THE OUTLINE OF THE CANADIAN TELEPHONE INDUSTRY STRUCTURAL MODEL

Institute of Applied Economic Research

August 1976

1. Introduction

The purpose of the "Canadian Telephone Industry Structural Model" (CAPTRA) is to analyse the past and present characteristics of the telephone industry in order that simulations may be developed describing various feasible future paths the industry may pursue.

The model is being developed by the Institute of Applied Economic Research for the Federal Department of Communications. Consequently, the aim of this paper is to highlight the general structure and interrelationships of the CAPTRA model.

The basic thrust of the Institute's model is to integrate the real (product, factor etc.) decisions, of the firms within the industry, with their financial (debt, equity etc.) decisions. This integration of the decision mechanisms, in the context of actual market behavior, will permit the evaluation of policy options under a simulated environment. The simulation experiments will depict potential market alternatives and these exercises may be initiated by alterations to the real or financial aspects of the firms. Moreover, as a consequence of the inherent nature of the model, one can readily trace the interdependent and cumulative effects upon the product demand and supply, factor and financial requirements.

The model, itself, will be principally comprised of three sub-modules,demand, production and financial. These components will then be integrated into a cohesive unit. The flow chart exhibits the complete and complex workings of the model.

The general description of the sub-modules which characterize the main activities of the industry are:

1) The determinants of the demand for telephone services, on a disaggregated (such as local, toll, etc.), as well as, aggregated demand.

2) The determinants of the production relations for telephone services, which will depend on the firms' demands for labour and capital services,in light of the technological capabilities of the industry.

3) The financial requirements in terms of debt and equity in order to satisfy the derived demand for material capital. In addition, the characteristics of the sources and uses of working capital and the regulatory environment will affect the firms' internal capacity to generate funds for the capital budget and the utilization of labour services.

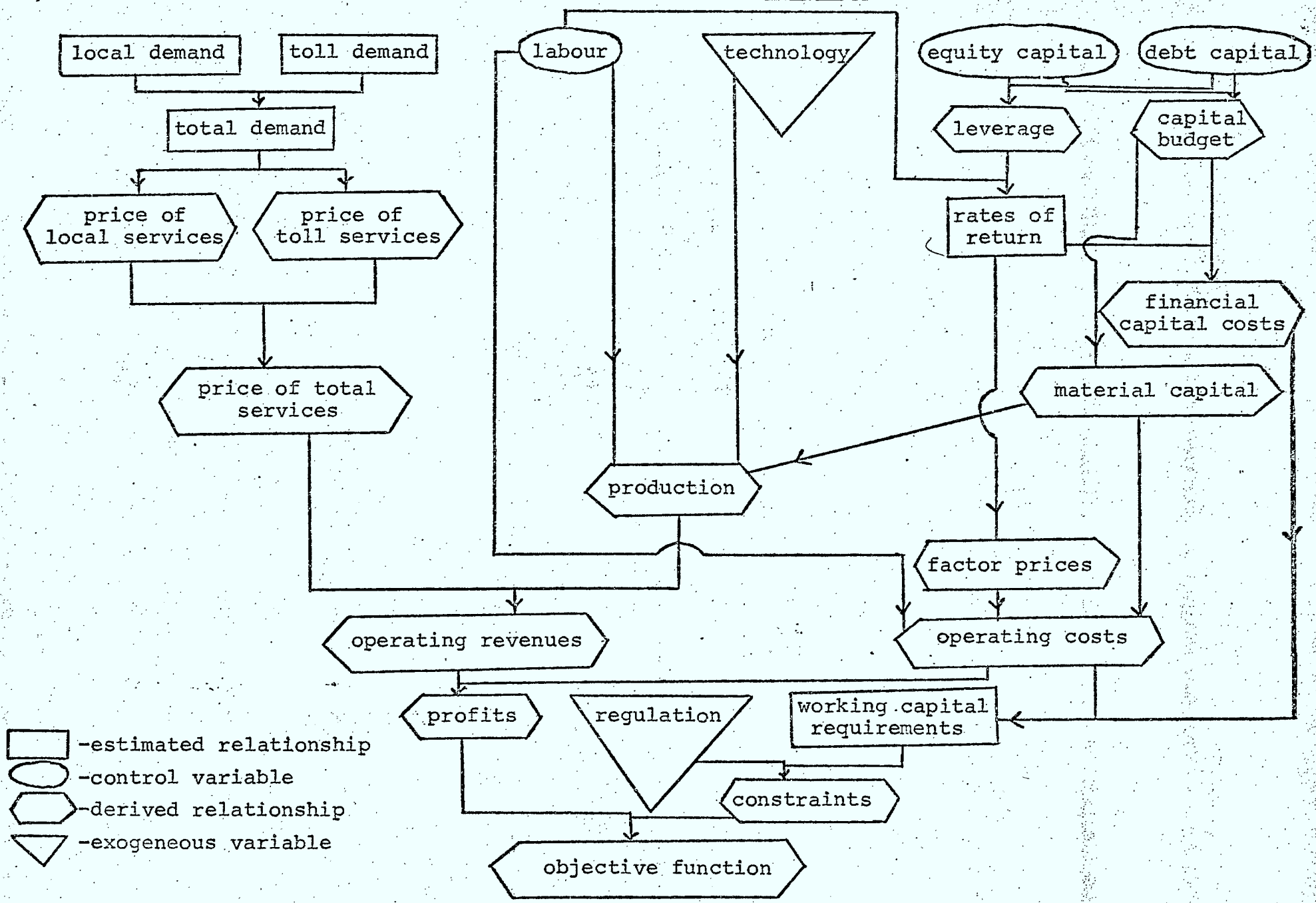
In each of these blocks various behavioral relationships have to be estimated. These relationships are then integrated in order that a complete picture of the industry is obtained so that

