****** COST EQUATIONS ******        $

FRML COSTFN  LHS = -LOG(COST) +CC0 + CW*WLN + (1-CW-CR)*VLN + CR*RLN
      + .5*(-CWR*WLN**2 - CWR*RLN**2)   + CWR*WLN*RLN
      + WLN*(CWQL*QLLN+CWQM*QMLN+CWQP*QPLN+CWT*TLN+CWU*ULN)
      - RLN*(CWQL*QLLN+CWQM*QMLN+CWQP*QPLN+CWT*TLN+CWU*ULN)
      + CQL*QLLN + CQM*QMLN + CQP*QPLN + CT*TLN + CU*ULN
      + .5*(CQLQL*QLLN**2 + CQMQM*QMLN**2 + CQPQP*QPLN**2 + CTT*TLN**2
      +  CUU*ULN**2)
      + TLN*(CQLT*QLLN+CQMT*QMLN+CQPT*QPLN)
      + ULN*(CQLU*QLLN+CQMU*QMLN+CQPU*QPLN)
      + QMLN*(CQMQL*QLLN+CQMQP*QPLN) + CQPQL*QPLN*QLLN $
FRML SCL
 LHL = CW-CWR*WLN+CWR*RLN+CWQL*QLLN+CWQM*QMLN+CWQP*QPLN+CWT*TLN+CWU*ULN $
FRML SCM LHM = CV $
FRML SCK LHK = CR-CWR*RLN+CWR*WLN-CWQL*QLLN-CWQM*QMLN-CWQP*QPLN
                        -CWT*TLN -CWU*ULN $
FRML TOLPRM MRM=(CQM+CQMQM*QMLN+CQMT*TLN+CQMU*ULN
                +CWQM*WLN-CWQM*RLN+CQMQL*QLLN+CQMQP*QPLN) $
FRML TPLPRM MRP=(CQP+CQPQP*QPLN+CQPT*TLN+CQPU*ULN
                +CWQP*WLN-CWQP*RLN+CQPQL*QLLN+CQMQP*QMLN) $
```

Cost	WLN	Log (wage cost)
	VLN	Log (material cost, including uncollectibles)
	RLN	Log (capital cost)
Outputs	QLLN	Log (local and miscellaneous services)
	QMLN	Log (MTS service, incl. WATS)
	QPLN	Log (toll private line service)
Technologies	TLN	% phones with access to DDD
	ULN	% COE SP1 or digital

Marginal Revenues

MRM $= P_M(1 + 1/\varepsilon_M)$ — P_M = Price of MTS; ε_M = elasticity MTS

MRP $P_P(1 + 1/\varepsilon_P)$ — P_P = Price of TPL; ε_P = elasticity of TPL

TABLE 4.2

COST FUNCTION ESTIMATION

EQUATION COSTFN

DEPENDENT VARIABLE	LHS	
SUM OF SQUARED RESIDUALS =		.353423E-02
R-SQUARED =		*******
SUM OF RESIDUALS =		-.109626E-02
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =		1.0989

EQUATION SCL

DEPENDENT VARIABLE	LHL	
SUM OF SQUARED RESIDUALS =		.282616E-03
R-SQUARED =		.9919
SUM OF RESIDUALS =		.347047E-03
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =		2.0373

EQUATION SCK

DEPENDENT VARIABLE	LHK	
SUM OF SQUARED RESIDUALS =		.679470E-03
R-SQUARED =		.9792
SUM OF RESIDUALS =		.469186E-03
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =		1.2436

EQUATION TOLPRM

DEPENDENT VARIABLE	MRM	
SUM OF SQUARED RESIDUALS =		.474158E-04
R-SQUARED =		.9686
SUM OF RESIDUALS =		.255887E-04
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =		1.9778

EQUATION TPLPRM

DEPENDENT VARIABLE	MRP	
SUM OF SQUARED RESIDUALS =		.121914E-04
R-SQUARED =		.9873
SUM OF RESIDUALS =		-.650176E-04
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =		1.1195

TABLE 4.2 (continued)

LOG OF LIKELIHOOD FUNCTION = 591.545

RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
CC0	3.66090	.117037	31.280
CW	.516850	.604266E-01	8.553
CR	.286975	.604361E-01	4.748
CWR	-.631002E-01	.193670E-01	-3.258
CWQL	-.586999E-01	.189958E-01	-3.090
CWQM	.119398E-01	.845894E-02	1.411
CWQP	-.113036E-01	.395825E-02	-2.856
CWT	-.104811	.797105E-02	-13.149
CWU	.269365	.228754E-01	11.775
CQM	.192656	.357706E-01	5.386
CQP	.220267	.111453E-01	19.763
CT	1.06667	.164636	6.479
CQLQL	.221103	.164194E-01	13.466
CQMQM	.537816E-01	.663190E-02	8.110
CQPQP	.344114E-01	.161004E-02	21.373
CQLT	-.148114	.309405E-01	-4.787
CQMT	.119489E-01	.413817E-02	2.887
CQPT	-.401859E-02	.183824E-02	-2.186
CQMU	-.104442	.797943E-02	-13.089
CQPU	.251603E-01	.446152E-02	5.639
CQMQL	-.720601E-01	.124208E-01	-5.802
CQPQL	-.449558E-01	.302958E-02	-14.839

The five equations were estimated simultaneously using SURE. The results are shown in Table 4.2 under the base model of $\varepsilon_M = -1.35$ and $\varepsilon_P = -2.0$. Coefficients which always were statistically insignificant at the 95% level over a large range of values for ε_M and ε_P were dropped. The t-values are very high in a number of cases, suggesting that these coefficients are very precisely estimated. The fits are good, as will be seen from the R^2, and the tracking reported below. In addition, for the labour share and message toll profit maximization equations, there is no evidence of serial correlation, which is an improvement over previous years studies.

The properties of this cost function were investigated in detail, and are shown, for selected years in Table 4.3. Marginal costs show a slight decline up to the end of the 1960's, and then increases rapidly through the 1970's. For message toll and toll private line, the marginal cost/$ revenue follows directly from the elasticity assumption, since MC = MR in the profit maximization equations. For local, marginal cost/$ revenue changes from 85¢ in 1956 to 70¢ in 1967, and then increases to 98¢ in 1980. It should be recalled that local service includes both basic primary as well as vertical services and miscellaneous services.

The function also exhibits scale; a value of 1.6 is achieved by 1961, and remains fairly constant over the rest of the period. This result is similar to that reported in previous studies. Cost complimentarity exists between local and message toll, and local and toll private line; however it does not exist between toll and

TABLE 4.3

COST FUNCTION PROPERTIES

	1956	1962	1967	1974	1980
Marginal Cost					
Local	.797	.706	.697	.970	1.648
Message Toll	.278	.278	.257	.296	.380
Toll Private Line	.489	.516	.486	.580	.956
Scale	1.455	1.591	1.618	1.615	1.624

toll private line, so scope cannot be inferred.

The function is well behaved in two important respects: First, it is weakly concave in factor prices (this follows from it being linearly homogeneous in factor prices together with constant material share). Second, the profit maximization second order conditions, which imply that the marginal cost intersects the marginal revenue curve from below is satisfied for both MTS and TPL for every data point.

CHAPTER 5

-FINANCIAL MODEL

The financial module of this model has been completely respecified and re-estimated. This was necessary since many of the equations in the financial module effectively reduced to a first order autoregressive form. For the majority of the equations, the sample chosen for estimation was that used for the cost model. - 1956-1980.

5.1 FINAN

The FINAN equation relates economic capital to accounting capital. The previous FINAN equation, which related real economic capital to real accounting capital produced significant coefficients only for the period 1967-1980, (see Breslaw [1] Fig. 2); for the period 1956-1980, only the coefficient for the serial correlation term was significant.

In its place a relationship between the change in the value of accounting capital and the change in the value of economic capital was specified. The results are shown in Table 5.1. Both coefficients are highly significant, and there is a very good fit, and no serial correlation.

TABLE 5.1

FINAN ESTIMATION

FRML FINAN AVAK = D0 + AVAK(-1) + D2*(PK*K-PK(-1)*K(-1)) $

AVAK	Accounting Capital, current $
K	Economic Capital, $1967
PK	Price index, telephone plant

EQUATION FINAN
****

DEPENDENT VARIABLE AVAK

MEAN OF DEPENDENT VARIABLE =	2939.33
STANDARD DEVIATION OF DEP. VARIABLE =	1771.85
SUM OF SQUARED RESIDUALS =	58068.4
STANDARD ERROR OF THE REGRESSION =	50.2465
R-SQUARED =	.9992
ADJUSTED R-SQUARED =	.9992
F-STATISTIC(1., 23.) =	29820.7
LOG OF LIKELIHOOD FUNCTION =	-132.355
NUMBER OF OBSERVATIONS =	25.
SUM OF RESIDUALS =	.254659E-10
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =	2.1858

RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
D0	78.1663	15.2900	5.112
D2	.406901	.277411E-01	14.668

5.2 DEBTR

This equation allocates the accounting capital to debt and equity. This equation replaces EQUA1 and EQUA2. These two previous equations related real equity (debt) with real accounting capital and the ratio of the return to equity to the return to debt. Unfortunately, the coefficient on this last term was not significant, and consequently the relationship between equity (debt) and accounting capital was fixed (except for a term correcting for serial correlation).

The DEBTR equation specifies that the debt ratio (debt/total) is given by the previous period's debt ratio, and by the price/earnings ratio. The rationale behind this is that a firm with a high P/E ratio will find it cheaper to fund by issuing stock, than by issuing debt. Thus an inverse relationship between the debt ratio, and the P/E ratio is postulated.

The estimation results are shown in Table 5.2. All coefficients are statistically significant at the 99% level, serial correlation is not a problem, and considering that the dependent variable is not trended, a very good fit is achieved. (R^2 = .96.)

Once the debt ratio is known, then, given accounting capital, debt and equity follow immediately.

TABLE 5.2

DEBTR ESTIMATION

```
FRML DEBTR RATIO = X0 + X1*APER + X2*RATIO(-1) $
```

RATIO	Debt ratio	Debt/(Debt + Equity)
APER	Average price/earnings ratio	

```
EQUATION DEBTR
******************

DEPENDENT VARIABLE                   RATIO

MEAN OF DEPENDENT VARIABLE =                            .444023
STANDARD DEVIATION OF DEP. VARIABLE =                   .446266E-01

