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A MODEL TO ANALYZE THE REGIONAL ECONOMIC IMPACT OF ELECTRIC RATE INCREASES*

by

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* A technical report on the adaptation of the Philadelphia STARLOC Model, prepared for the City of Philadelphia.

I. Introduction

This technical report contains the mathematical specifications and estimated parameters of the Philadelphia STARLOC Model, the development of which was commissioned and partly sponsored by the City of Philadelphia. It is an outgrowth of a model of the Philadelphia area economy designed to forecast the impact of various local conditions on interregional mobility of labor and capital and on the relocation of industry, which has been under development by the Wharton Policy Modeling Workshop since August 1984 (see Schinnar and Wood, 1985). The adaptation of the model reported herein is designed to forecast the economic impact of electric rate increases on a regional economy.

In September 1985 the Philadelphia Electric Company (PECO) filed a request for a 28.2% electric rate increase with the Pennsylvania Public Utility Commission (PUC). The Company's Rate Proposal is intended to reflect the increased capital and operating costs associated with the Limerick Nuclear Generating Station Unit 1 and 100% of the common plant which it will share with a second nuclear station, to be completed in 1991. In an attempt to ameliorate the economic impact of the electric rate increase, PECO has proposed to phase in the 28.2% increase over a three-year period.

The City of Philadelphia, concerned about the possible adverse economic effects of PECO's Rate Proposal, commissioned an economic study of the Philadelphia region's economy, seeking an electric rate policy that would balance PECO's stated need for revenue increases with the Philadelphia region's need for sustained economic growth. The analysis focused on the following questions:

- What will the impact of the PECO Rate Proposal be on job growth in the Philadelphia regional economy?
- If there are adverse effects, which sectors of the economy, occupational groups and household groups will be most affected?
- What will the increases in electricity bills and other energy costs be for industry, commerce, residential ratepayers, and City government?
- How will the City government's finances be affected?
- Is PECO's Rate Proposal, including its phase-in schedule, feasible in light of economic trends and conditions?

The adaptation of the Philadelphia STARLOC Model presented in this report is a regional energy-economy model which draws on a broad literature on regional modeling and energy economics. At its hub is a multisector input-output multiplier of the Philadelphia economy which describes the structure of economic transactions among 9 manufacturing and 14 non-manufacturing sectors. Employment and household consumption are linked: partly through a portrayal of the employment structure of 23 sectors by 7 occupational groups, with earnings by 6 income groups; and partly through a mapping of household consumption of 17 consumer products by 6 income groups onto 23 industry commodities describing the private consumption component of final demand. (See figure 1.1.) The employment-consumption link forms an income-induced multiplier which encompasses the interindustry multiplier. Together these two multipliers form the basic characterization of the region's economic and demographic structure.

Three submodels are used to alter the structure of STARLOC (figure 1.2): a growth submodel (top right), which forecasts sector-specific employment growth based on U.S. growth, relative wages and temporal trends; a price submodel (top left), which adjusts the electricity rate increase to reflect the real change in the price of electricity relative to inflation and its impact on the relative price structure of commodities in the economy; and a demand submodel (left bottom), which simulates the change in energy demand (electricity, fuel oil, gas) and other expenditures as a result of electric price increases. The demand submodel includes a detailed residential component with variables on dwelling characteristics, demographic and income attributes of households, appliance stock, climate, and energy related public assistance.

The STARLOC Model may be regarded as a third generation Philadelphia model. The first was constructed by Walter Isard and colleagues in the sixties and constituted the first detailed input-output model of a regional economy (see Isard and Langford, 1971). The input-output framework is also an important part of the STARLOC model, but it is extended to explicitly link the economy with the demographic characteristics of the labor force (after Schinnar, 1976), and makes allowance for variation in the technical coefficients' response to local prices (inspired by the Hudson and Jorgenson model, 1974).

The second generation of Philadelphia models follows the tradition of macro-econometric model building, initially estimated by Glickman (1971) and updated and used throughout the seventies by Wharton Econometric Forecasting Associates, Inc. (see Adams and Glickman, 1980). Many of the variables in these models are included in STARLOC, implicit in the formulation of the price, demand and growth submodels.

The present report, which contains specifications, key parameters and essential data of the STARLOC Model, is the first in a series of papers on the model's development. Later reports, referred to in the text, will include:

STARLOC Report 2: Economic Impact on the Philadelphia Region Economy of Electric Rate Policy (based on direct testimony of A.P. Schinnar before the PUC)

STARLOC Report 3: Employment Multipliers and Elasticities of the Philadelphia Economy (and Other Data of the Philadelphia STARLOC Model)

STARLOC Report 4: Residential Energy Demand Elasticities by Region and Income: Electricity, Gas and Fuel Oil

STARLOC Report 5: Government Energy Demand Elasticities: A Comment

STARLOC Report 6: An Economic Growth Model of the Philadelphia Service and Manufacturing Sectors

II. Income-Induced Interindustry Multipliers of a Regional Economy

In this section we develop an extension to the Leontief model by endogenizing the private consumption component of final demand through a link with employment. Unlike the common practice in models of socialist economies in which a household row and column are added to the interindustry transactions table, our approach follows the work of Schinnar (1976, 1977, 1978, 1980), Kasraie (1980), and Schinnar and Schlosser (1982), which explicitly account for consumption behaviour of economically active populations and their dependents. The present formulation distinguishes itself by the detail in which employment and consumption are described and by the focus on a regional economy at the SMSA level.

Interindustry Transactions. Consider a 23 sector regional economy characterized by the Leontief model:

$$x = (I - A)^{-1} y \qquad (2.1)$$

where

- x = a vector of gross outputs by sector (see Table 2.1)
- y = a vector of final demand, including private (household) consumption, government purchases, investment and exports
- A = a matrix of input-output coefficients that form the intermediate demand level, Ax, and the Leontief multiplier, $(I-A)^{-1}$, of direct and indirect demand for goods and services.

Let

a_o = a vector of labor coefficients with elements defining the demand for labor in each industry per unit of gross output

such that

$$L_a = \hat{a}_o x , \tag{2.2}$$

is a vector of labor employed by each sector, and where $\hat{a}_o = \text{diag}(a_o)$, is a diagonal matrix with diagonal elements constructed from the components of a_o. We include establishment jobs as well as proprietors in a_o.

Next, by inserting (2.1) into (2.2), we have

$$L_a = \hat{a}_o (I - A)^{-1} y , \tag{2.3}$$

the common characterization of a Leontief-type economy in which demand for labor is induced by the final demand of end-buyers.