the important simulations will be based on information from the actual and total industrial structure.

The remainder of the paper will highlight the sub-sections of the model, the theoretical structure of the model and the interesting policy questions for the simulations.

I.A.E.P. Project

General Structure of the Model



2. The Demand Module

The demand module deals with the determinants of the demand for the services provided by the various telephone companies. We formulate econometric models to examine the disaggregated (or component) demand and aggregated (or total) demand. These components will generally consist of local services, toll services and directory services.

The variables, dictated by economic theory, which usually have the greatest impact on demand are relative prices and real income. In our framework relative prices are represented by the price index of a particular revenue category deflated by the price index of the gross product for the area in which a company has the jurisdiction to operate. The real income variable is defined as the representative gross product divided by the gross product's price index. The quantity demanded variable should, ideally, be measured in some homogeneous unit, such as minutes of calls. Unfortunately, we do not have data measuring the duration of calls. Therefore, we are forced to use the different revenue components deflated by the appropriate price index as the output variable.

The form of our demand function for all demand categories is referred to as the Rotterdam Model as may be written as,

$$\alpha_t(\log x_t - \log x_{t-1}) = \beta_0 + \beta_1(\log p_t - \log p_{t-1}) + \beta_2(\log y_t - \log y_{t-1}) + e_t$$

where x_t is the demand in period t, p_t the relative price in period t, y_t real income in period t and e_t the stochastic disturbance. In this model $\alpha_t = \frac{a_t + a_{t+1}}{2}$ where a_t is the proportion of the value of demand for a particular service to the total demand. According to economic theory and verified by our empirical results we find that $\beta_1 < 0$ and $\beta_2 > 0$. This means that an increase in relative prices (real income fixed) will decrease the quantity demanded for telephone services. On the other hand, an increase in real income (relative prices fixed) will increase the quantity demanded for telephone services. Hence, telephone services are superior products.

3. The Production Module

The purpose of the production module is to estimate the determinants of the supply of telephone services by means of regression analysis. We postulate that there are essentially two fundamental factors of production which determine output; they are labour and material capital.

The labour and capital inputs, along with a variable designating technological change, are combined in a functional relationship in order that the structural specification is captured. An attractive production function is one, which can be considered as a second order approximation to any production function around a point in which the logarithms of each of the inputs are made equal to zero. This form of production function is called the Transcendental Logarithmic Production Function (translog) and may be written as,

$$\log q_t = \gamma_0 + \gamma_1 \log A_t + \gamma_2 \log L_t + \gamma_3 \log K_t + \gamma_{22}(\log L_t)^2 + \gamma_{33}(\log K_t)^2 + \gamma_{33}(\log L_t)(\log K_t) + e_t$$

where q_t is output, A_t is technological change, L_t is labour and K_t is capital.