SUM OF SQUARED RESIDUALS =                              .150526E-02
STANDARD ERROR OF THE REGRESSION =                      .827169E-02
R-SQUARED =                                              .9688
ADJUSTED R-SQUARED =                                     .9660
F-STATISTIC(  2.,   22.) =                              341.424
LOG OF LIKELIHOOD FUNCTION =                            85.9974
NUMBER OF OBSERVATIONS =                                    25.
SUM OF RESIDUALS =                                      .106581E-13
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =            2.1332
```

RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
X0	.171132	.487531E-01	3.510
X1	-.281215E-02	.868613E-03	-3.238
X2	.715708	.838079E-01	8.540

5.3 EQ6

The total equity has to be allocated between common and preferred stock. In the previous formulation real average preferred equity was assumed to follow an autoregressive structure. Although this produced significant coefficients, it did not perform as well as the formulation described below.

The ratio of preferred equity to total accounting capital was specified in an autoregressive form. The results are shown in Table 5.3. Although the fit is poor (R^2 = .55), the resulting values of preferred equity track somewhat better than the previous formulation.

TABLE 5.3

EQ6 ESTIMATION

FRML EQ6 RATIOP = W0 + W1*RATIOP(-1) $

RATIOP = Preferred Equity/Total Accounting Capital

EQUATION EQ6
****

DEPENDENT VARIABLE	RATIOP
MEAN OF DEPENDENT VARIABLE =	.638015E-01
STANDARD DEVIATION OF DEP. VARIABLE =	.970235E-02
SUM OF SQUARED RESIDUALS =	.379501E-03
STANDARD ERROR OF THE REGRESSION =	.688750E-02
R-SQUARED =	.5521
ADJUSTED R-SQUARED =	.4961
F-STATISTIC(1., 8.) =	9.85965
LOG OF LIKELIHOOD FUNCTION =	36.7068
NUMBER OF OBSERVATIONS =	10.
SUM OF RESIDUALS =	.155431E-14
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =	2.6466

RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
W0	.346776E-01	.952741E-02	3.640
W1	.483076	.153846	3.140

CHAPTER 6

INCOME STATEMENT

Equations used for the Income Statement module were also respecified for the same reasons as in the financial module.

6.1 Total Operating Expenses

In the previous formulation, the relationship between real total operating expenses and real costs was expressed in STA10A. This produced reasonable results, but tended to underestimate operating expenses when predicted on future costs. For this reason, given the importance of this item, a detailed analysis was undertaken.

The components of total operating expenses are:

1) Employee expense

2) Depreciation

3) Other expenses

4) Non-income taxes

1) Employee expense is given by $w \times L$, or total labour compensation (NAPO, 612, Table 6). This series has been adjusted to include labour taxes (BELL (CAC) 511, p. 2).

2) Accounting depreciation is evaluated from data on economic capital (K) and the composite depreciation rate on average depreciable plant (DECC). One would expect the depreciation to be proportional to the various amount of capital invested each year. The following geometric average is assumed:

$$DEP_t = a \cdot DECC_t \cdot \tilde{K}_t^{\beta_o} \tilde{K}_{t-1}^{\beta_1} \tilde{K}_{t-2}^{\beta_2} \cdots \qquad \text{where } \tilde{K} = K.P_K$$

Assume that the β are related by $\beta_i = \beta_o\lambda^i$, and taking logarithms

$$\log(DEP_t) = \alpha + \log(DECC_t) + \beta_o[\log(\tilde{K}_t) + \lambda \log(\tilde{K}_{t-1}) + \lambda^2 \log(\tilde{K}_{t-2}) \ldots]$$

Taking a Koych transformation

$$\log(DEP_t) = \alpha(1-\lambda) + \log(DECC_t) + \lambda[\log(DEP_{t-1}) - \log(DECC_{t-1})] + \beta_o \log(\tilde{K}_t) \qquad (1)$$

The estimation, from 1956 to 1980 is shown in Table 6.1a.

3) Other expenses includes materials, maintenance, rentals, travel, R & D, etc. as well as the Ontario official Telephone Service Tax (Kiss, p. 36). The material series M, and its price v is a Divisia series consisting of material expenses, revenue taxes, and uncollectables. It has also been adjusted to include the material tax mentioned above. Thus uncollectable expenses must be subtracted from this series.

4) Non income taxes.

These include the following:

a) Labour taxes (UIC, QHIP, etc.). These are already accounted for in employee expenses.

b) Material taxes (Ontario Telephone Service tax). This is already accounted for in material expenses.

c) Capital taxes (Ontario capital, Quebec capital, etc.).

These are included in the price of capital, but this is of no help here. The procedure followed is to assume a relationship between capital tax and the current value of net physical capital, in the same manner as for accounting depreciation. However, in place of DECC, a rate has to be established. This rate changes in 1972, due to change in treatment of leased plant, and again in 1979, when the Quebec special tax was repealed. Thus:

$$CAPTAX_t = (a_o + a_1 D_1 + a_2 D_2)\, \tilde{K}_t^{\beta_o}\, \tilde{K}_{t-1}^{\beta_1}\, \tilde{K}_{t-2}^{\beta_2} \cdots$$

$$\log(CAPTAX_t) = (a_o + a_1 D_1 + a_2 D_2)(1-\lambda) + \lambda \log(CAPTAX_{-1}) + \beta_o \log(\tilde{K}_t) \qquad (2)$$

where $D_1 = 1$ if $t \geq 1972$

$D_2 = 1$ if $t \geq 1979$.

The estimation, from 1956 to 1980 resulted in a statistically insignificant value for λ. Equation (2) thus becomes double log, and the results are shown in Table 6.1b. The linear model was also tested, but the double log was superior.

d) Taxes (non income) for expenses changed construction (CONTAX) are excluded (Bell Canada, 309). Following CRTC 78-01, Directive 13, general expenses changed construction, which includes this item will no longer be permitted, as of October 1980. The effect of these accounting changes is taken into account in the variable CRTC 78-01.

TABLE 6.1a

STA11A ESTIMATION

```
FRML STA11A LDEPRE = H0*(1-LAM) + LOG(DECC) + LAM*(LDEPRE(-1)-LOG(DECC(-1)))
          + H1*LOG(PK*K) $
```

LDEPRE	Logarithm of accounting depreciation
DECC	Composite depreciation rate on plant
K	Average net economic capital ($1967)
PK	Telephone plant price index

EQUATION STA11A
****

DEPENDENT VARIABLE	LDEPRE
MEAN OF DEPENDENT VARIABLE =	5.06108
STANDARD DEVIATION OF DEP. VARIABLE =	.793080
SUM OF SQUARED RESIDUALS =	.496171E-02
STANDARD ERROR OF THE REGRESSION =	.150177E-01
R-SQUARED =	.9997
ADJUSTED R-SQUARED =	.9996
F-STATISTIC(2., 22.) =	33455.2
LOG OF LIKELIHOOD FUNCTION =	71.0875
NUMBER OF OBSERVATIONS =	25.
SUM OF RESIDUALS =	.568434E-12
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =	2.6796

RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
H0	1.19768	.128232	9.340
LAM	.698057	.397047E-01	17.581
H1	.266898	.363360E-01	7.345

TABLE 6.1b

STA12A ESTIMATION

FRML STA12A LKAPTAX = (N0+N1*DUM1+N2*DUM2) + N3*LOG(PK*K) $

LKAPTAX	Logarithm of capital tax
K	Average net economic capital ($1967)
PK	Telephone plant price index
DUM1	Step variable, equal unity 1972 on
DUM2	Step variable, equal unity 1979 on.

EQUATION STA12A
****

DEPENDENT VARIABLE LKAPTAX

MEAN OF DEPENDENT VARIABLE =	2.81690
STANDARD DEVIATION OF DEP. VARIABLE =	.658187
SUM OF SQUARED RESIDUALS =	.391964E-01
STANDARD ERROR OF THE REGRESSION =	.432030E-01
R-SQUARED =	.9962
ADJUSTED R-SQUARED =	.9957
F-STATISTIC(3., 21.) =	1849.78
LOG OF LIKELIHOOD FUNCTION =	45.2521
NUMBER OF OBSERVATIONS =	25.
SUM OF RESIDUALS =	.476064E-12
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =	1.5816

RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
N0	-6.01933	.177273	-33.955
N1	-.457453	.345405E-01	-13.244
N2	-.191377	.370165E-01	-5.170
N3	1.13120	.236162E-01	47.899

Thus the resulting relationship is:

$$TOE = w \cdot L + v \cdot M + DEP + KAPTAX - UNCOL - CONTAX + CRTC7801$$

L, M and K are predicted by the cost model, and DEP and KAPTAX from STA11A and STA12A. The remaining variables were discussed in Chapter 2.

6.2 Interest Payments

The relationship between interest payments and debt previously expressed in STA14A begins to break down as interest rates diverge from the rate of inflation. Thus STA14A was reformulated such that the interest rate is expressed as a function of the yield on corporate bonds (McLeod, Young, Weir), and on autoregressive lines. The results are shown in Table 6.2. The coefficients (excluding the constant) are all statistically significant, with good fit and no serial correlation. Given debt and interest rate on debt, the level of interest follows immediately.

TABLE 6.2

STA14A ESTIMATION

FRML STA14A INDBT = L0 + L1*YIELDMYB + L2*INDBT(-1) $

INDBT Interest rate on debt

YIELDMYB 50 bond yield average

EQUATION STA14A
****

DEPENDENT VARIABLE	INDBT
MEAN OF DEPENDENT VARIABLE =	.577405E-01
STANDARD DEVIATION OF DEP. VARIABLE =	.142751E-01
SUM OF SQUARED RESIDUALS =	.206800E-04
STANDARD ERROR OF THE REGRESSION =	.969536E-03
R-SQUARED =	.9958
ADJUSTED R-SQUARED =	.9954
F-STATISTIC(2., 22.) =	2590.42
LOG OF LIKELIHOOD FUNCTION =	139.592
NUMBER OF OBSERVATIONS =	25.
SUM OF RESIDUALS =	.310862E-14
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =	2.1571

RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
L0	.217014E-03	.899556E-03	.241
L1	.677833E-03	.244703E-03	2.770
L2	.936241	.422920E-01	22.138

6.3 Income Tax

The previous formulation (STA16A) assumed a constant rate of tax (on the taxbase), with correction for serial correlation. To make this more general, since the rate does vary by over 7 points (42-49%) the rate is assumed to be related to both the previous year's rate, and to the rate of growth of the tax base. Thus if the tax base should fall, it would be expected that the tax rate would also decline, and conversely.

The estimation is shown in Table 6.3. The coefficients are statistically significant at the 95% level, and, though the fit is poor (R^2 = .49) the tracking of actual tax paid is superior to the previous formulation.

TABLE 6.3

STA16A ESTIMATION

FRML STA16A TXRTIO = K0+K1*TXRTIO(-1)+ K2*(TAXBASE-TAXBASE(-1))/TAXBASE(-1)$

TXRTIO	Tax rate = Income Tax/Tax base
TAXBASE	Income subject to income tax

EQUATION STA16A
****

DEPENDENT VARIABLE	TXRTIO
MEAN OF DEPENDENT VARIABLE =	.458030
STANDARD DEVIATION OF DEP. VARIABLE =	.184273E-01
SUM OF SQUARED RESIDUALS =	.417582E-02
STANDARD ERROR OF THE REGRESSION =	.137772E-01
R-SQUARED =	.4876
ADJUSTED R-SQUARED =	.4410
F-STATISTIC(2., 22.) =	10.4677
LOG OF LIKELIHOOD FUNCTION =	73.2430
NUMBER OF OBSERVATIONS =	25.
SUM OF RESIDUALS =	.355271E-13
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =	1.6187

RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
K0	.152467	.692061E-01	2.203
K1	.653956	.150033	4.359
K2	.657566E-01	.318812E-01	2.063

6.4 Preferred Dividend

The previous formulation expressed the dividend paid to preference stockholders as a function of preferred equity, both expressed in real terms. This suffers from the same problem that affected interest payments - effectively, the real rate changes, as inflation rate and interest rates diverge.

STA20A expresses a relationship between the rate of return to preferred stock, and the average corporate yield (MYB) and the rate of return to preferred stock lagged. The results are shown in Table 6.4. The results are quite good, given that the dependent variable is a rate, and the resultant tracking of preferred dividends is superior to the previous formulation.

TABLE 6.4

STA20A ESTIMATION

FRML STA20A DIVAPE = M0 + M1*YIELDMYB + M2*DIVAPE(-1) $

DIVAPE = Return to preferred stock

YIELDMYB = 50 bond yield average

EQUATION STA20A
****

DEPENDENT VARIABLE	DIVAPE
MEAN OF DEPENDENT VARIABLE =	.774201E-01
STANDARD DEVIATION OF DEP. VARIABLE =	.942256E-02
SUM OF SQUARED RESIDUALS =	.885879E-04
STANDARD ERROR OF THE REGRESSION =	.355745E-02
R-SQUARED =	.8891
ADJUSTED R-SQUARED =	.8575
F-STATISTIC(2., 7.) =	28.0700
LOG OF LIKELIHOOD FUNCTION =	43.9811
NUMBER OF OBSERVATIONS =	10.
SUM OF RESIDUALS =	0.
DURBIN-WATSON STATISTIC (ADJ. FOR 0. GAPS) =	1.2037

RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
M0	-.616937E-03	.104793E-01	-.059
M1	.215722E-02	.969380E-03	2.225
M2	.747833	.160624	4.656

CHAPTER 7

HISTORICAL VALIDATION

Given the goodness of fit in the estimation of the various equations, it would be expected that the predicted values would track the created values very closely. This indeed is the case.

Table 7.1a shows the actual and predicted values for local output (QLOC, QLOCS) and actual and predicted values for local revenue (RLOC, RLOCS). Table 7.1b shows the Theil description for the output series. The tracking is very tight, and almost all the error is due to residual variance.

A similar set of results is given for message toll service, shown in Tables 7.2a and 7.2b. Again, the tracking is good, though not as tight as for local service.

The cost validation is shown in Tables 7.3a and 7.3b, based on the actual level of factors. For each factor (L - labour, M - materials, K - capital), and for the cost there is a tight correspondence between actual and predicted values. The Theil decomposition is shown in Tables 7.3b.

Rather than compare the historical with the predicted value for each variable in the financial module and income statement module, a historical tracking of the income statement is presented under four regimes:

TABLE 7.1a

DEMAND MODEL VALIDATION - LOCAL SERVICE

	QLOC	QLOCS	RLOC	RLOCS
1952	126.400	130.232	116.794	120.334
1953	137.000	139.078	127.821	129.760
1954	148.000	145.644	138.084	135.886
1955	162.900	161.459	151.986	150.641
1956	181.700	184.687	169.526	172.313
1957	200.600	196.576	187.160	185.274
1958	216.600	211.006	203.387	198.135
1959	233.600	235.819	233.600	235.819
1960	250.900	248.686	250.900	248.686
1961	269.500	263.123	269.500	263.123
1962	289.600	287.229	289.600	287.229
1963	308.700	305.886	308.700	305.886
1964	325.000	328.548	325.000	328.548
1965	350.800	352.724	350.800	352.724
1966	380.700	385.091	380.700	385.091
1967	410.000	409.669	410.000	409.669
1968	437.600	438.501	437.600	438.501
1969	471.400	475.631	472.814	477.058
1970	504.300	505.284	512.369	513.368
1971	538.000	541.494	568.128	571.618
1972	579.800	582.552	629.663	632.652
1973	625.500	626.085	698.058	698.711
1974	679.400	689.644	774.516	786.194
1975	734.300	719.155	878.223	860.109
1976	779.700	773.210	990.219	981.976
1977	820.500	839.283	1107.68	1133.03
1978	855.800	849.454	1263.08	1253.71
1979	883.700	880.539	1392.71	1387.73
1980	928.400	919.606	1562.50	1547.70

TABLE 7.1b

COMPARISON OF ACTUAL AND PREDICTED TIME SERIES