Inasmuch as (2.3) characterizes a regional/local economy, several remarks are in order. The elements of A will usually be smaller than those of a national input-output table because of extensive inter-regional trade. This implies larger than usual coefficients for the wholesale and retail sectors, because output in these sectors in measured on a cost or "value added" basis rather than in terms of gross sales or value of shipment. In view of this, special care must be taken in defining final demand for a regional economy. Many of the goods and services purchased locally are produced elsewhere, thus appearing as demand for the goods and services of the wholesale and retail sectors. This assignment of demand also necessitates a change in measurement from "sales" to "cost" basis, which understates the level of local expenditures on consumption. In Philadelphia, for example, the household consumption component of final demand will show only 80% of household expenditures because many of these appear as transactions through the wholesale and retail sectors.

Labor, Households and Consumers. Consider a partitioning of the labor force into 7 skill/occupation groups and 6 income (wage) groups, with households partitioned as well into 6 income/consumer groups. Let

K = a skill (7) by sector (23) matrix of the labor force with columns describing the occupational structure of each sector; a typical entry K_{ij} gives the relative size of skill group i in sector j such that $\sum_i k_{ij} = 1$, all j

S = an income (6) by skill (7) matrix with columns giving the relative size distribution of income for each skill/occupation group; a typical element S_{ij} gives the relative size of income group i in skill group j, $\sum_i S_{ij} = 1$, all j

R = a vector of reciprocals of the labor participation rates of households categorized by income groups, $\hat{R} = \text{diag}(R)$

n = a vector of total consumption expenditures of households divided into income groups, $\hat{n} = \text{diag}(n)$

M = a product (17) by income (6) matrix of consumer expenditures, with columns providing the relative distribution of household expenditures on 17 consumer product groups.

A combination of the above definitions maps from labor by sector to consumer expenditures on consumer products:

$$L_k = KL_a \tag{2.4}$$

gives the distribution of workers by skill/occupation groups,

$$L_c = SL_k = SKL_a \tag{2.5}$$

gives the distribution of labor by household income groups,

$$h = \hat{R}L_c = \hat{R}SKL_a \tag{2.6}$$

gives the distribution of households by income groups, and

$$M\hat{n}h = M\hat{n}\hat{R}SKL_a \tag{2.7}$$

constitutes a vector of total expenditures of households in the region on 17 consumer products. These consumer expenditures require further adjustment to reflect the regional levels of private consumption by sector.

<u>Consumer Products and Industry Commodities</u>. The link of consumer expenditures to final demand, y, is accomplished in two steps. First, consumer products represented by categories of household expenditures are allocated to industrial commodities. Then commodities are assigned to industrial sectors in which they are produced. Here we follow Richard Stone's development of the SNA (United Nations, 1968) variant of the Leontief model, in which industry production and consumption is described by industrial sectors and commodity categories. The commodity technology assumption used to derive the economic multiplier requires industry to produce commodities in fixed proportion. We modify this assumption further to reflect the structure of the regional economy in which many commodities are provided through wholesale and retail to consumers (see STARLOC Report 3, forthcoming).

Two tables are thus defined:

H = a mapping of consumer products into industry commodities; a 23 by 17 matrix with elements H_{ij} denoting the proportion of expenditures on consumer products j assigned to industry commodity i, $\sum_i H_{ij} = 1$

C = a 23 by 23 mapping of sector output into industry commodity categories; a typical element C_{ij} gives the share of output of industry i obtained from producing commodity j, $\sum_j C_{ij} = 1$.

The matrix C^{-1} provides a mapping of industry commodities (columns) into sectors (rows), after H has mapped household expenditures ($M\hat{h}h$) onto industry commodities. Hence

$$y_h = C^{-1}HM\hat{h}h \tag{2.8}$$

defines the household consumption portion of final demand, with its residual

$$f = y - y_h \tag{2.9}$$

consisting of government purchases, investment and exports.

Ordinarily, final demand follows the definition of GNP and includes exports, net of imports. In regional modeling, where inter-regional trade is of paramount importance, we follow the GDP convention for final demand by treating imports and exports separately.

<u>Income-induced Multipliers</u>. With equations (2.3) through (2.9) we may endogenize the employment and household consumption of the model. First, insert (2.9) into (2.3):

$$L_a = \hat{a}_o(I - A)^{-1}(y_h + f) . \tag{2.10}$$

Then inserting (2.7) into (2.8) and (2.8) into (2.10) gives

$$L_a = \hat{a}_o(I - A)^{-1}(C^{-1}HM\hat{h}\hat{R}SKL_a + f) . \tag{2.11}$$

Next by solving (2.11) for L_a we obtain the labor distribution by sector:

$$L_a = (I - Z_a)^{-1}\hat{a}_o(I - A)^{-1}f \qquad (2.12)$$

where

$$Z_a = \hat{a}_o(I - A)^{-1}C^{-1}HM\hat{n}\hat{R}SK . \qquad (2.13)$$

Similar substitutions with equations (2.3) through (2.9) yield the following solutions: labor distribution by skill/occupation:

$$L_k = (I - Z_k)^{-1}K\hat{a}_o(I - A)^{-1}f \qquad (2.14)$$

where

$$Z_k = K\hat{a}_o(I - A)^{-1}C^{-1}HM\hat{n}\hat{R}S , \qquad (2.15)$$

labor distribution by household income-group:

$$L_c = (I - Z_c)^{-1}SK\hat{a}_o(I - A)^{-1}f \qquad (2.16)$$

where

$$Z_c = SK\hat{a}_o(I - A)^{-1}C^{-1}HM\hat{n}\hat{R} , \qquad (2.17)$$

distribution of gross output by sector:

$$x = (I - Z_x)^{-1}(I - A)^{-1}f \qquad (2.18)$$

where

$$Z_x = (I - A)^{-1}C^{-1}HM\hat{n}\hat{R}SK\hat{a}_o , \qquad (2.19)$$

and distribution of household expenditures by consumer product:

$$n = (I - Z_n)^{-1}\hat{R}SK\hat{a}_0(I - A)^{-1}f \qquad (2.20)$$

where

$$Z_n = \hat{R}SK\hat{a}_o(I - A)^{-1}C^{-1}HM . \qquad (2.21)$$

These solutions constitute the principal structure of the STARLOC model. They entail a number of multipliers of labor and GIX (government purchases, investment, exports) discussed in STARLOC Report 3, forthcoming. For example, the labor multiplier in Figure 3 gives the total number of jobs induced in the economy by the creation of an additional job in each of the 23 sectors of the Philadelphia SMSA economy. General background on economic trends in the Philadelphia SMSA is available in Summers and Luce (1985).