Empirically we defined the variables as;

q_t - total revenues minus indirect taxes

L_t - weighted man-hours, where the weights are the relative hourly wage rate of the different labour categories.

K_t - net capital stock (including construction)

A_t - direct distance dialing.

Finally economic theory states and again verified by our empirical results that $\gamma_2 > 0$ and $\gamma_3 > 0$.

4. The Financial Module

The purpose of the financial segment is to incorporate the regulatory with the financial behavior of the industry. Most telephone companies operate in a regulated environment and according to economic theory this regulation may be represented by the following constraint;

$$\Pi + w_k K \leq sK$$

where Π are the firms' profits, w_k the factor price of capital. and s the fair rate of return. This constraint states that residual profits and the return to capital must not exceed some fair rate of return to capital multiplied by the existing capital stock.

Firms, do not only operate in a regulated economy, but also in one where money is needed to carry out transactions. Hence, we must be aware of the constraint vis à vis working capital requirements that confronts all firms. Formally, we recognize that debt and equity and revenues are basically sources of funds, while the uses of funds are determined by the payments to the factors of productions, input credit arrangements, the retirement of debt etc. Consequently we can represent the working capital constraint as

$$g(K - \bar{K}, L) - p_b(B - B) - p_s(S - \bar{S}) \leq 0$$

where g is the net money requirements function which depends on

changes in the capital stock ($\bar{K}$ is the previous period's capital) and labour which in turn determine operating costs and revenues; $\bar{B}$ and $\bar{S}$ are the previous period's amount of debt and equity respectively. The impact of these constraints is to restrict the nature of the factor requirements which are used in the production process to generate revenues.

5. The Integrated Model

This section incorporates the information pertaining to the sub-modules described in sections 2, 3 and 4.

If we take a general view with regards to the various functional relationships we may define the profits of each of the firms' in the telephone industry as

$$\Pi = pF(K,L) - w_\ell L - w_k K$$

where p is the output price, w_ℓ is the factor price of labour. Moreover, we know from the demand module that the price of output is a negative function of the product (since $\beta_1 < 0$).

When we incorporate the regulatory constraint

$$\Pi + w_k K \leq sK$$

and the financial requirements constraint (generally)

$$g(K - \bar{K}, L) - p_b(B - \bar{B}) - p_s(S - \bar{S}) \leq 0$$

then the firm desires to maximize profits subject to the two previous constraints. Indeed, we see that the control variables are labour, debt and equity capital (because material capital is related to the financial capital by the market value of the balance sheet for each of the firms). The firm, given the estimated behavioral relationships, selects the amount of labour to be demanded, debt and equity to be supplied in each and every period.

We find that the actual sequence of decisions for the firm in our model is the following:

Sequence 1 Determine labour, debt, and equity

Sequence 2 Determine leverage, and the capital budget

Sequence 3 Determine material capital

Sequence 4 Determine output

6. Simulation

Once the complete model is estimated thereby revealing the past and existing structure of the telephone industry many interesting questions may be asked with respect to the future development of the industry. The solutions to these questions will have important ramifications for the governmental policies towards the telephone industry.

We envision, at least, four important areas in which simulation exercises are to be performed. The first pertains to the regulatory aspect. What is the impact on production, debt, equity and the inputs when the industry faces a market rate of return on its material capital rather than a regulated. Secondly, what are the effects of an exogeneous change in the production capabilities of the firm, for example a change in product mix or a change in factor intensity, such as the industry becoming more labour-intensive. Thirdly, what is the impact if the firms are subject to maintaining a fixed debt/equity ratio rather than one which is self-determined by the decision-making of the firm. Finally, what is the effect of an institutionally fixed level of investment while the debt/equity ratio is free to vary according to the optimal behavior of the firm.

These and many more simulation experiments may be carried out using the CAPTRA model depicting the market behavior of firms' operating in the telephone industry.