```
ACTUAL AND PREDICTED VARIABLES...        QLOC               QLOCS

SAMPLE =          1       29

CORRELATION COEFFICIENT =     .9997
               (SQUARED =     .9994

ROOT-MEAN-SQUARED ERROR =     6.064

MEAN ABSOLUTE ERROR =         4.421

MEAN ERROR =                  .7940E-01

REGRESSION COEFFICIENT OF ACTUAL ON PREDICTED =       1.001

THEIL"S INEQUALITY COEFFICIENT =                      .5981E-02

FRACTION OF ERROR DUE TO BIAS =                       .1714E-03

FRACTION OF ERROR DUE TO DIFFERENT VARIATION =        .3665E-02

FRACTION OF ERROR DUE TO DIFFERENT CO-VARIATION =     .9960

ALTERNATIVE DECOMPOSITION (LAST 2 COMPONENTS)
     FRACTION OF ERROR DUE TO DIFFERENCES OF REGRESSION
          COEFFICIENT FROM UNITY =                    .2496E-02
     FRACTION OF ERROR DUE TO RESIDUAL VARIANCE =     .9973
```

TABLE 7.2a

DEMAND VALIDATION - MESSAGE TOLL

	QTOL	QTOLS	RTOL	RTOLS
1952	52.6077	53.0094	55.9897	56.4171
1953	56.7166	57.7767	60.4341	61.5637
1954	61.1979	61.6386	65.2568	65.7267
1955	70.1543	67.8256	74.7680	72.2862
1956	79.0625	77.2723	84.1340	82.2914
1957	86.2282	86.7077	91.5396	92.0486
1958	90.3138	91.8676	96.7327	98.3968
1959	98.6588	95.6701	110.229	106.890
1960	103.744	100.548	117.370	113.754
1961	110.268	108.913	123.426	121.976
1962	130.493	130.880	135.899	136.303
1963	138.735	142.102	144.195	147.695
1964	154.376	157.645	160.199	163.590
1965	175.738	175.248	182.147	181.640
1966	199.900	205.893	201.769	207.618
1967	223.800	229.825	223.800	229.825
1968	244.814	256.416	242.719	254.222
1969	280.929	284.773	279.437	283.261
1970	304.512	279.076	326.491	299.219
1971	320.647	331.447	348.130	360.529
1972	360.728	365.015	397.493	402.217
1973	421.557	412.726	474.014	464.085
1974	485.528	487.727	553.355	555.861
1975	553.017	539.280	652.724	636.510
1976	596.983	593.012	743.042	738.099
1977	649.829	684.055	830.131	673.854
1978	728.943	723.376	979.473	971.992
1979	791.470	778.271	1119.58	1100.91
1980	875.775	854.000	1286.20	1254.22

TABLE 7.2b

COMPARISON OF ACTUAL AND PREDICTED TIME SERIES

ACTUAL AND PREDICTED VARIABLES... QTOL QTOLS

SAMPLE = 1 29

CORRELATION COEFFICIENT = .9991
(SQUARED = .9981

ROOT-MEAN-SQUARED ERROR = 10.52

MEAN ABSOLUTE ERROR = 6.727

MEAN ERROR = .4831

REGRESSION COEFFICIENT OF ACTUAL ON PREDICTED = 1.008

THEIL"S INEQUALITY COEFFICIENT = .1396E-01

FRACTION OF ERROR DUE TO BIAS = .2108E-02

FRACTION OF ERROR DUE TO DIFFERENT VARIATION = .3777E-01

FRACTION OF ERROR DUE TO DIFFERENT CO-VARIATION = .9601

ALTERNATIVE DECOMPOSITION (LAST 2 COMPONENTS)
FRACTION OF ERROR DUE TO DIFFERENCES OF REGRESSION
COEFFICIENT FROM UNITY = .2998E-01
FRACTION OF ERROR DUE TO RESIDUAL VARIANCE = .9679

TABLE 7.3a

COST MODEL VALIDATION

	L	LS	K	KS
1952	44.9000	52.5457	660.900	648.162
1953	46.1000	51.8482	728.200	729.540
1954	48.2000	52.2028	795.800	788.282
1955	51.9000	53.2365	890.600	884.423
1956	55.7000	56.2204	996.200	1012.03
1957	57.8000	57.9111	1114.90	1100.38
1958	57.6000	56.2148	1244.20	1234.09
1959	56.5000	56.8931	1373.10	1364.86
1960	54.6000	53.8712	1506.70	1500.47
1961	52.4000	52.0782	1631.50	1619.46
1962	52.3000	54.2743	1753.50	1754.83
1963	53.5000	54.4531	1885.50	1858.42
1964	54.4000	53.7625	2013.70	2016.39
1965	55.8000	54.9523	2140.10	2139.72
1966	57.5000	56.3713	2279.10	2305.60
1967	56.6000	57.4766	2422.80	2443.05
1968	55.5000	56.9085	2561.90	2582.96
1969	56.6000	57.5233	2711.90	2730.51
1970	57.8000	57.0060	2856.70	2855.80
1971	57.4000	58.4581	3012.80	3024.25
1972	57.5000	57.1789	3180.60	3185.29
1973	60.4000	59.3029	3326.90	3294.69
1974	63.9000	62.8605	3499.50	3518.89
1975	64.1000	64.2015	3707.50	3670.28
1976	67.3000	68.0666	3910.60	3886.65
1977	69.8000	72.0609	4108.10	4167.74
1978	75.2000	74.8080	4239.30	4192.53
1979	77.5000	76.3304	4345.30	4348.41
1980	81.1000	78.7205	4518.30	4507.79

TABLE 7.3a (continued)

COST MODEL VALIDATION

	M	MS	COST	COSTS
1952	41.2490	52.3704	184.248	204.227
1953	44.4642	55.1691	196.151	214.916
1954	49.6361	57.2572	213.694	226.402
1955	56.6543	61.1559	237.415	242.935
1956	66.1309	65.8406	268.337	270.782
1957	68.1494	70.8905	295.965	296.916
1958	75.2408	75.0502	323.206	318.889
1959	79.6249	81.6123	353.320	355.013
1960	83.8778	85.3776	376.788	375.573
1961	88.6960	90.2013	398.786	397.682
1962	95.7533	96.8368	425.031	431.545
1963	101.149	100.709	457.245	456.459
1964	102.557	104.157	482.206	482.114
1965	112.108	108.194	520.732	514.497
1966	117.745	115.341	571.698	568.925
1967	117.400	122.451	613.597	624.191
1968	123.239	132.506	676.807	694.435
1969	145.227	144.432	779.329	784.944
1970	147.384	153.754	863.490	866.823
1971	171.182	162.481	952.776	949.715
1972	179.509	172.894	1051.74	1042.96
1973	202.532	188.193	1213.87	1183.50
1974	214.275	207.646	1427.66	1415.98
1975	217.524	227.158	1683.54	1689.71
1976	237.008	246.766	1971.29	1987.29
1977	259.565	265.011	2251.13	2298.95
1978	281.045	272.871	2574.33	2541.15
1979	300.065	290.167	2951.43	2919.15
1980	324.754	306.480	3476.60	3405.80

TABLE 7.3b

COMPARISON OF ACTUAL AND PREDICTED TIME SERIES

ACTUAL AND PREDICTED VARIABLES...	L	LS
SAMPLE =	1 29	
CORRELATION COEFFICIENT =	.9730	
(SQUARED =	.9466	
ROOT-MEAN-SQUARED ERROR =	2.198	
MEAN ABSOLUTE ERROR =	1.459	
MEAN ERROR =	-.6151	
REGRESSION COEFFICIENT OF ACTUAL ON PREDICTED =		1.106
THEIL"S INEQUALITY COEFFICIENT =		.1848E-01
FRACTION OF ERROR DUE TO BIAS =		.7830E-01
FRACTION OF ERROR DUE TO DIFFERENT VARIATION =		.2151
FRACTION OF ERROR DUE TO DIFFERENT CO-VARIATION =		.7066
ALTERNATIVE DECOMPOSITION (LAST 2 COMPONENTS)		
FRACTION OF ERROR DUE TO DIFFERENCES OF REGRESSION COEFFICIENT FROM UNITY =		.1293
FRACTION OF ERROR DUE TO RESIDUAL VARIANCE =		.7924

ACTUAL AND PREDICTED VARIABLES...	K	KS
SAMPLE =	1 29	
CORRELATION COEFFICIENT =	.9998	
(SQUARED =	.9997	
ROOT-MEAN-SQUARED ERROR =	21.37	
MEAN ABSOLUTE ERROR =	16.02	
MEAN ERROR =	1.817	
REGRESSION COEFFICIENT OF ACTUAL ON PREDICTED =		.9995
THEIL"S INEQUALITY COEFFICIENT =		.3999E-02
FRACTION OF ERROR DUE TO BIAS =		.7230E-02
FRACTION OF ERROR DUE TO DIFFERENT VARIATION =		.2725E-03
FRACTION OF ERROR DUE TO DIFFERENT CO-VARIATION =		.9925
ALTERNATIVE DECOMPOSITION (LAST 2 COMPONENTS)		
FRACTION OF ERROR DUE TO DIFFERENCES OF REGRESSION COEFFICIENT FROM UNITY =		.6406E-03
FRACTION OF ERROR DUE TO RESIDUAL VARIANCE =		.9921

TABLE 7.3b (continued)

```
ACTUAL AND PREDICTED VARIABLES...        M                 MS

SAMPLE =         1      29

CORRELATION COEFFICIENT =      .9968
               (SQUARED =      .9937

ROOT-MEAN-SQUARED ERROR =     7.258

MEAN ABSOLUTE ERROR =         5.815

MEAN ERROR =                 -.3893

REGRESSION COEFFICIENT OF ACTUAL ON PREDICTED =        1.045

THEIL"S INEQUALITY COEFFICIENT =                        .2241E-01

FRACTION OF ERROR DUE TO BIAS =                         .2877E-02

FRACTION OF ERROR DUE TO DIFFERENT VARIATION =          .2566

FRACTION OF ERROR DUE TO DIFFERENT CO-VARIATION =       .7405

ALTERNATIVE DECOMPOSITION (LAST 2 COMPONENTS)
     FRACTION OF ERROR DUE TO DIFFERENCES OF REGRESSION
          COEFFICIENT FROM UNITY =                      .2223
     FRACTION OF ERROR DUE TO RESIDUAL VARIANCE =       .7748