Data Sources and Parameters. Greater detail on the construction of the Philadelphia data base from which the model was assembled will be given in STARLOC Report 3, forthcoming. The model parameters are given in Tables 2.2 through 2.6 of the Appendix. The data sources are as follows:

A: obtained from the Regional Science Research Institute (courtesy of the Wharton Regional Economic Monitoring Project) and subsequently modified with economic baseline data on the Philadelphia SMSA assembled from County Business Patterns and the Censuses of Service, Contract Construction, Wholesale, Retail and Manufacturing

$K\hat{a}_0$: derived from the same source as A; BLS establishment jobs were supplemented with estimates of proprietor and agricultural employment from the Bureau of Economic Analysis (BEA)

S: based on the 1980 Census Occupation by Earnings table for the Philadelphia SMSA adjusted for 1981

R: based on the 1980 Census for the Philadelphia SMSA (Table 222, civilian labor force by income group, and Table 243, the number of households by income group)

Mñ: based on the National Consumer Expenditures Survey, 1980-81, obtained from the Bureau of Labor Statistics (BLS)

H: based on the Consumer Expenditure Survey (above) and the Commodity Expenditure in the Survey of Current Business, 1981

C: based on Commodity Expenditures in the Survey of Current Business for 1981, and the "make" table of the BEA national input-output table for 1979.

III. The Philadelphia Growth Sub-Model

The growth of many northeastern metropolitan economies in the past two decades has been marked by the following trends: (i) shift of jobs from inner cities to the suburbs, (ii) flight of manufacturing jobs to the sunbelt region, and (iii) growth of the service economy. There is a considerable and still growing literature on the first two phenomena (see, e.g., Vining, 1982; and Milne, 1981), but little in the way of models that forecast the shift of employment from manufacturing to non-manufacturing. This chapter develops a simple growth model of the Philadelphia SMSA economy which differentiates factors influencing the growth pattern of service and manufacturing sectors. The model is then adapted to serve as a submodel within STARLOC to forecast growth in final demand.

Model Specification. The model consists of two equations:

$$\ln E_N = A_0 + A \ln E_M + B \ln E_{US} + FT \qquad (3.1)$$

$$\ln(E_N + E_M) = G_0 + G \ln E_{US} + HT + KW \qquad (3.2)$$

where

E_N = number of non-manufacturing jobs in the region

E_M = number of manufacturing jobs in the region

E_{US} = number of total jobs in the U.S.A.

T = time

W = relative wage rate (average regional wage divided by average U.S. wage).

The first equation is specified to reflect "economic base theory" (see Lane, 1966, and Lowry, 1964) where non-basic (non-manufacturing) employment in the region depends on basic activities (manufacturing jobs) and the level of U.S. demand for local exports expressed by the level of U.S. employment.

The second equation is specified to portray the "regional advantage" of the local economy to business enterprises: the level of total employment in the region is expressed as dependent on the level of U.S. employment and the regional wage advantage expressed by the relative wage rate. Future extension of the model will include the relative regional tax burden and other local amenities and services.

Time is added to both equations to capture temporal changes in the local economy that have not been explicitly modeled. For example, changes in population and location of residence affecting labor supply or spatial decentralization of industrial activities that increase inter-regional trade flows (regional exports and imports).

In order to derive the growth rate from (3.1) we specify a time-dependent version of (3.1)

$$\ln E_N(T) = A_0 + A \ln E_M(T) + B \ln E_{US}(T) + FT \qquad (3.1a)$$

and subtract it from the (T+1) equation

$$\ln E_N(T+1) = A_0 + A \ln E_M(T+1) + B \ln E_{US}(T+1) + F(T+1) \qquad (3.1b)$$

to obtain

$$\ln\left(\frac{E_N(T+1)}{E_N(T)}\right) = A \ln\left(\frac{E_M(T+1)}{E_M(T)}\right) + B \ln\left(\frac{E_{US}(T+1)}{E_{US}(T)}\right) + F \qquad (3.3)$$

or

$$\ln(1+\beta) = A \ln(1+\alpha) + B \ln(1+\delta) + F \qquad (3.4)$$

where

β = growth rate of non-manufacturing jobs in the region

α = growth rate of manufacturing jobs in the region

δ = growth rate of total jobs in the U.S.

For small β, α, δ (say $\alpha, \beta, \delta \leq .05$) we may write $\alpha \approx \ln(1+\alpha)$, $\beta \approx \ln(1+\beta)$, and $\delta \approx \ln(1+\delta)$. Hence (3.4) reduces to

$$\beta = A\alpha + B\delta + F . \tag{3.5}$$

By following similar steps for equation (3.2), we obtain

$$\gamma = G\delta + H + K\Delta W \tag{3.6}$$

where

ΔW = change in the relative wage rate

γ = growth rate of total regional employment $(E_M + E_N)$.

Further, observe that

$$\gamma = S_M\alpha + S_N\beta \tag{3.7}$$

where S_M is the share of manufacturing jobs in the region and $S_N = 1-S_M$ is the share of non-manufacturing employment. Thus by equating (3.6) and (3.7), we obtain a new equation which may then be combined with (3.5) to solve for α and β in terms of δ and ΔW.

Estimation. Direct estimation of (3.1) and (3.2) fits the data well but is plagued with multicollinearity and autocorrelation problems. Estimation of (3.5) and (3.6) instead fails to capture temporal trends, and when T is added to (3.5) problems of collinearity arise. Furthermore, the estimated parameter A is unstable and the general fit of the equations poor. Consequently, slightly modified forms of (3.5) and (3.6) are estimated: Instead of (3.1) or (3.5) we estimate

$$\beta - \alpha = A_0 + B\delta + FT \tag{3.8}$$

and instead of (3.2) or (3.6) we estimate

$$Y = G_0 + G\delta + HT + KW \,. \quad (3.9)$$

The parameter estimates for (3.8) and (3.9) are given in Table 3.1 of the Appendix. These are based on wage and establishment employment data obtained from BEA and BLS, respectively, for the period 1965 through 1983.

A solution for the model may now be derived by equating (3.7) and (3.9) and solving the system of equations:

$$\begin{vmatrix} S_M & S_N \\ -1 & 1 \end{vmatrix} \begin{vmatrix} \alpha \\ \beta \end{vmatrix} = \begin{vmatrix} G_0 + G\delta + HT + KW \\ A_0 + B\delta + FT \end{vmatrix} \quad (3.10)$$

resulting in

$$\alpha = (G_0 - S_N A_0) + (G - S_N B)\delta + (H - S_N F)T + KW \quad (3.11)$$

$$\beta = (G_0 + S_M A_0) + (G + S_M B)\delta + (H + S_M F)T + KW \,. \quad (3.12)$$

Observe that since α and β may yield different growth rates for manufacturing and non-manufacturing, the share of employment in each sector (S_M, S_N) will vary with time. As a result, the parameters preceding δ and T vary with time, implying that $S_N = f(\alpha,\beta)$. Table 3.2 in the Appendix shows the parameters in (3.11) and (3.12) for the years 1965 and 1983. Generally, model estimates suggest that growth in non-manufacturing will moderate faster with time than will growth in manufacturing jobs. Growth in manufacturing jobs is far more dependent on U.S. growth rate than growth in non-manufacturing jobs, but the dependence of non-manufacturing jobs on U.S. growth is increasing at a faster rate than the dependence of growth in manufacturing jobs (see the forthcoming STARLOC Report 6 for further discussion).