ACTUAL AND PREDICTED VARIABLES...        COST              COSTS

SAMPLE =         1      29

CORRELATION COEFFICIENT =      .9998
               (SQUARED =      .9996

ROOT-MEAN-SQUARED ERROR =     20.69

MEAN ABSOLUTE ERROR =         13.18

MEAN ERROR =                  1.060

REGRESSION COEFFICIENT OF ACTUAL ON PREDICTED =        1.012

THEIL"S INEQUALITY COEFFICIENT =                        .7982E-02

FRACTION OF ERROR DUE TO BIAS =                         .2624E-02

FRACTION OF ERROR DUE TO DIFFERENT VARIATION =          .2724

FRACTION OF ERROR DUE TO DIFFERENT CO-VARIATION =       .7250

ALTERNATIVE DECOMPOSITION (LAST 2 COMPONENTS)
     FRACTION OF ERROR DUE TO DIFFERENCES OF REGRESSION
          COEFFICIENT FROM UNITY =                      .2635
     FRACTION OF ERROR DUE TO RESIDUAL VARIANCE =       .7339
```

	VARIABLES		
	Output (QLOC, QTOL)	Cost (K, L, M)	Financial and Income Statement
REGIME			
1	Actual	Actual	Actual
2	Actual	Actual	Simulated
3	Actual	Simulated	Simulated
4	Simulated	Simulated	Simulated

Regime 1 is the base case, and is shown in Table 7.5a. That corresponds to B-81-1, p. 1, the historic situation. During the period 1976 to 1980, the average return to capital for Non-consolidated Bell fell approximately in the range of 8½ to 9½%.

In Table 7.5b, the effect of simulating the financial and income statements is shown. Total revenue and factors remain at the historic level, but total operating expenses are estimated using the historic levels of K, L, M as inputs into the TOE function. Depreciation and capital tax are both estimated. As can be seen, the historic and predicted total operating expenses are very similar. In a similar manner both predicted interest changes and income tax closely track actual values. Thus it is not surprising to find that income before extraordinary item is fairly close. Thus, providing that the simulation of net average capital is also accurate, the % return of average total capital should also be close. This indeed is the case, with a maximum difference in the order of .2% points. The relationship between actual and predicted capital is shown in Table 7.4. The % return to average common equity requires the estimation of the preferred dividend, and net average equity; again the difference between actual and predicted is small (less than .3% points).

In Table 7.5c, revenues are kept at the historic level, but factors levels are simulated. The simulated factors then lead into the total operating expense function, resulting in net revenue. The remainder of the income statement is evaluated, based on the simulated factors and tax base. As can be seen, the total operating expenses are over-estimated at the beginning of the sample period (1976) and underestimated at the end (1980). The degree of underestimation (in 1980) is about 2%, and this corresponds very closely to the degree to which estimated cost falls short of actual cost.* This results in return to average total capital being less than historic values at the beginning, and larger at the end of the period. The difference however, is less than .4% points.

In Table 7.5d, all quantities are simulated. Simulated total revenue tracks actual total revenue fairly well, with an error of less than 1.5%. in 1980 (underestimate). Using these quantities, the factors are evaluated from the cost system, and hence the total operating expenses. Thus in 1980, these will be lower than in Regime 3, since simulated quantities are less. The income statement is evaluated as before, and it can be seen that the % return to average total capital is very close to

*Though the difference between the logarithm of actual and estimated cost in 1980 is less than .2%.

Regime 1 for 1977 to 1979. In 1980 the difference is less than .2% points.

It seems clear from this validation that the model is capable of predicting a return to capital that is close to the actual value. Based on Breslaw [1], a prediction of a % return on average total capital of 9.03% was made, assuming the rate request was granted; the actual rate for 1980 was 9.48%.

TABLE 7.4

VALIDATION OF AVERAGE TOTAL CAPITAL

	AVAK	AVAKS
1976	4797.3	4827.8
1977	5171.3	5233.7
1978	5733.7	5666.9
1979	6298.3	6198.0
1980	6888.1	6853.7

TABLE 7.5a

INCOME STATEMENT VALIDATION–REGIME 1

INCOME STATEMENT - BELL CANADA

	1976.	1977.	1978.	1979.	1980.
TELECOM. OPERATIONS					
LOCAL REVENUE	990.22	1107.68	1263.08	1392.71	1562.50
TOLL REVENUE	867.72	970.46	1152.42	1329.09	1529.10
MISC. REVENUE (NET)	46.00	55.30	81.87	94.70	111.60
TOTAL OPERATING REVENUES	1903.92	2133.42	2497.43	2817.11	3203.12
TOTAL OPERATING EXPENSES	1367.68	1572.50	1784.50	2054.47	2390.32
NET OPERATING REVENUES	536.25	560.92	712.93	762.64	812.80
OTHER INCOME	65.23	52.96	56.79	80.84	75.82
INCOME BEFORE UNDER ITEMS	601.47	613.88	769.72	843.48	888.62
INTEREST CHARGES	177.29	202.39	231.02	252.59	286.94
INCOME AFTER INTEREST	424.19	411.49	538.70	590.89	601.68
AMORTIZATION FXLTD	0.00	0.00	-5.49	-9.89	-10.03
INCOME BEFORE INCOME TAX	424.19	411.49	533.21	581.00	591.65
INCOME TAX	185.70	178.59	240.12	256.37	272.56
NET INCOME - TELECOM.	238.49	232.90	293.10	324.63	319.09
CONTRACT OPERATIONS					
NET INCOME - CONTRACT	0.00	0.00	7.72	31.18	46.85
NON-CONSOLIDATED					
INCOME BEFORE EXTRA. ITEM	238.49	232.90	300.82	355.81	365.94
EXTRAORDINARY ITEM	0.00	0.00	4.12	29.84	0.00
INCOME AFTER EXTRA. ITEM	238.49	232.90	304.94	385.64	365.94
PREFERRED SHARE DIVIDEND	28.85	31.53	38.70	30.52	38.24
INCOME APPLIC. TO COMMON	209.65	201.36	266.24	355.12	327.70
% RETURN ON AVE. COM. EQTY.	10.06	9.02	11.09	11.51	10.64
% RETURN ON AVE. TOT. CAP.	8.67	8.42	9.28	9.66	9.48

TABLE 7.5b

INCOME STATEMENT VALIDATION-REGIME 2

INCOME STATEMENT - BELL CANADA

	1976.	1977.	1978.	1979.	1980.
TELECOM. OPERATIONS					
LOCAL REVENUE	990.22	1107.68	1263.08	1392.71	1562.50
TOLL REVENUE	867.72	970.46	1152.42	1329.09	1529.10
MISC. REVENUE (NET)	46.00	55.30	81.87	94.70	111.60
TOTAL OPERATING REVENUES	1903.94	2133.43	2497.37	2816.50	3203.20
TOTAL OPERATING EXPENSES	1372.88	1575.18	1786.36	2052.02	2387.48
NET OPERATING REVENUES	531.05	558.25	711.01	764.48	815.72
OTHER INCOME	65.23	52.96	56.79	80.84	75.82
INCOME BEFORE UNDER ITEMS	596.28	611.21	767.80	845.32	891.54
INTEREST CHARGES	183.57	202.98	225.69	253.27	292.15
INCOME AFTER INTEREST	412.71	408.23	542.11	592.05	599.39
AMORTIZATION FXLTD	0.00	0.00	-5.49	-9.89	-10.03
INCOME BEFORE INCOME TAX	412.71	408.23	536.63	582.16	589.36
INCOME TAX	186.16	182.38	249.71	269.17	268.56
NET INCOME - TELECOM.	226.55	225.85	286.92	312.99	320.81
CONTRACT OPERATIONS					
NET INCOME - CONTRACT	0.00	0.00	7.72	31.18	46.85
NON-CONSOLIDATED					
INCOME BEFORE EXTRA. ITEM	226.55	225.85	294.64	344.16	367.66
EXTRAORDINARY ITEM	0.00	0.00	4.12	29.84	0.00
INCOME AFTER EXTRA. ITEM	226.55	225.85	298.76	374.00	367.66
PREFERRED SHARE DIVIDEND	26.97	28.72	31.10	34.87	41.60
INCOME APPLIC. TO COMMON	199.58	197.13	267.67	339.13	326.06
% RETURN ON AVE. COM. EQTY.	9.69	8.75	10.79	11.50	10.91
% RETURN ON AVE. TOT. CAP.	8.49	8.19	9.18	9.64	9.63

TABLE 7.5c

INCOME STATEMENT VALIDATION-REGIME 3

INCOME STATEMENT - BELL CANADA

	1976.	1977.	1978.	1979.	1980.
TELECOM. OPERATIONS					
LOCAL REVENUE	990.22	1107.68	1263.08	1392.71	1562.50
TOLL REVENUE	867.72	970.46	1152.42	1329.09	1529.10
MISC. REVENUE (NET)	46.00	55.30	81.87	94.70	111.60
TOTAL OPERATING REVENUES	1903.94	2133.43	2497.37	2816.50	3203.20
TOTAL OPERATING EXPENSES	1398.66	1589.84	1770.47	2023.41	2345.18
NET OPERATING REVENUES	505.27	543.60	726.90	793.09	858.02
OTHER INCOME	65.23	52.96	56.79	80.84	75.82
INCOME BEFORE UNDER ITEMS	570.50	596.56	783.69	873.93	933.84
INTEREST CHARGES	183.12	202.32	224.43	253.51	292.67
INCOME AFTER INTEREST	387.38	394.24	559.26	620.42	641.17
AMORTIZATION FXLTD	0.00	0.00	-5.49	-9.89	-10.03
INCOME BEFORE INCOME TAX	387.38	394.24	553.77	610.53	631.14
INCOME TAX	173.07	175.76	260.63	285.12	290.39
NET INCOME - TELECOM.	214.31	218.48	293.15	325.41	340.75
CONTRACT OPERATIONS					
NET INCOME - CONTRACT	0.00	0.00	7.72	31.18	46.85
NON-CONSOLIDATED					
INCOME BEFORE EXTRA. ITEM	214.31	218.48	300.87	356.59	387.60
EXTRAORDINARY ITEM	0.00	0.00	4.12	29.84	0.00
INCOME AFTER EXTRA. ITEM	214.31	218.48	304.99	386.42	387.60
PREFERRED SHARE DIVIDEND	26.90	28.62	30.92	34.90	41.67
INCOME APPLIC. TO COMMON	187.41	189.86	274.07	351.52	345.93
% RETURN ON AVE. COM. EQTY.	9.12	8.46	11.12	11.95	11.55
% RETURN ON AVE. TOT. CAP.	8.25	8.07	9.32	9.83	9.91

TABLE 7.5d

INCOME STATEMENT VALIDATION-REGIME 4

INCOME STATEMENT - BELL CANADA

	1976.	1977.	1978.	1979.	1980.
TELECOM. OPERATIONS					
LOCAL REVENUE	981.97	1133.03	1253.71	1387.73	1547.69
TOLL REVENUE	862.78	1014.18	1144.94	1310.42	1497.12
MISC. REVENUE (NET)	46.00	55.30	81.87	94.70	111.60
TOTAL OPERATING REVENUES	1890.75	2202.51	2480.52	2792.85	3156.41
TOTAL OPERATING EXPENSES	1394.18	1608.43	1766.36	2018.46	2332.91
NET OPERATING REVENUES	496.56	594.08	714.16	774.39	823.50
OTHER INCOME	65.23	52.96	56.79	80.84	75.82
INCOME BEFORE UNDER ITEMS	561.79	647.04	770.95	855.23	899.33
INTEREST CHARGES	183.86	205.72	225.14	254.40	292.76
INCOME AFTER INTEREST	377.93	441.32	545.81	600.83	606.56
AMORTIZATION FXLTD	0.00	0.00	-5.49	-9.89	-10.03
INCOME BEFORE INCOME TAX	377.93	441.32	540.32	590.94	596.54
INCOME TAX	168.24	200.64	251.00	273.27	271.74
NET INCOME - TELECOM.	209.69	240.68	289.32	317.66	324.80
CONTRACT OPERATIONS					
NET INCOME - CONTRACT	0.00	0.00	7.72	31.18	46.85
NON-CONSOLIDATED					
INCOME BEFORE EXTRA. ITEM	209.69	240.68	297.04	348.84	371.65
EXTRAORDINARY ITEM	0.00	0.00	4.12	29.84	0.00
INCOME AFTER EXTRA. ITEM	209.69	240.68	301.16	378.68	371.65
PREFERRED SHARE DIVIDEND	27.01	29.11	31.02	35.02	41.69
INCOME APPLIC. TO COMMON	182.68	211.58	270.14	343.65	329.96
% RETURN ON AVE. COM. EQTY.	8.66	9.27	10.92	11.62	11.01
% RETURN ON AVE. TOT. CAP.	8.14	8.42	9.24	9.69	9.67

CHAPTER 8

PREDICTION

The model described above was used to forecast 1981-1983 levels of outputs, factors, expense and other financial variables, based on the set of values for the exogenous variables described in Chapter 2, and a set of prices. Three price scenarios were undertaken:

1) Constant 1981 nominal prices remain in effect through 1983.

2) The 1981 rate request is granted in September 1981, and these prices remain in effect through 1983. This involves an increase in the price of local services by 19.9%, and for message toll, including WATS of 13.2%. For other toll services, a price increase of 9.6% is implied. These values are derived in Table 8.1.

3) The price increases by the same rate as inflation commencing January 1, 1982.

The predicted level of outputs, revenues, factors, costs and expenses for the three scenarios are shown in Tables 8.2a, 8.3a and 8.4a respectively; the income statement for each scenario is shown in Tables 8.2b, 8.3b and 8.4b. To facilitate comparison of the variables shown in the "a" series of tables, the equivalent values predicted by Bell are shown in Table 8.5a. The income statement prediction by Bell is shown in Table 8.5b.

TABLE 8.1

1981 RATE REQUEST

1982 Values $m

1) LOCAL

	No Increase a)	Reprice b)	Curtailed c)
Local	1844.7	2207.4	2181.3

∴ Increase 19.66%

2) MTS INCL. WATS d)

	No Increase	Reprice	Curtailed
MTS e)	890.9	1081.1	1040.6
Other Intra MTS f)	18.6	18.6	18.6
Settled MTS g)	505.6	505.6	505.6
Intra WATS h)	180.4	215.7	215.7
Other WATS i)	36.8	34.8	36.9
	1630.3	1855.8	1815.3

∴ Increase 13.83%

3) OTHER TOLL, EXCL. WATS

	No Increase	Reprice	Curtailed
Other Toll j)	292.3	320.7	320.7

∴ Increase 9.6%

4) MISCELLANEOUS k)