The performance of the model solution (3.11) and (3.12) over the estimation period is shown in Figures 3.1 and 3.2.

Calibration of the Model for STARLOC. In order to benchmark equations (3.11) and (3.12) to the year for which the Philadelphia STARLOC Model was constructed, we let

$$C_\alpha^{81} = (G_0 - S_N^{81}A_0) + (H - S_N^{81}F)T_{81} + KW_{81} \quad (3.13)$$

$$C_\beta^{81} = (G_0 + S_M^{81}A_0) + (H + S_M^{81}F)T_{81} + KW_{81} \quad (3.14)$$

and then write

$$\alpha = C_\alpha^{81} + (G - S_N^{81}B)\delta + (H - S_N^{81}F)\Delta T + K\Delta W \quad (3.15)$$

$$\beta = C_\beta^{81} + (G + S_M^{81}B)\delta + (H + S_M^{81}F)\Delta T + K\Delta W \quad (3.16)$$

From inspection of Figure 3.3 we expect the relative wage rate to remain stable in the near future and thus set $\Delta W = 0$ for present forecasts; nor do we adjust other parameters such as $S_N = f(\alpha,\beta)$ and C_α^{81}, as their rates of change are small for a three year horizon. Equations (3.15) and (3.16) will be used to forecast average annual growth rates $\bar{\alpha}$ and $\bar{\beta}$ from a stipulated average annual job growth rate for the U.S., $\bar{\delta}$. Since $\bar{\delta}$ is taken as an average annual growth rate to be sustained over time period ζ, then $\bar{\alpha} = (\alpha_1 + \alpha_2 + \ldots + \alpha_\zeta)/\zeta$. This then implies that ΔT is the "average time period," or $\Delta T = \frac{\zeta}{2}(\zeta+1)/\zeta = \frac{1}{2}(\zeta+1)$.

Sector Equations. To allocate the growth of manufacturing and non-manufacturing sectors to specific industries (9 manufacturing and 14 non-manufacturing) the following equations were estimated:

For manufacturing sectors 3, 5 through 10 (see Table 2.1)

$$\ln E_i = A_i + B_i T + C_i \ln E_M \qquad i = 1,\ldots,8 \quad (3.17)$$

For non-manufacturing sectors 2, 12 through 23

$$\ln E_j = A_j + B_j T + C_j \ln E_N \qquad j = 1,\ldots,12 \tag{3.18}$$

For the sectors 2, 4, 11

$$\ln E_k = A_k + B_k T + C_k \ln(E_M + E_N) \qquad k = 1,2,3 \tag{3.19}$$

where E_i connotes employment in sector i of the regional economy, and A_i, B_i and C_i are associated parameters.

Thus from equation (3.17) we have

$$\ln(1+\alpha_i) = B_i \Delta T + C_i \ln(1+\alpha) \tag{3.20}$$

which is approximated by

$$\alpha_i = B_i \Delta T + C_i \alpha \tag{3.21}$$

where α_i is the growth rate of sector i. When $\bar{\alpha}$ is an average annual growth rate

$$\bar{\alpha}_i = B_i + C_i \bar{\alpha} \tag{3.22}$$

for a time interval ΔT, the growth factor thus becomes

$$1 + \bar{\alpha}_i(\Delta T) = 1 + (B_i + C_i\bar{\alpha})(\Delta T) \; . \tag{3.23}$$

Similarly for equation (18), we derive

$$1 + \bar{\beta}_j(\Delta T) = 1 + (B_j + C_i\bar{\alpha})(\Delta T) \tag{3.24}$$

and for equation (19)

$$1 + \bar{\beta}_k(\Delta T) = 1 + [B_k + C_k(S_M\bar{\alpha} + S_N\bar{\beta})](\Delta T) \; . \tag{3.25}$$

Table 3.3 provides estimates of the B's and the C's for 17 sectors of the Philadelphia economy using establishment employment data obtained from the BLS. These are used to share-down to specific sectors our forecasts of growth rates of jobs in manufacturing and non-manufacturing.

Equations (3.21) - (3.23) are seemingly independent but in fact should be constrained in the estimation to satisfy the condition

$$\sum_{i \varepsilon M} s_i \alpha_i + \sum_{k \varepsilon M} s_k \beta_k = \alpha \qquad (3.26)$$

where s_i, s_k are the shares of employment of specific manufacturing industries in total manufacturing employment ($i,k \varepsilon M$), and

$$\sum_{j \varepsilon N} s_j \beta_j + \sum_{k \varepsilon N} s_k \beta_i = \beta \qquad (3.27)$$

where s_j, s_k are the shares of employment of specific non-manufacturing industries in total non-manufacturing employment of the region ($j,k \varepsilon N$). We apply these conditions subsequent to estimation, adjusting the parameters as follows:

$$B_i^* = B_i + \Delta B_M \qquad i \ \varepsilon \ M \qquad (3.28a)$$

$$B_k^* = B_k + \Delta B_M \qquad k \ \varepsilon \ M \qquad (3.28b)$$

$$B_j^* = B_j + \Delta B_N \qquad j \ \varepsilon \ N \qquad (3.28c)$$

$$B_k^* = B_k + \Delta B_N \qquad i \ \varepsilon \ N \qquad (3.28d)$$

where

$$\Delta B_M = \bar{\alpha} - \left(\sum_{i \varepsilon M} s_i (B_i + C_i \bar{\alpha}) \right) - \left(\sum_{k \varepsilon M} s_k (B_k + C_k \gamma) \right) \qquad (3.29)$$

$$\Delta B_N = \bar{\beta} - \left(\sum_{j \varepsilon N} s_j (B_j + C_j \bar{\beta}) \right) - \left(\sum_{k \varepsilon N} s_k (B_k + C_k \gamma) \right) \qquad (3.30)$$

Incorporation of Growth in STARLOC. At present the STARLOC model does not include an endogenous growth component, because only scant information is available on investment and trade flows in and out of the Philadelhia SMSA. Instead, the above growth model is used to exogenously propel the model to some future state. This procedure does not include the multitude of adjustments entailing, for example, changes in household consumption behavior, labor migration in and out of the region, or inflation effects on interindustry transactions. Rather, it locates the "present" economy in some "future" state where final demand is adjusted in "real" terms to reflect a level of exports, government purchases and investment that would stipulate the level of employment forecasted by the exogenous growth model described in this section.