	No Increase	Reprice	Curtailed
Net	146.3	143.2	142.8
Uncollectables	(22.0)	(25.2)	(25.6)
Gross	168.3	168.4	168.4

∴ Decrease 2.4%

Notes to Table 8.1

a) B-81-224

b) B-81-235

c) B-81-235

d) From B-81-236, Total curtailment, all services, is $66.05m in 1982; Local curtailment is $26.05m, and long distance curtailment is $40.389m (B-81-235). In B-81-237, long distance curtailment ($40.389m) is applied to a service with current revenue of $890.6m; from B-81-231 this corresponds to Intra Bell MTS. ∴. No other services has curtailment applied.

e) Bell (CRTC) 9 Jan. 81-501 and B-81-236.

f) Intra Bell MTS (BELL (NAPO) 30 MAR. 81-612) contains some settled revenue from independent companies (Kiss, (6) Appendix, p. 1). This is the difference between the NAPO and CRTC figures for Intra Bell MTS.

g) Intra + Trans + USO (BELL (NAPO) 30 MAR. 81-612).

h) Bell (CRTC) 09 Jan. 81-501.

i) Difference between WATS reported from BELL (NAPO) 30 MAR. 81-612, and Bell (CRTC) 09 JAN. 81-501. Note that the estimates in the former correspond to the no price increase case for revenues; consequently it is assumed that this also applies for factors.

j) Bell (CRTC) 09 JAN. 81-501, toll totals, less MTS, including WATS.

k) B-81-1 and B-81-235 for Net. B81-236 and Bell (CRTC) 501 for uncollectables. Gross by addition.

TABLE 8.2a

PREDICTED VALUES - CONSTANT 1981 PRICES

	PLOC	PTOL
1980	1.6830	1.4646
1981	1.8444	1.5485
1982	1.8444	1.5485
1983	1.8444	1.5485

	QLOC	RLOC	QTOL	RTOL	ROTH
1981	947.8	1748.1	930.7	1441.2	279.7
1982	1026.9	1893.9	1094.2	1694.4	292.5
1983	1111.5	2050.0	1284.4	1989.0	304.8

	L	K	M
1981	83.0	4656.2	320.3
1982	90.6	4960.2	347.4
1983	96.4	5299.2	373.9

	COST	TOE
1981	3936.2	2765.9
1982	4679.6	3353.5
1983	5519.4	3955.3

TABLE 8.2b

INCOME STATEMENT - CONSTANT 1981 PRICES

INCOME STATEMENT - BELL CANADA

	1979.	1980.	1981.	1982.	1983.
TELECOM. OPERATIONS					
LOCAL REVENUE	1392.71	1562.50	1748.09	1893.94	2049.97
TOLL REVENUE	1329.09	1529.10	1720.88	1986.93	2293.77
MISC. REVENUE (NET)	94.70	111.60	128.35	146.30	166.76
TOTAL OPERATING REVENUES	2817.11	3203.12	3597.32	4027.16	4510.50
TOTAL OPERATING EXPENSES	2054.47	2390.32	2765.93	3353.45	3955.33
NET OPERATING REVENUES	762.64	812.80	831.39	673.71	555.17
OTHER INCOME	80.84	75.82	82.65	91.09	100.40
INCOME BEFORE UNDER ITEMS	843.48	888.62	914.03	764.81	655.57
INTEREST CHARGES	252.59	286.94	329.30	383.80	447.57
INCOME AFTER INTEREST	590.89	601.68	584.73	381.00	208.00
AMORTIZATION EXLTD	-9.89	-10.03	-9.70	-9.70	-9.70
INCOME BEFORE INCOME TAX	581.00	591.65	575.03	371.30	198.30
INCOME TAX	256.37	272.56	259.86	157.70	79.24
NET INCOME - TELECOM.	324.63	319.09	315.17	213.61	119.06
CONTRACT OPERATIONS					
NET INCOME - CONTRACT	31.18	46.85	44.43	46.87	49.42
NON-CONSOLIDATED					
INCOME BEFORE EXTRA. ITEM	355.81	365.94	359.61	260.48	168.49
EXTRAORDINARY ITEM	29.84	0.00	0.00	0.00	0.00
INCOME AFTER EXTRA. ITEM	385.64	365.94	359.61	260.48	168.49
PREFERRED SHARE DIVIDEND	30.52	38.24	46.39	55.32	64.86
INCOME APPLIC. TO COMMON	355.12	327.70	313.22	205.15	103.62
% RETURN ON AVE. COM. EQTY.	11.51	10.64	9.33	5.48	2.46
% RETURN ON AVE. TOT. CAP.	9.66	9.48	9.12	7.63	6.49

TABLE 8.3a

PREDICTED VALUES - BELL'S REQUESTED PRICE INCREASE

	PLOC	PTOL
1980	1.6830	1.4686
1981	1.9653	1.6199
1982	2.2070	1.7627
1983	2.2070	1.7627

	QLOC	RLOC	QTOL	RTOL	ROTH
1981	917.0	1802.1	875.6	1418.4	288.7
1982	935.2	2064.0	918.3	1618.6	320.6
1983	1012.2	2234.0	1077.9	1900.0	334.0

	L	K	M
1981	81.6	4553.1	313.9
1982	86.3	4658.2	328.3
1983	91.8	4976.5	353.3

	COST	TOE
1981	3857.3	2724.2
1982	4421.7	3211.0
1983	5215.3	3777.6

TABLE 8.3b

INCOME STATEMENT - REQUESTED PRICE INCREASE

INCOME STATEMENT - BELL CANADA

	1979.	1980.	1981.	1982.	1983.
TELECOM. OPERATIONS					
LOCAL REVENUE	1392.71	1562.50	1802.05	2063.96	2234.00
TOLL REVENUE	1329.09	1529.10	1707.07	1939.22	2234.07
MISC. REVENUE (NET)	94.70	111.60	126.35	146.30	166.76
TOTAL OPERATING REVENUES	2817.11	3203.12	3637.46	4149.47	4634.83
TOTAL OPERATING EXPENSES	2054.47	2390.32	2724.15	3210.98	3777.61
NET OPERATING REVENUES	762.64	912.90	913.32	938.50	857.21
OTHER INCOME	80.84	75.92	82.65	91.09	100.40
INCOME BEFORE UNDER ITEMS	843.48	888.62	995.97	1029.59	957.61
INTEREST CHARGES	252.59	286.94	324.36	367.39	427.75
INCOME AFTER INTEREST	590.89	601.68	571.61	662.20	529.87
AMORTIZATION EXLTD	-9.69	-10.03	-9.70	-9.70	-9.70
INCOME BEFORE INCOME TAX	581.00	591.65	561.91	652.50	520.17
INCOME TAX	256.37	272.56	305.51	295.84	225.61
NET INCOME - TELECOM.	324.63	319.09	356.40	356.66	293.56
CONTRACT OPERATIONS					
NET INCOME - CONTRACT	31.18	46.85	44.43	46.87	49.42
NON-CONSOLIDATED					
INCOME BEFORE EXTRA. ITEM	355.81	365.94	400.83	403.53	342.93
EXTRAORDINARY ITEM	29.34	0.00	0.00	0.00	0.00
INCOME AFTER EXTRA. ITEM	385.64	365.94	400.83	403.53	342.98
PREFERRED SHARE DIVIDEND	30.52	38.24	45.69	52.96	61.99
INCOME APPLIC. TO COMMON	355.12	327.70	355.14	350.58	280.99
% RETURN ON AVE. COM. EQTY.	11.51	10.64	10.74	9.78	6.99
% RETURN ON AVE. TOT. CAP.	9.65	9.49	9.75	9.54	8.50

TABLE 8.4a

PREDICTED VALUE - INFLATION PRICE

	PLOC	PTOL
1980	1.6830	1.4686
1981	1.8444	1.5485
1982	2.0381	1.7111
1983	2.2520	1.8908

	QLOC	RLOC	QTOL	RTOL	ROTH
1981	947.8	1748.1	930.7	1441.2	279.7
1982	974.8	1946.7	955.9	1635.7	323.2
1983	1009.6	2255.7	980.3	1853.5	372.2

	L	K	M
1981	83.0	4656.2	320.3
1982	87.8	4777.3	335.4
1983	90.5	4919.1	348.8

	COST	TOE
1981	3936.2	2765.9
1982	4518.2	3263.8
1983	5148.8	3741.7

TABLE 8.4b

INCOME STATEMENT - INFLATION PRICE

INCOME STATEMENT - BELL CANADA

	1979.	1980.	1981.	1982.	1983.
TELECOM. OPERATIONS					
LOCAL REVENUE	1392.71	1562.50	1748.09	1986.72	2255.71
TOLL REVENUE	1329.09	1529.10	1720.88	1958.91	2225.67
MISC. REVENUE (NET)	94.70	111.60	128.35	146.30	166.76
TOTAL OPERATING REVENUES	2817.11	3203.12	3597.32	4091.94	4648.15
TOTAL OPERATING EXPENSES	2054.47	2390.32	2765.93	3263.82	3741.73
NET OPERATING REVENUES	762.64	812.80	831.39	828.12	906.41
OTHER INCOME	80.84	75.82	82.65	91.09	100.40
INCOME BEFORE UNDER ITEMS	843.48	888.62	914.03	919.21	1006.81
INTEREST CHARGES	252.59	286.94	329.30	373.86	424.22
INCOME AFTER INTEREST	590.89	601.68	584.73	545.35	582.59
AMORTIZATION FXLTD	-9.89	-10.03	-9.70	-9.70	-9.70
INCOME BEFORE INCOME TAX	581.00	591.65	575.03	535.65	572.89
INCOME TAX	256.37	272.56	259.86	237.57	256.14
NET INCOME - TELECOM.	324.63	319.09	315.17	298.09	316.76
CONTRACT OPERATIONS					
NET INCOME - CONTRACT	31.18	45.85	44.43	46.87	49.42
NON-CONSOLIDATED					
INCOME BEFORE EXTRA. ITEM	355.81	355.94	359.61	344.96	366.18
EXTRAORDINARY ITEM	29.84	0.00	0.00	0.00	0.00
INCOME AFTER EXTRA. ITEM	385.54	355.94	359.61	344.96	366.18
PREFERRED SHARE DIVIDEND	30.52	38.24	46.39	53.89	61.48
INCOME APPLIC. TO COMMON	355.12	327.70	313.22	291.07	304.70
% RETURN ON AVE. COM. EQTY.	11.51	10.54	9.33	7.98	7.65
% RETURN ON AVE. TOT. CAP.	9.65	9.48	9.12	8.74	8.78

TABLE 8.5a

BELL'S PREDICTED VALUES

	Constant 1981 Prices			Requested Prices		
	RLOC	RTOL	ROTH	RLOC	RTOL	ROTH
1981	1770.1	1487.7	279.7	1883.1	1548.3	289.1
1982	1844.7	1630.4	292.5	2181.3	1815.7	320.7
	L	K				
1981	86.7	4680.3				
1982	90.5	4807.4				
		TOE			TOE	
1981		2805.0			2804.8	
1982		3258.9			3264.3	

TA[illegible] 8

INCOME STATEMENT - BELL CANADA PREDICTIONS

THOUSANDS OF DOLLARS EXCEPT LINES 33 AND 34 AND COLUMNS (g, i, k, m)	1980 UNAUDITED	1981 ESTIMATED		1981 PRO-FORMA INCLUDING RATES PROPOSED IN THIS APPLICATION		1982 ESTIMATED		1982 PRO-FORMA INCLUDING RATES PROPOSED IN THIS APPLICATION	
		Amount	% Change over 1980	Amount	% Change over 1980	Amount	% Change over 1981 est.	Amount	% Change over 1981 est. with rates
	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
COMMUNICATIONS OPERATIONS									
Local Service	1 562 498	1 770 144	13.3	1 883 134	20.5	1 844 726	4.2	2 181 331	15.8
Long Distance Service	1 529 014	1 767 368	15.6	1 837 409	20.2	1 922 888	8.8	2 136 432	16.3
Miscellaneous – Net	111 604	128 350	15.0	127 260	14.0	146 300	14.0	143 159	12.5
TOTAL OPERATING REVENUES	3 203 116	3 665 862	14.4	3 847 803	20.1	3 913 914	6.8	4 460 922	15.9
Depreciation	586 666	650 237	10.8	650 237	10.8	712 980	9.6	712 680	9.6
Maintenance	538 426	610 221	13.3	610 321	13.4	719 798	18.0	717 998	17.6
Operator Services	125 002	129 775	3.8	129 675	3.7	147 183	13.4	146 983	13.3
Customer Provisioning	296 178	350 171	18.2	349 971	18.2	408 818	16.7	408 718	16.8
Facilities Provisioning	292 063	392 019	34.2	392 019	34.2	483 873	23.4	483 873	23.4
General Administration	189 745	217 706	14.7	217 706	14.7	258 124	18.6	258 124	18.6
Other	362 236	454 856	25.6	454 856	25.6	528 164	16.1	535 901	17.8
TOTAL OPERATING EXPENSES	2 390 316	2 804 985	17.3	2 804 785	17.3	3 258 940	16.2	3 264 277	16.4
NET OPERATING REVENUES	812 800	860 877	5.9	1 043 018	28.3	654 974	(23.9)	1 196 645	14.7
Dividend Income	38 801	42 283	9.0	42 283	9.0	46 847	10.8	46 847	10.8
Allowance for Funds Used During Construction	18 554	27 176	46.5	27 476	48.1	35 995	32.5	39 882	45.2
Miscellaneous Income — Net	18 468	11 811	(36.0)	12 887	(30.2)	8 251	(30.1)	10 376	(19.5)
TOTAL OTHER INCOME	75 823	81 270	7.2	82 646	9.0	91 093	12.1	97 105	17.5
INCOME BEFORE UNDERLISTED ITEMS	888 623	942 147	6.0	1 125 664	26.7	746 067	(20.8)	1 293 750	14.9
Interest on Long Term Debt	277 070	322 228	16.3	322 228	16.3	353 387	9.7	353 387	9.7
Other Interest Charges	9 872	7 901	(20.0)	5 918	(40.1)	36 245	358.7	8 685	46.8
TOTAL INTEREST CHARGES	286 942	330 129	15.1	328 146	14.4	389 632	18.0	362 072	10.3
INCOME AFTER INTEREST CHARGES	601 681	612 018	1.7	797 518	32.5	356 435	(41.8)	931 678	16.8
Amortization of Unrealized Gain (Loss) on Foreign Exchange–Long Term Debt	(10 029)	(9 698)	3.3	(9 698)	3.3	(9 698)	—	(9 698)	—
INCOME BEFORE INCOME TAXES	591 652	602 320	1.8	787 820	33.2	346 737	(42.4)	921 980	17.0
Income Taxes	272 561	271 165	(0.5)	366 388	34.4	125 505	(53.7)	408 993	11.6
NET INCOME — TELECOMMUNICATIONS OPERATIONS	319 091	331 155	3.8	421 432	32.1	221 232	(33.2)	512 987	21.7
TRACT OPERATIONS									
NET INCOME — CONTRACT OPERATIONS	46 850	44 433	(5.2)	44 433	(5.2)	46 871	5.5	46 871	5.5
-CONSOLIDATED									
NON-CONSOLIDATED NET INCOME BEFORE EXTRAORDINARY ITEM	365 941	375 588	2.6	465 865	27.3	268 103	(28.6)	559 858	20.2
Extraordinary Item*	—	—	—	—	—	—	—	—	—
NON-CONSOLIDATED NET INCOME AFTER EXTRAORDINARY ITEM	365 941	375 588	2.6	465 865	27.3	268 103	(28.6)	559 858	20.2
Dividends on Preferred Shares	38 243	35 164	(8.1)	35 164	(8.1)	42 654	21.3	42 654	21.3
NON-CONSOLIDATED NET INCOME APPLICABLE TO COMMON SHARES AFTER EXTRAORDINARY ITEM	327 698	340 424	3.9	430 701	31.4	225 449	(33 8)	517 204	20.1
NON-CONSOLIDATED PERCENT RETURN ON AVERAGE COMMON EQUITY BEFORE EXTRAORDINARY ITEM	10.64	10.15	xxx	12.67	xxx	6.55	xxx	14.07	xxx
NON-CONSOLIDATED PERCENT RETURN ON AVERAGE TOTAL CAPITAL	9.47	9.52	xxx	10.67	xxx	8.20	xxx	11.52	xxx

Comparison with Bell's Predictions

1) Local Revenue

Bell assumes local service to be almost price inelastic, while we assume an elasticity of -.52. Thus, given a fall in real prices (constant 1981 prices) we would predict a larger gain in revenue than would Bell; indeed, although Bell estimates a value of $1770 in 1981 which exceeds our estimate of $1748 m, by 1982 our estimate $1893 exceeds Bell's estimate of $1845 m.

An increase in real price will result in higher revenues in both cases, but curtailment will be larger in our case than in Bell's case. This is the case, with the Bell estimate in 1981 of $1883 m exceeding our estimate of $1802 m, and Bell's 1982 estimate of $2181 m exceeding our estimate of $2063 m.

2) Message Toll Revenue, including WATS