We do this via equation (2.12) of Section II, by inverting the model to solve for f

$$f^* = (I - A)\hat{a}_0^{-1}(I - Z_a)L_a^* \qquad (3.31)$$

where L_a^* is a forecast obtained from the growth model. f^* is then inserted into the STARLOC model and subjected to the impact of the price and demand submodels, whose descriptions follow.

IV. Price Submodel

The price submodel contains all the necessary adjustments in parameters which follow from an electric rate increase. Four principal price adjustments are discussed:

(i) computation of real electric rate increases

(ii) adjustment of relative prices

(iii) adjustment of real output

(iv) price effects on technical coefficients.

Real Rate Increases. Nominal rate increases for each sector of the economy are converted to real price increases by adjusting for the inflation rate. Inflation rates are computed for each sector of the economy by using sector specific price deflators. For the residential ratepayers and the government sector, the Consumer Price Index (CPI) rates are used. This procedure is a key step in the model as the impact of the rate increase revealed by the demand submodel depends on the relative price increase and not the absolute level.

By way of illustration: Consider a nominal average annual rate increase of 10% over a three-year period, assuming an average annual inflation rate of 6%. The resulting real increase relative to other prices is approximately 4% (actually 3.8%). Now suppose that in the case of the City the rate increase does not apply to street lighting, which constitutes approximately 20% of its total electricity demand. The average annual nominal rate increase for the City as a whole is therefore only 8%, or a 2%

real electric rate increase, implying that the City's real electric rate increase is half that of other customers.

To illustrate the computation of the real rate increase we use a semi-log cost share equation, used extensively in Section VI.

Let S_i denote the cost share of factor input i in total cost, expressed as

$$S_i = \gamma_o + \sum_{j\varepsilon\psi} \gamma_{ij} \ln p_j \qquad (4.1)$$

where ψ is the set of factor inputs and γ_{ij} is a parameter associated with the price of factor input j. Let p_e be the price of electricity, which is raised to p_e^* by a factor of $(1+r_N)$, where r_N is the rate of the nominal price increase. All other prices are assumed to rise at a rate that follows the inflation rate of ϕ. Thus

$$S_i^* = \gamma_{io} + \gamma_{ie} \ln p_e^* + \sum_{j\varepsilon\psi_e} \gamma_{ij} \ln p_j^*$$

$$= \gamma_{io} + \gamma_{ie} \ln[p_e(1+r_N)] + \sum_{j\varepsilon\psi_e} \gamma_{ij} \ln[p_j(1+\phi)] \qquad (4.2)$$

where ψ_e is a subset of ψ exclusive of the price of electricity. By subtracting (4.1) from (4.2), we obtain

$$\Delta S_i = S_i^* - S_i = \gamma_{ie} \ln(1+r_N) + \sum_{j\varepsilon\psi_e} \gamma_{ij} \ln(1+\phi) . \qquad (4.3)$$

Next we add and subtract $\gamma_{ie}\ln(1+\phi)$ and rearrange terms to obtain

$$\Delta S_i = \gamma_{ie} \ln\left(\frac{1+r_N}{1+\phi}\right) + \left(\sum_{j\varepsilon\psi} \gamma_{ij}\right) \ln(1+\phi) . \qquad (4.4)$$

Now, because the homogeneity of the cost share equation with respect to prices is zero, $\sum_{j\epsilon\psi} \gamma_{ij} = 0$, this implies

$$\Delta S_i = \gamma_{ie} \ln(\frac{1+r_N}{1+\phi}) , \tag{4.5}$$

where $(1+r_N)/(1+\phi)$ is the factor increase in the real price of electricity.

$$(\frac{1+r_N}{1+\phi}) = 1 + (\frac{r_N-\phi}{1+\phi}) = 1+r , \tag{4.6}$$

where

$$r = \frac{r_N-\phi}{1+\phi} \tag{4.7}$$

is the rate of the real price increase.

The precision of expression (4.5) depends principally on the magnitude of the variance of the sector specific inflation rates about its mean, relative to the nominal price hike in the electricity sector. In the case of Philadelphia, for a 4% annual inflation rate compounded over three years, inflation stands at 12.5% with a sector standard deviation of 0.47%. In relation to a 28.2% price hike, thirty-three standard deviations away, equation (4.5) offers a very good estimate of real price increase, in this case 13.95%.

Adjustment of Relative Prices. Consider the price balance equation

$$p_1 = \begin{vmatrix} p_1 & p_3 \end{vmatrix} \begin{vmatrix} A_1 \\ A_3 \end{vmatrix} \tag{4.8}$$

where

p_1 = vector of relative prices (or price deflators) for the 23 sectors of the economy

A_1 = matrix of input-output technical coefficients

A_3 = row vector of coefficients of primary inputs (value added) and imports

p_3 = average price of primary inputs and imports.

Since A_1 and A_3 are constructed from financial transactions, initially $[p_1, p_3] = (1,...,1) = e$, a vector with unity for all its components.

Next we partition p_1 and A_1 to single out the electric utility sector in the last column and row respectively (without any loss of generality)

$$p_1 = \begin{vmatrix} p_{11} & p_{21} \end{vmatrix} \qquad A_1 = \begin{vmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{vmatrix}$$

$$A_3 = \begin{vmatrix} A_{31} & A_{32} \end{vmatrix}$$

where p_{11} is a subvector of p_1 of the non-electricity sector, p_{12} is the price deflator of the electricity sector, and A_{11} is the non-electricity submatrix of A_1, with A_{21}, A_{22} and A_{12} constructing the row and column of coefficients corresponding to the electricity sector.

Now we rewrite (4.8) in partitioned form

$$\begin{vmatrix} p_{11} & p_{21} \end{vmatrix} = \begin{vmatrix} p_{11} & p_{21} & p_3 \end{vmatrix} \begin{vmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \\ A_{31} & A_{32} \end{vmatrix} \qquad (4.9)$$

or from the first 22 equations

$$p_{11} = p_{11}A_{11} + p_{21}A_{21} + p_3A_{31} \qquad (4.10)$$

implying

$$p_{11} = (p_{21}A_{21} + p_3A_{31})(I - A_{11})^{-1} \; . \qquad (4.11)$$

Observe that $p_3=1$ (we are keeping changes in wage rates exogenous to the model) and that

$$p_{21} = 1 + r \tag{4.12}$$

where r = the rate of change in real price of electricity. By inserting (4.12) and $p_3=1$ into (4.11), we obtain

$$p_{11} = (A_{21} + A_{31})(I - A_{11})^{-1} + rA_{21}(I - A_{11})^{-1} \tag{4.13}$$

but

$$e = eA_{11} + A_{21} + A_{31} \tag{4.14}$$

implying

$$e = (A_{21} + A_{31})(I - A_{11})^{-1} \tag{4.15}$$

Hence (4.13) reduces to the price multiplier adjustment equation

$$p_{11} = e + rA_{21}(I - A_{11})^{-1} . \tag{4.16}$$

Equation (4.16) gives the indirect effect of electric rate increases on relative prices in the economy; a secondary price deflator.

Adjustment of Real Output. The change in relative prices requires a change in the "quantity" transactions of the economy because the labor coefficients are defined in reference to real output levels. Let y denote the final demand and Ax the intermediate demand of the economy (expressed in dollar terms) after the economy has undergone an r rate of increase in electric rates. The resulting vector of price deflators is

$$p_1 = [(e + rA_{21}(I-A_{11})^{-1}), (1+r)] \tag{4.17}$$

obtained from (4.16). Let $\hat{p}_1 = \text{diag}(p_1)$, then the real intermediate demand is $\hat{p}^{-1}Ax$ and real final demand is $\hat{p}^{-1}y$, giving rise to a real output level of

$$x = \hat{\beta}^{-1} Ax + \hat{\beta}^{-1} y \quad (4.18)$$

and the solution to the multiplier

$$x = (\hat{\beta}_1 - A)^{-1} y . \quad (4.19)$$

Price Effects on Technical Coefficients. Ordinarily as prices vary in the economy over time, "real" transactions need adjustment as well. Since our model does not track transactions over time (which would entail updating model parameters to some future state) but rather is a "comparative statics" type of analysis applied to a simulated state of the economy, temporal price adjustments are not included. The procedure for price adjustment in technical coefficients is well known (see Paelinck and Nijkamp, 1975, p. 273). The new matrix of technical coefficients is then

$$A^* = \hat{q} A \hat{q}^{-1} \quad (4.20)$$

where $\hat{q}$ = diag(q) and q is the vector of temporal price deflators. Any temporal adjustment in the model benchmark year would require this adjustment as well, but would not be limited only to this case. For example, household expenditures and the income distribution of households must be adjusted as well.

V. Residential Energy: Demand Submodel

The change in real price of electricity alters the pattern of its use by households, industry and government. In this section we describe our approach to estimating the change in demand for electricity and other energy resources by residential rate payers. This is an important component of the model since households account for approximately one-third of electricity demand in the SMSA. Although residential demand equations have been estimated by a number of authors (see Bohi, 1981, for a review of the literature), these studies do not suit our objectives for several reasons:

(i) demand elasticities are not available by income group; with the large number of households below poverty level in the Philadelphia region it becomes especially important to assess the financial burden of different income groups

(ii) demand elasticities are not available by region; since patterns of energy use vary by climate, housing characteristics and household attributes which differ among regions, it is necessary to provide estimates which correspond to local conditions

(iii) past estimates of demand elasticities provide adequate specification for economic variables but omit (at least partially) many important variables such as appliance stock, dwelling structure, demographic characteristics, etc.

(iv) few studies provide estimates of cross-price elasticities; i.e., change of demand for other energy sources (gas, fuel oil) in response to change in the electricity price

(v) long- and short-term elasticities are rarely computed from the same data base, making comparisons between long- and short-term estimates difficult.

To overcome these difficulties, we undertook the estimation of a residential energy demand model using data from the Residential Energy Consumption Survey (1981), which is reported elsewhere (see STARLOC Report 4, forthcoming). Here we present a succinct summary of the model specifications and estimated parameters.

Specification of equations. The general form of the estimated equations is:

$$\ln Q_e = \xi_e(P,C,D,W,H,A,V) \tag{5.1}$$

where

Q_e = consumption of electricity measured in Kwh

{P} = vector of energy prices including electricity, natural gas and fuel oil, liquefied petroleum gas (4 variables)

{C} = vector of income by source including household earnings, public assistance and unemployment benefits (3 variables)

{D} = vector of demographic characteristics reflecting age, race, gender of head of household, number of children and level of education (6 variables)

{W} = climatic conditions measured by cooling and heating degree days (2 variables)

{H} = vector of dwelling characteristics reflecting the age, size, ownership, detached/attached structure, number of windows and floors, and insulation (14 variables)

{A} = vector of appliance stocks or end-use variables of energy such as space heating, cooking fuel, air conditioning, water heating fuel, washer/dryer, television, refrigerator, etc. (17 variables)

{V} = policy variables such as energy assistance, utility vouchers and other direct energy aid (4 variables).

Only 44 of the above 50 variables were used in the estimation in order to circumvent problems of multicollinearity. Similar equations were specified for Q_g (natural gas) and Q_o (fuel oil). Parameters were estimated for nine U.S. regions, but only estimates of the Mid-Atlantic Region were used in the Philadelphia STARLOC model.

Demand Elasticities. To differentiate between long- and short-term parameters we use a novel approach entailing a modification in the specifications of equation (5.1), which is used for the estimation of short-term elasticities. For the estimation of long-term elasticities, we omit the 17 appliance stock variables and the 4 policy variables since we expect technology to change and become more energy efficient as the price of electricity rises. We retain, however, the climate, demographic and dwelling characteristics which we do not expect to change in response to an electric price rise. The natural gas equation is the exception: cooking fuel is retained for estimates of cross-price elasticities of existing housing stock and omitted for estimates of new construction.

Income specific elasticities were estimated by replacing the household earnings variable with six intervals of electric price corresponding to the six income groups of the STARLOC model. The estimated equation has the form

$$\ln Q_e = \gamma_{eo}^{re} \ln p_e + \sum_{i=1}^{5} d_i (\Delta\gamma_{ei}^{re}) \ln p_{ei} + \xi_e^o(C_o,D,W,H,A,V) \qquad (5.2)$$

where γ_{eo}^{re} is the parameter of residential electricity demand elasticity (denoted by the superscript re) with respect to the price of electricity (denoted by the subscript e) of an omitted income group (denoted by o). The parameter, $(\Delta\gamma_{ei}^{re})$, reflects the deviation of the elasticity for income group i from that of income group o; and d_i is a zero-one variable: $d_i=1$ when the household (observation) is in the ith income group and $d_i=0$ otherwise.