Bell assumes intra message toll to be inelastic, with an own price elasticity of -.175 for MTS, or -.158 for message toll, including WATS. This compares to an own price elasticity of -1.35 used in this study. Thus an increase in price will result in increased revenue for Bell, but decreased revenue for us. This is borne out. For 1981, Bell predicts slightly higher revenue (RTOL) under constant 1981 prices ($1488 m, vs $1441 m). Given a price increase, Bell's revenue increases to $1548 m, while our estimate decreases to $1418 m. Going from 1981 to 1982, at constant 1981 prices, results in a larger increase in demand, as a consequence of the fall in real price in our case then in Bell's, and hence a larger increase in revenue. Bell's revenue increases by $143 m, while in our study RTOL increases by $253 m. A similar situation exists for the 1982 figures - Bell predicts a larger gain in revenue under the requested price, to $1816 m, compared to a figure of $1619 m in our case.

3) Other Toll Revenue

Bell's values were used; however, we believe these values to be underestimates for 1982.

4) Miscellaneous Revenues

Bell's values were used.

5) Total Revenue

Under the constant 1981 price regime, Bell's revenue exceeds ours by $69 m in 1981, and falls short of ours by $113 m in 1982.

Under the requested price regime, Bell's total revenue exceeds ours by $210 m in 1981 and by $312 m in 1982. These differences come about almost entirely as a consequence of the elasticity assumptions.

6) Total Operating Expenses

Bell shows almost no curtailment in operating expenses, as a consequence of decreased output; indeed for 1982 operating expenses increased as output declines.

For the constant 1981 price, the 1981 value shown in Table 8.2b ($2765.9 m) falls short of Bell's estimate of $2805. m.

We note that our prediction of labour and capital are also lower than Bell's. The reduction in output following the price rise results in a further fall to $2724 m.

For 1982, our estimate of $3353 m exceeds Bell's estimate of $3259 m for the 1981 price case, since, given our elasticities, larger quantities of output are produced. Similarly, under the requested price, smaller quantities are produced, leading to lower costs - $3211 m versus Bell's $3264 m.

7) Financial Statement - Constant 1981 Prices

a) 1981

Given similar net operating revenues (Bell $861 m, Concordia $831 m) and similar interest charges ($330 m Bell, $329 m Concordia), income before income tax is quite close. Similar tax rates were used (Bell 45.0%, Concordia 45.2%). Hence net income was very similar (Bell $331 m, Concordia $315 m), resulting in similar returns on total capital (9.52% Bell, 9.12% Concordia).

b) 1982

This result is similar to 1981; net income is quite similar ($655 m Bell, $676 m Concordia) as are interest changes ($390 m Bell, $386 m Concordia). Bell assumes a much lower tax rate than Concordia (36.2% Bell, 42.5% Concordia) which results in the difference in net income ($221 m Bell, $213 m Concordia). Again % return on total capital (8.2% Bell, 7.6% Concordia) and on common equity (6.6% Bell, 5.5% Concordia) are in the same ballpark.

Requested Price

a) 1981

Net operating revenue predicted by Bell is $1043 m compared to the Concordia figure of $913 m. Interest changes are similar, and although the difference is mitigated somewhat by Bell's higher income tax ($366 m Bell, $306 m Concordia), there still exists a large difference between Bell's prediction of net income ($421 m) and Concordia's ($356 m). This results in a one point difference in return to capital (10.7% Bell, 9.8% Concordia) and a two point difference in return to common equity (12.7% Bell, 10.7% Concordia).

b) 1982

The difference between the two studies is even greater in this case. Net operating revenue differs by $258 m ($1197 m Bell, $939 m Concordia), and again interest charges are similar. Income taxes are, understandably, higher in the Bell study, but again net income revenue is higher in the Bell study ($513 m Bell, $404 m Concordia). This results in much lower returns to average total capital (11.5% Bell, 9.5% Concordia) and considerably lower returns to common equity (14.1% Bell, 9.8% Concordia).

SUMMARY AND CONCLUSIONS

In this study, an econometric model of Canada was constructed, estimated and historically validated. The model consisted of four modules:

1) Demand module
2) Cost module
3) Financial module
4) Income statement module.

Once the model has been built, it was then used to predict the rate of return to total average capital that Bell would achieve under a number of scenarios. Three scenarios were undertaken:

1) Rates remain at their 1981 nominal value
2) Rates increase as of September 1981 to reach the level requested by Bell in the 1981 rate request
3) Rates increase as of January 1982, at the same rate as inflation, and again in January 1983.

In the case of the first two scenarios, a detailed comparison was made between Bell's predicted values, and those predicted by this study.

The Concordia study and the Bell forecasts are in fairly close agreement for all variables, with the exception of revenues. Here the two studies can be viewed as being polar opposites. Bell takes the position of very low or zero own price elasticities for all services, and consequently very little curtailment as a consequence of rate increase.

The Concordia study, on the other hand, has estimated demands based on much higher elasticity estimate - -0.52 for local, and -1.35 for message toll. Demand is thus subject to considerable curtailment following a rate increase.

Thus the Bell results can be considered as the upper bound forecast, and the Concordia results as the lower bound. Differences between the two models relating to other variables do not seem to be nearly as significant as the revenue difference; indeed, very good agreement is reached in a number of cases.

Thus, given the following conclusions:

a) The forecast of other toll revenues

b) The net income from contract operations

c) The current level of productivity at Bell

Then

1) It is clear from both Bell's study and our study, with very different assumptions on elasticities, that maintaining rates at the 1981 level will result in a return to common equity in 1982 which approaches one quarter the return that could be achieved in a term deposit. The difficulty in raising capital under these conditions is obvious.

2) Under the requested price, Bell predicts a return to common equity of 14.1%. The Concordia study suggests that if the services are more elastic than Bell postulates, then this return will not be met, and the actual rate may be substantially beneath it.

Given the present level of interest rates, Bell will be forced, yet again, to apply to the CRTC for a rate request, even if the 1981 request is granted in full. There are only two ways that Bell can avoid this situation:

a) Substantially increased revenue from contract operations

b) Substantial cost reductions through increased efficiency and productivity.

<u>Cross-Subsidy Issue</u>

At the rate hearings, July 1981, there was some argument which suggested that the low level of return to capital could come about as a consequence of message toll services cross-subsidizing competitive services. The latter, it was suggested, were not yet capable of making much of a contribution towards net earnings, and consequently, total return to capital was low, and, by implication, lower than it would be if Bell were not to compete in this area.

Bell argued that though cross-subsidization was possible, it was at the most a few million dollars, and had negligible effect on the rate of return.

There is very little cost data available that allows for an accurate determination as to whether cross-subsidization is taking place, although the cost inquity, eventually, should provide this data. In the meantime, the only data on allocation of investment and expenses by service comes from the TCTS revenue sharing hearings, May-June 1980. It was argued by CNCP (3) that Trans-Canada competitive services were not compensatory. However, it should be borne in mind that the expense data is restated by TCTS, and do not necessarily reflect actual costs.

The economic Council, in a study of government regulation of the economy (5), has suggested that competition should be encouraged in the telecommunications industry. Although it is hard to draw a line between what should and what should not be regulated, it is clear that any cross-subsidization signifies unfair competition. It may well be time to consider splitting off from Bell those areas outside the basic telephone service, as separate, arm's length companies. In this way, there can be no question of the basic telephone user supporting Bell's activities in new markets by paying higher rates than would otherwise exist.

APPENDIX 1

Long Distance Message Services - Elasticity

1982

Revenue without price increase	P_1Q_1 =	890.9	Bell (CRTC) 501
Reprice revenue	P_2Q_1 =	1081.1	B-81-236
Revenue after curtailment	P_2Q_2 =	1040.7	B-81-236

Let $P_1 = 1 \therefore Q_1 = 890.9$

$$P_2 = P_2Q_1/P_1Q_1 = 1081.1/890.9 = 1.2135$$

$$Q_2 = P_2Q_2/P_2 = 1040.7/1.2135 = 857.6.$$

$$\Delta P/P = .2135/1 = .2135$$

$$\Delta Q/Q = -33.3/890.9 = -.03737$$

$$\therefore \quad \varepsilon = \frac{\Delta Q/Q}{\Delta P/P} = -.175$$

Message Toll Service, Including WATS - Elasticity

1982

Revenue without price increase	P_1Q_1 =	1630.3	Table 8.1
Reprice revenue	P_2Q_1 =	1855.8	
Revenue after curtailment	P_2Q_2 =	18.5.3	

$$P_1 = 1 \therefore Q_1 = 1630.3$$

$$P_2 = P_2Q_1/P_1Q_1 = 1855.8/1630.3 = 1.1383$$

$$Q_2 = P_2Q_2/P_2 = 1815.3/1.1383 = 1596.7$$

$$\Delta P/P = .1383/1 = .1383$$

$$\Delta Q/Q = -35.6/1630.3 = -.0218$$

$$\therefore \quad \varepsilon = \frac{\Delta Q/Q}{\Delta P/P} = -.158$$

Local Price Elasticity

1982

No price increase	$P_1Q_1 = 1844.7$
Repriced	$P_2Q_1 = 2203.3$
Curtailed	$P_2Q_2 = 2181.3$

$P_1 = 1$ $Q_1 = 1844.7$

$P_2 = 1.1944$ $Q_2 = 1826.3$

$\Delta P = .1944$

$\Delta Q = -18.6$

$$\varepsilon = -\frac{\Delta Q/Q}{\Delta P/P} = -0.05$$

APPENDIX 2

Relationship between Consumer Response Factor, and Elasticity

Consumer response factor 81-237

Revenue at current rates	A		P_1Q_1
Reprice revenue	B		P_2Q_1
Reprice revenue increase	C = B − A	=	$Q_1[P_2 - P_1] = Q_1\Delta P$
Revenue curtailment	D	=	$P_2[Q_1 - Q_2] = -P_2\Delta Q$

$$\therefore \quad CRF = D/C = -\frac{\Delta Q}{\Delta P} \cdot \frac{P_2}{Q_1} \approx \varepsilon$$

E.g. for long distance message

CRF = −.212 ε = −.198

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1981 BELL CANADA
RATE REQUEST ANALYSIS

Report #2:
Direct and Indirect Effects

SECTION I- INTRODUCTION

The purpose of the analysis presented in this report is to design and simulate a general equilibrium model of the Quebec-Ontario regional economy in order to analyze the direct and indirect price effects of proposed Bell Canada rate changes. The model is developed along classic Leontief input-output lines. The novelty of the approach lies in the fact that telecommunications output (and in particular, the output of Bell Canada) is treated as a primary input into the production process of all sectors of the regional economy. In this way, it is possible to evaluate the percentage change in prices of the various sectors resulting from a given percentage change in telecommunications prices. At the same time, the distribution of these effects across sectors and upon the consumer price index can be evaluated. The principal drawback of the analysis lies in the fact that the input-output assumption of fixed production coefficients limits the substitution possibilities of the sectors which may result from relative price changes. As such, the model can be thought of as providing short to medium run estimates of price adjustments on the part of other sectors of the economy.

The analysis is presented in the following way. In section II we present a description of the input-output model and the general method by which equilibrium prices are determined. We also show how the general model can be adapted in order to study the effects of telecommunications rate changes. The first part of this section may be skipped by those who are familiar with I-O models. In section III characteristics of the Quebec-Ontario regional input-output model used in this study are summarized. Particular attention is directed towards the sectoral importance of telecommunications services and the size of Bell Canada relative to the regional telecommunications sector. In section IV results of simulating the effects of various rate changes on the part of Bell Canada are presented under the assumption that the telecommunications sector output forms a primary input into the production processes of other sectors. In section V we conclude with a discussion of the implications of the research for proposed rate changes.

SECTION II- STRUCTURE OF THE LEONTIEF INPUT-OUTPUT MODEL

An Example

We begin this section by examining a simple economy in which there are three sectors, two primary factors (capital and labour), indirect taxes, imports, and four types of final demand (households, exports, investment and government).[1] The summary tableau of this economy is given in Table (2.1).

We assume that the data for the tableau has been compiled from information available in a given year. All of the entries in the tableau represent the money value of the indicated transactions.

In the north-west corner of the tableau, the matrix $[f_{ij}]$ represents the inter-sectoral flow of funds arising from the purchase and sale of sectoral outputs for use in production in other sectors. The element f_{ij} represents the value of output of sector i sold to sector j for use in the production of output in sector j. These are named intermediate flows.

The matrix in the north-east corner of the tableau represents payments for the rest of the sectoral outputs. For example, H_2 is the total payments by households for the output of sector 2 and G_3 is the total payments by government for output purchased from sector 3. These payments are labelled final demand payments and are thus distinguished from intermediate demand payments (or flows).

TABLE 2.1

INPUT-OUTPUT TABLEAU FOR THE EXAMPLE THREE SECTOR ECONOMY

		INTERMEDIATE FLOWS			FINAL DEMANDS				
		Sector 1	Sector 2	Sector 3	Households	Exports	Investments	Govt.	Row Total
INTERMEDIATE FLOWS	1	f_{11}	f_{12}	f_{13}	H_1	E_1	I_1	G_1	RT_1
	2	f_{21}	f_{22}	f_{23}	H_2	E_2	I_2	G_2	RT_2
	3	f_{31}	f_{32}	f_{33}	H_3	E_3	I_3	G_3	RT_3
PRIMARY INPUTS	Labour	w_1L_1	w_2L_2	w_3L_3	LH			LG	RT_4
	Capital	r_1K_1	r_2K_2	r_3K_3	KH			KG	RT_5
	Taxes	T_1	T_2	T_3	TH		TI	TG	RT_6
	Imports	M_1	M_2	M_3	MH		MI	MG	RT_7
	Column Total	CT_1	CT_2	CT_3	CT_4	CT_5	CT_6	CT_7	

/4

The last column in the north-east matrix with typical element RT_i (i = 1,2,3) is the row sum of sector i and represents the total value of sales made by sector i. This includes intermediate and final demand payments. Thus $RT_i = \sum_j f_{ij} + H_i + E_i + I_i + G_i$, i = 1,2,3.

The south-west matrix of the tableau details the rest of the value of inputs paid by the sectors. For example, w_1L_1 is the total value of labour services used by sector 1 and is in the form price (w_1) times quantity (L_1). Similarly, r_3K_3 is the value of capital services used as input in sector 3. The last two rows of this matrix contain the total indirect taxes paid by each sector (net of subsidies) and the value of imports used in the production process. The imports listed here include non-competing (or complementary) imports of goods not domestically produced, as well as competing imports. The indirect taxes represent those paid by the sectors - for example, manufacturers' sales taxes.

The south-east quadrant of the tableau shows the value of inputs used directly by the final demand sectors as well as imports and indirect taxes paid by final users - for example, retail sales taxes. Typically all final demands except exports, will include taxes and imports, and only households and government will make payments for labour and capital services.

The last row of the tableau contains the column sums where CT_i (i = 1,2,3) represents the total cost (in terms of intermediate inputs, primary inputs, taxes and imports) of producing the output of sector i. The remaining CT_i values (i = 4,5,6,7) represent the total value of final demands for sectoral outputs and factors.

By convention, total profit is included in the payments to the primary factor capital. Thus, the total revenue from selling the output of sector i (RT_i) must equal the total cost of producing sector i's output (CT_i) and thus:

$$RT_i = CT_i \qquad i = 1,2,3 \qquad (2.1)$$

The values RT_i and CT_i are calculated at producer prices.

The values provided in the tableau can also be used to calculate gross regional product (GRP) and gross regional expenditure (GRE) at both producer and user prices.

Gross regional product at producers prices is defined from national income accounting as the sum of payments to capital and labour plus indirect taxes paid by producing sectors. Thus GRP at factor prices is equal to $RT_4 + RT_5 + T_1 + T_2 + T_3$. Gross regional product at user prices includes final demand indirect taxes and is given by:

$$GRP = RT_4 + RT_5 + RT_6 \qquad (2.2)$$

Gross regional expenditure is defined as

$$GRE = H + E + I + G - M \qquad (2.3)$$

where H, E, I, and G are respectively the total value of household, export, investment, and government payments for goods and services and M is the total value of imports defined as RT_7. Thus in terms of producer prices, GRE is given by $CT_4 + CT_5 + CT_6 + CT_7 - RT_7 - TH - TI - TG$. In terms of user prices, GRE is given by $CT_4 + CT_5 + CT_6 + CT_7 - RT_7$.

A General Development of the Structure

We now consider generalizing the model to the case of n sectors.[2] The resulting tableau will have north-east and north-west matrices which are respectively dimensioned $(n \times 4)$ and $(n \times n)$. In this model imports continue to be treated as inputs into sectoral production. If we divide through each row of resulting north-west and north-east matrices by the corresponding sectoral output price[3] then the intermediate flows, final demands, and the row total will now be measured in physical units. Thus physical intermediate and final demands will now add up to total domestic sectoral output in each sector. We define q_i as the total output of sector i, q_{iF} as the total final demand for sector i $(= q_{iH} + q_{iI} + q_{iE} + q_{iG})$ and q_{ij} as the total physical output of sector i sold to sector j. It follows from these definitions that:

$$\sum_j q_{ij} + q_{iF} = q_i \qquad i = 1,\ldots,n \qquad (2.4)$$

If we define $a_{ij} = q_{ij}/q_j$ where a_{ij} can be interpreted as the amount of input from sector i necessary to produce 1 unit of output in sector j, the system of n equations defined by (2.5) can be written in matrix form as:

$$q - A \cdot q = q_F \qquad (2.5)$$

where A is the Leontif matrix of dimension $(n \times n)$ with typical element a_{ij}, q is an $(n \times 1)$ vector with typical element q_i, q_F is an $(n \times 1)$ vector with typical element q_{iF} and a 'dot' $(\cdot)$ denotes matrix multiplication. Equation (2.6) summarizes the n sectoral exhaustion requirements that what is left over from total output

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$$[I - A]\cdot q = q_F \qquad (2.6)$$

where I is an identity matrix with unity as the diagonal elements and zeros elsewhere. If we consider final demands as fixed then then using (2.7) we can solve for the vector of total outputs which will satisfy the given final demands and implied intermediate demands. In particular,

$$q^* = [I - A]^{-1}\cdot q_F \qquad (2.7)$$

In addition to the primal equations noted above, it is possible to use the tableau to develop a dual set of equations representing the relationships which must hold between output and input prices in equilibrium. Working with the (n × n) north-west intermediate flow matrix and the (4 × n) primary inputs, taxes and imports matrix in the south-west, we divide each of the n sectoral columns by the physical quantity produced by that sector. Recalling the definition of a_{ji} used above, we obtain the following system of n equations:

$$p_j = \sum_i a_{ij}p_i + w_j\ell_j + r_jk_j + m_j + t_j \qquad j = 1,\ldots,n \qquad (2.8)$$

where p_j is the price (average cost) of a unit of output of sector j, $\ell_j = L_j/q_j$ is the quantity of labour required in the production of 1 unit of output in sector j, $k_j = K_j/q_j$ is the quantity of capital required to produce 1 unit of output in sector j and $m_j = M_j/q_j$ and $t_j = T_j/q_j$ are respectively the per unit value of imports and producer taxes per unit of output in sector j. These equations can be written in matrix form as:

$$[I - A^T] \cdot p = y \tag{2.9}$$

where T is the transpose operator, p is an $(n \times 1)$ vector of producer prices and y is an $(n \times 1)$ vector of total factor payments per unit of output with typical element $y_j = w_j \ell_j + r_j k_j + m_j + t_j$. In principle if the y_i are fixed then (2.9) can be used to solve for the implicit equilibrium sectoral output prices as:

$$p^* = [I - A^T]^{-1} \cdot y \tag{2.10}$$

As well, equation (2.11) can be used to study the effects of changes in the prices of the underlying primary factors. Differentiating (2.11) we obtain:

$$\Delta p^* = [I - A^T]^{-1} \cdot \Delta y \tag{2.11}$$

where Δp^* is an $(n \times 1)$ vector of equilibrium price changes resulting from the exogenous primary factor changes given by the $(n \times 1)$ vector Δy. It should be noted that the Leontief matrix of production coefficients A (and hence A^T) is assumed to remain unchanged when factor prices change. This reflects the limited substitution possibilities.

Application to Bell Canada

In what follows we demonstrate the way in which the foregoing model can be used to simulate the size and sectoral distribution of general equilibrium effects arising from the proposed Bell Canada rate changes. We assume at the outset that it is possible to sufficiently disaggregate the Quebec-Ontario region telecommunications sector so as to effectively identify Bell Canada. With this in mind, consider next treating the 'Bell Canada' sector as a primary input in a Leontief input-output model. The benefit of doing this is to be able to treat the price of telecommunications services as exogenous in a model in which the rest of the sectoral prices are endogenously determined. Thus equation (2.12) can be used to calculate the general equilibrium price changes resulting from a proposed change in the price of telecommunications services. This greatly simplifies the simulation procedure in that stated rate requests can be used without the need for sorting out the myriad of primary factor changes which lead up to the rate request. Indeed, this latter exercise is better handled with the econometric modelling techniques used elsewhere in this study. The cost which arises from using the approach outlined here is that the telecommunications price is no longer endogenous to the model and therefore feedback effects upon telecommunications prices arising from changes in other sectoral prices (which changed as a result of the change in telecommunications prices) will not be captured. Given the size of the telecommunications sector relative to the rest of the Quebec-Ontario region, we feel that the feedback effects upon the telecommunications sector are likely to be small anyway.