After estimation of (5.2) the income group specific elasticities are constructed via

$$\gamma_{ei}^{re} = \gamma_{eo}^{re} + \Delta\gamma_{ei}^{re} \qquad i = 0,\ldots,5 \qquad (5.3)$$

The resulting elasticities are reported in Table 5.1 (discussion). Figures 5.1 compares these own price elasticities of electricity across nine regions of the U.S. Estimates for other variables of the model are provided elsewhere (see STARLOC Report 4, forthcoming).

For notational simplicity we suppress the income subscript and use $Z_e = \xi_e(P,C,D,W,H,A,V)$ to connote all other variables in equation (5.1). The general form of the equation is thus

$$\ln Q_e = \gamma_e^{re} \ln p_e + Z_e \qquad (5.4)$$

with parameters

$$\frac{\partial \ln Q_e}{\partial \ln p_e} = \gamma_e^{re} \qquad (5.5)$$

connoting the electricity demand elasticity with respect to electric price, holding all other factors constant.

STARLOC Residential Demand Equations. To adapt the estimated demand equations to the Philadelphia STARLOC model, we apply equation (5.4) to the share of household expenditures on electricity, which is a row in the consumption pattern matrix M in equation (2.7) of section II. The share equation is derived from (5.4) by adding $\ln p_e$ and subtracting lnExp from both sides of the equation, where Exp reflects total household expenditures

$$\ln Q_e + \ln p_e - \ln Exp = \gamma_e^{re} \ln p_e + Z_e + \ln p_e - \ln Exp \quad (5.6)$$

resulting in the expression

$$\ln S_e^{re} = (1 + \gamma_e^{re}) \ln p_e + (Z_e - \ln Exp) \quad (5.7)$$

where

$$S_e^{re} = \frac{p_e Q_e}{Exp}$$

is the share of household expenditures on electricity.

For gas and fuel oil, equation (5.4) is replaced with

$$\ln Q_g = \gamma_e^{rg} \ln p_e + Z_g \quad (5.8)$$

$$\ln Q_f = \gamma_e^{rf} \ln p_e + Z_f \quad (5.9)$$

where the subscripts g and f connote the gas and fuel oil equations and associated parameters. To derive the share equations for gas and fuel oil, add $\ln p_g$ and $\ln p_f$, respectively, and subtract lnExp, resulting in

$$\ln S_g^{rg} = \gamma_e^{rg} \ln p_e + [Z_g + \ln p_g - \ln Exp] \quad (5.10)$$

where

$$S_g^{rg} = \frac{p_g Q_g}{Exp}$$

and

$$\ln S_f^{rf} = \gamma_e^{rf} \ln p_e + [Z_f + \ln p_f - \ln Exp] \tag{5.11}$$

where

$$S_f^{rf} = \frac{p_f Q_f}{Exp} .$$

Now consider change in the price of electricity from p_e to p_e^*. From equation (5.7) we have

$$\ln S_e^{re}* = (1 + \gamma_e^{re})\ln p_e^* + (Z_e - \ln Exp) \tag{5.12}$$

By subtracting (5.7) from (5.12) and by following the procedure outlined in (4.1) - (4.7), we obtain

$$\ln(\frac{S_e^{re}*}{S_e^{re}}) = (1 + \gamma_e^{re})\ln(1 + r) \tag{5.13}$$

where r is the rate of change in real electricity price, assuming a ϕ rate of inflation

$$r = \frac{(\frac{p_e^* - p_e}{p_e}) - \phi}{1 + \phi} . \tag{5.14}$$

Next, by solving for the new share of expenditure on electricity, we obtain the equation

$$S_e^{re}* = S_e^{re}(1 + r)^{(1 + \gamma_e^{re})} \tag{5.15}$$

and

$$\Delta S_e^{re} = S_e^{re}* - S_e^{re} \tag{5.16}$$

The natural gas and fuel oil equations are derived in a similar manner. From (5.10)

$$S_g^{rg}* = S_g^{rg}(1 + r)^{\gamma_g^{rg}} \tag{5.17}$$

and

$$\Delta S_g^{rg} = S_g^{rg}* - S_g^{rg} . \tag{5.18}$$

From (5.11)

$$S_f^{rf}* = S_f^{rf}(1 + r)^{\gamma_f^{rf}} \tag{5.19}$$

and

$$\Delta S_f^{rf} = S_f^{rf}* - S_f^{rf} \tag{5.20}$$

Finally,

$$\Delta S_m^{rm} = -(\Delta S_e^{re} + \Delta S_g^{rg} + \Delta S_f^{rf}) \tag{5.21}$$

where ΔS_m^{rm} connotes household expenditures on non-energy commoditites.

VI. Demand Submodel: Industrial, Commercial, Labor and Government

The portion of the demand submodel that deals with the industrial and commercial sectors was inspired by Hudson and Jorgenson's 1974 paper which was the first to incorporate explicit demand equations into the definition of technical coefficients of the Leontief model. To the extent feasible, we are departing from Hudson-Jorgenson's approach and other related empirical studies (see Halvorsen, 1978; Uri, 1982; Halvorsen and Ford, 1979, Berndt and Wood, 1975; and Bohi, 1981) by avoiding direct reference to a translog minimun cost function. This circumvents an important shortcoming in the Hudson-Jorgenson formulation, which assumes an underlying production function for the transactions of an aggregate sector level Leontief economy and a duality between cost and production at that level of aggregation. These assumptions are present, however, inasmuch as we use the estimates of share equations to derive parameters for the Philadelphia STARLOC Model (Halvorsen, 1978; Hudson and Jorgenson, 1974).

This section consists of three parts:

(i) Industrial and own- and cross-price elasticities (Table 6.1)

(ii) Labor cross-price elasticities (Table 6.2)

(iii) Commercial and government elasticities (Table 6.3).

Industrial Elasticities. Our methodological approach is based on the availability of parameter estimates of cost share equations (specified in the literature as elasticities of translog cost functions). These equations usually have the form

$$S_{ej} = \gamma_e^{ej} \ln p_e + Z_{ej} \qquad (6.1)$$

where S_{ej} is the cost share expended on electricity by sector j, and γ_e^{ej} is a parameter associated with the price of electricity (subscript) of the electricity demand equation of sector j (superscript). Z_{ej} connotes a vector of other variables in logarithm form which includes the prices of other energy fuels (gas, fuel oil, coal products), labor and material as well as total output.

When (6.1) is subjected to a new electric rate, say p_e^*,

$$S_{ej}^* = \gamma_e^{ej} \ln p_e^* + Z_{ej} \tag{6.2}$$

then by subtracting (6.2) from (6.1), following the procedure (4.1) - (4.7), we obtain

$$\Delta S_{ej} = S_{ej}^* - S_{ej} = \gamma_e^{ej} \ln(1+r) \qquad j=1,\ldots,23 \tag{6.3}$$

where r = the real increase in electricity rate defined in (5.14).