The technical details associated with implementing the procedure described above are straightforward. The $(n \times n)$ matrix of intermediate sectoral flows is reduced in dimension by 1 to become an $(n-1 \times n-1)$ matrix. The deleted telecommunications columns are appended to the final demand columns. The deleted telecommunications row is added to the rows representing primary inputs. Thus, the per unit flow of primary inputs into any sector j is now written:

$$y_j = w_j \ell_j + r_j k_j + m_j + t_j + \pi_j s_j \qquad (2.12)$$

where all terms are as defined above except for π_j which is the price of a unit of telecommunications services entering sector j (later assumed constant across sectors at π) and s_j which represents the quantity of telecommunications services for the production of one unit of output in sector j. Under the assumption that π is constant across sectors, the vector of primary changes resulting from an exogenous increase in π would be given by:

$$\Delta y = \Delta\pi[s_1, s_2, \ldots, s_{n-1}]^T \qquad (2.13)$$

As a result, all of the information necessary to compute the effects of the telecommunications price change is available. These results can be transformed into percentage changes in order to facilitate their interpretation in terms of present rate change requests.

SECTION III- DATA DESCRIPTION

The regional (Quebec-Ontario) input-output tableau with which we work in this report was prepared by Statistics Canada. The table was prepared for the year 1974. There are 44 sectors in the version which we used. The standard aggregation is 43 sectors; however, we were given a finer breakdown of communications services[4] which allowed us to more carefully distinguish telecommunications services.

The value of GRE at user costs calculated from the table for Quebec and Ontario was 95.980 billion dollars. This is almost exactly equal to the value of 95.813 billion dollars reported in the Statistics Canada, Provincial Economic Accounts, annual, cat. 13-213. The value of GRP has also been reconciled.

The total revenue of Bell from its service outputs for the year 1974 was 1.4446 billion dollars. The value of the telecommunications sector on the 1974 table was 1.793 billion dollars. Bell Canada therefore accounted for approximately 81% of the telecommunications sector in Quebec and Ontario. The telecommunications sector accounts for 2.25% of the value of GRP in Quebec and Ontario.

The distribution of telecommunications across sectors as an input is given in Table 2. As can be seen, most sectors use less than one percent of telecommunications output. The largest user is sector 35 - finance, insurance and real estate. Other large users include the transportation and storage industry (29) as well as other service sectors including retail trade (33), business management services (38)

TABLE 2.2

SECTORAL DISTRIBUTION OF TELECOMMUNICATIONS OUTPUT

	Sector Description	% Usage of Total Telecommunications Output
1	AGRICULTURE	.6523
2	FORESTRY	.0828
3	FISHING, HUNTING & TRAPPING	.0031
4	METAL MINES	.1753
5	MINERAL FUELS	.0003
6	NON-METAL MINES & QUARRIES	.0745
7	SERVICES INCIDENTAL TO MINING	.0447
8	FOOD & BEVERAGE INDUSTRIES	1.3778
9	TOBACCO PRODUCTS INDUSTRIES	.0809
10	RUBBER & PLASTICS PRODUCTS INDUSTRIES	.4617
11	LEATHER INDUSTRIES	.1230
12	TEXTILE INDUSTRIES	.4531
13	KNITTING MILLS	.1042
14	CLOTHING INDUSTRIES	.3192
15	WOOD INDUSTRIES	.2642
16	FURNITURE & FIXTURE INDUSTRIES	.2451
17	PAPER & ALLIED INDUSTRIES	.7082
18	PRINTING & PUBLISHING	.9287
19	PRIMARY METAL INDUSTRIES	.8738
20	METAL FABRICATING INDUSTRIES	1.1853
21	MACHINERY INDUSTRIES	.8571
22	TRANSPORTATION EQUIPMENT INDUSTRIES	1.4209
23	ELECTRICAL PRODUCTS INDUSTRIES	1.8613
24	NON-METALLIC MINERAL PRODUCTS INDUSTRIES	.4503
25	PETROLEUM & COAL PRODUCTS	.2997
26	CHEMICAL & CHEMICAL PRODUCTS INDUSTRIES	1.4780
27	MISCELLANEOUS MANUFACTURING INDUSTRIES	.5968
28	CONSTRUCTION INDUSTRY	1.3016
29	TRANSPORTATION & STORAGE	4.8795
30	RADIO, TELEPHONE, BROADCASTING, POST OFFICE	1.5720
31	ELECTRIC POWER, GAS, OTHER UTILITIES	.3429
32	WHOLESALE TRADE	5.3796
33	RETAIL TRADE	3.8569
34	OWNER OCCUPIED DWELLINGS	.0000
35	OTHER FINANCE, INSURANCE & REAL ESTATE	9.7779
36	EDUCATION & HEALTH SERVICES	2.5035
37	AMUSEMENT & RECREATION SERVICES	.3352
38	SERVICES TO BUSINESS MANAGEMENT	3.2187
39	ACCOMMODATION & FOOD SERVICES	1.4098
40	OTHER PERSONAL & MISCELLANEOUS SERVICES	.4335
41	TRANSPORTATION MARGINS	.0000
42	OPERATING, OFFICE, LAB. & FOOD	.0000
43	TRAVEL & ADVERTISING, PROMOTION	.0088
44	COMMUNICATION INDUSTRIES	1.5157
	FINAL DEMANDS	48.3509

and wholesale trade (32). Approximately 1.52% of telecommunications output is used within the telecommunications sector (44). Overall, 51.65% of telecommunications output is directed towards intermediate usage.

SECTION IV- SIMULATION RESULTS

In this section we report on the results of simulating an increase in the telecommunications price in the order of magnitude of the recent rate request. As noted in Section II, telecommunications is treated as a primary input so that telecommunications price changes can be treated as exogenous to the model.

The simulation proceeds in the following way.

First, the consistency of the model is verified by computing the base year equilibrium prices. Since the calculation of the a_{ij} coefficients from base year values implicitly introduces a normalization into the model with no loss of generality, all of the base year equilibrium prices can be taken equal to 1.

Secondly, the telecommunicastions price change is introduced into the model. Bell estimates that its 1982 revenues with no price increase would be 3.914 billion dollars. If the price increases are granted Bell estimates that their revenues would increase to 4.461 billion dollars after curtailment. The price requests therefore amounts to a 14% increase in revenues for Bell. Now, given that Bell represents approximately 81% of the input-output telecommunications sector, the Bell revenue increase would amount to an 11.32% increase in the telecommunications primary input costs to each sector. On the basis of the new primary costs, the new equilibrium sectoral price vector is calculated. These prices are shown in Table 3. In Table 3 the consumer price index (CPI) weights of the various sectors are reported as well.

Examining Table 3 we find that overall the prices of all sectors will increase but that these increases will be very small. The CPI increase from a base value of 1 to a new value of 1.003 - an increase of only three tenths of a percentage point. The results require little explanation other than to note that those sectors identified in Section III as using larger percents of telecommunications output as input tend to have the largest price effects. The largest percentage increase in price is only .48% and this is in the radio telephone broadcasting and post office sector (30). Approximately 4% of the production cost of this sector arises from telecommunications output.

The explanation of these findings lies in the fact that inter-sectoral sales of telecommunications services are small relative to find sales and the fact that telecommunications forms only 2.25% of GNP in Quebec and Ontario. As a final point it should be noted that the small magnitudes of the price changes imply that any feedback (indirect) price effect on the telecommunications sector will be very small and therefore that the price changes shown in Table 3 effectively represent all of the direct and indirect effects.

TABLE 2.3

SIMULATION RESULTS

	Sector Description	Initial Prices	Prices after Bell Request	CPI Sector-Weights
1	AGRICULTURE	1.0000	1.0008	.0155
2	FORESTRY	1.0000	1.0009	.0003
3	FISHING, HUNTING & TRAPPING	1.0000	1.0004	.0001
4	METAL MINES	1.0000	1.0005	.0002
5	MINERAL FUELS	1.0000	1.0004	.0000
6	NON-METAL MINES & QUARRIES	1.0000	1.0007	.0003
7	SERVICES INCIDENTAL TO MINING	1.0000	1.0008	.0000
8	FOOD & BEVERAGE INDUSTRIES	1.0000	1.0008	.1188
9	TOBACCO PRODUCTS INDUSTRIES	1.0000	1.0009	.0083
10	RUBBER & PLASTICS PRODUCTS INDUSTRIES	1.0000	1.0010	.0057
11	LEATHER INDUSTRIES	1.0000	1.0010	.0069
12	TEXTILE INDUSTRIES	1.0000	1.0008	.0096
13	KNITTING MILLS	1.0000	1.0008	.0058
14	CLOTHING INDUSTRIES	1.0000	1.0008	.0279
15	WOOD INDUSTRIES	1.0000	1.0009	.0013
16	FURNITURE & FIXTURE INDUSTRIES	1.0000	1.0009	.0132
17	PAPER & ALLIED INDUSTRIES	1.0000	1.0008	.0067
18	PRINTING & PUBLISHING	1.0000	1.0014	.0090
19	PRIMARY METAL INDUSTRIES	1.0000	1.0007	.0003
20	METAL FABRICATING INDUSTRIES	1.0000	1.0009	.0046
21	MACHINERY INDUSTRIES	1.0000	1.0011	.0018
22	TRANSPORTATION EQUIPMENT INDUSTRIES	1.0000	1.0007	.0182
23	ELECTRICAL PRODUCTS INDUSTRIES	1.0000	1.0013	.0126
24	NON-METALLIC MINERAL PRODUCTS INDUSTRIES	1.0000	1.0010	.0011
25	PETROLEUM & COAL PRODUCTS	1.0000	1.0004	.0293
26	CHEMICAL & CHEMICAL PRODUCTS INDUSTRIES	1.0000	1.0013	.0146
27	MISCELLANEOUS MANUFACTURING INDUSTRIES	1.0000	1.0012	.0095
28	CONSTRUCTION INDUSTRY	1.0000	1.0007	.0006
29	TRANSPORTATION & STORAGE	1.0000	1.0020	.0263
30	RADIO, TELEPHONE, BROADCASTING, POST OFFICE	1.0000	1.0048	.0049
31	ELECTRIC POWER, GAS, OTHER UTILITIES	1.0000	1.0005	.0236
32	WHOLESALE TRADE	1.0000	1.0023	.0488
33	RETAIL TRADE	1.0000	1.0014	.1559
34	OWNER OCCUPIED DWELLINGS	1.0000	1.0001	.1121
35	OTHER FINANCE, INSURANCE & REAL ESTATE	1.0000	1.0024	.1260
36	EDUCATION & HEALTH SERVICES	1.0000	1.0027	.0244
37	AMUSEMENT & RECREATION SERVICES	1.0000	1.0014	.0182
38	SERVICES TO BUSINESS MANAGEMENT	1.0000	1.0023	.0088
39	ACCOMMODATION & FOOD SERVICES	1.0000	1.0012	.0712
40	OTHER PERSONAL & MISCELLANEOUS SERVICES	1.0000	1.0012	.0220
41	TRANSPORTATION MARGINS	1.0000	1.0019	.0125
42	OPERATING, OFFICE, LAB. & FOOD	1.0000	1.0009	.0040
43	TRAVEL & ADVERTISING, PROMOTION	1.0000	1.0017	.0024
44	COMMUNICATION INDUSTRIES	1.0000	1.1132	.0167

FOOTNOTES

1) The discussion which follows has been guided to a large extent by the analysis contained in Hansen [1977, pp. 171-182].

2) Although it is a straightforward procedure, we do not undertake the task of disaggregating final demands nor of disaggregating primary inputs to include, for example, explicit accounting for land. In practice, it is never practical to completely disaggregate the model. The analysis is therefore conducted in value terms at the outset so that aggregation is possible.

   This analysis assumes each activity produces one aggregate commodity, and hence the northwest quadrant is square. In general, Statistics Canada produces an $n \times m$ matrix, where there are n activities and m commodities.

3) The existence of this price begs an important index number issue whereby the several commodities produced in any given sector can be successfully aggregated.

4) The communications sector was provided in a disaggregated form, consisting of two sectors: telecommunications and post office, radio telephone and broadcasting.