With equations similar to (6.2) available for gas, oil and coal, we may derive the following equations:

For gas

$$\Delta S_{gj} = \gamma_e^{gj} \ln(1+r) \tag{6.4}$$

For fuel oil

$$\Delta S_{fj} = \gamma_e^{fj} \ln(1+r) \tag{6.5}$$

For coal

$$\Delta S_{cj} = \gamma_e^{cj} \ln(1+r) . \tag{6.6}$$

Next observe that the A_{ij} coefficient of the Leontief table corresponds to the share of factors in the production process. Equations

(6.3) through (6.6) provide the change in these technical coefficients of the Leontief multiplier in equation (2.1) of Section II.

Although we make no direct use of demand elasticities, these are obtainable through application of Shepard's lemma to twice differentiable industry minimum cost functions. The own-price elasticities

$$\eta_{ee}^{j} = \frac{S_{ej}^{2} - S_{ej} + \gamma_{e}^{ej}}{S_{ej}} \qquad (6.7)$$

and the cross-price elasticities

$$\eta_{ke}^{j} = \frac{S_{ej}S_{kj} + \gamma_{e}^{kj}}{S_{kj}} \qquad (6.8)$$

where k = g,o,c (see Berndt and Wood, 1975; Halvorsen, 1978, and Halvorsen and Ford, 1979).

Equations (6.7) and(6.8) can be used in two ways. The first is to derive local own- and cross-price elasticities using the parameters γ_{e}^{ej} and γ_{e}^{kj} obtained from studies using U.S. data and the shares S_{ej}, S_{kj} of the local economy. The second use of (6.7) and (6.8) entails solution for γ_{e}^{ej} and γ_{e}^{kj}

$$\gamma_{e}^{ej} = S_{ej}(\eta_{ee}^{j} + 1 - S_{ej}) \qquad (6.9)$$

$$\gamma_{e}^{kj} = S_{kj}(\eta_{ke}^{j} - S_{ej}) \qquad (6.10)$$

Table 6.1 gives the industrial and commercial elasticities derived in this manner of "localizing" industry-wide estimates. These were obtained using equations (6.7) - (6.8). When elasticities obtained from the literature are used, (6.9) - (6.10) are applied to derive the cost share γ coefficients (See STARLOC Report 3, forthcoming).

Labor Elasticities. Cross-price elasticities of substitution for labor and electricity require special derivation because they are available for only a few select industries (see Hudson and Jorgenson, 1974) and need to be derived from aggregate models on the relationshp between energy and labor (the KLEM model of Hudson and Jorgenson, 1974; and Berndt and Wood, 1975) and between energy and electricity (see energy models of Hudson and Jorgenson, 1974;and Halvorsen, 1978).

From the KLEM model we have the equation

$$S_{Lj} = \gamma_E^{Lj} \ln p_E + Z_L \tag{6.11}$$

where

$$S_{Lj} = \frac{L_j p_{Lj}}{x_j} = (\frac{L_j}{x_j})p_{Lj} = a_{oj}p_{Lj} \tag{6.12}$$

is the cost share of labor for sector j, p_{Lj} is the wage rate, L_j is the level of establishment employment, and E connotes an energy parameter which includes electricity, gas, fuel oil, and coal.

From (6.11)

$$\frac{\partial S_{Lj}}{\partial \ln p_E} = \gamma_E^{Lj} \tag{6.13}$$

but we want

$$\frac{\partial S_L}{\partial \ln p_e} = \frac{\partial S_{Lj}}{\partial \ln p_E} \frac{\partial \ln p_E}{\partial \ln p_e} \tag{6.14}$$

Assuming cost-minimizing of energy factor inputs, from the price frontier equation of the energy model (see Hudson, 1981) we have

$$\frac{\partial \ln p_E}{\partial \ln p_e} = S^j_{e/E} \tag{6.15}$$

where $S_{e/E}$ is the cost share of electricity in total energy cost

$$S^j_{e/E} = \frac{S_{ej}}{S_{ej} + S_{gj} + S_{fj} + S_{cj}} = \frac{S_{ej}}{S_{Ej}} \tag{6.16}$$

where S_{Ej} is the cost share of energy in the cost of production. By inserting (6.15) and (6.13) into (6.14), we obtain

$$\frac{\partial S_{Lj}}{\partial \ln p_e} = \gamma^{Lj}_E S^j_{e/E} \tag{6.17}$$

However, to derive the price effect on the labor coefficients, we note in (6.12) that

$$\frac{\partial S_{Lj}}{\partial \ln p_e} = \left(\frac{\partial a_{oj}}{\partial \ln p_e}\right) p_{Lj} \tag{6.18}$$

because real wage rates remain unchanged in the present formulation of the model. Hence for (6.17) and (6.18) we have

$$\frac{\partial a_{oj}}{\partial \ln p_e} = \left(\frac{1}{p_{Lj}}\right) \gamma^{Lj}_E S^j_{e/E} \tag{6.19}$$

The difficulty with our approach so far is that (6.17) and (6.19) are derived parameters, and unlike the industrial elasticities, no share equations for labor cost were estimated in the literature. We therefore apply a Taylor equation to develop a two-term expansion for S^*_{Lj} and a^*_{oj}, about the points S_{Lj} and a_{oj}.

$$S^*_{Lj} = S_{Lj} + \sum_{k\epsilon\psi} \left(\left.\frac{\partial S_{Lj}}{\partial \ln p_k}\right|_u\right)(\ln p^*_k - \ln p_k) \tag{6.20}$$

where the derivatives are to be evaluated at point vector u with element

$$u_k = \ln p_k + \sigma(\ln p^*_k - \ln p_k) , \quad 0<\sigma<1 , \quad k\epsilon\psi \tag{6.21}$$

in the interval between $\ln p_k$ and $\ln p_k^*$. Equation (6.20) is an exact form (not an approximation) which may be further simplified by observing that $(\ln p_e^* - \ln p_e) = \ln(1+r_N)$ and $(\ln p_k^* - \ln p_k) = \ln(1+\phi)$, $k \epsilon \psi_e$. See (4.1) - (4.7). Hence

$$\Delta S_{Lj} = S_{Lj}^* - S_{Lj} = \left.\frac{\partial S_{Lj}}{\partial \ln p_e}\right|_u \ln(1+r) + \Big(\sum_{k\epsilon\psi} \left.\frac{\partial S_{LJ}}{\partial \ln p_e}\right|_u\Big)\ln(1+\phi) \qquad (6.22)$$

where r is as defined in (5.14) and

$$u_e = \ln p_e + \sigma \ln(1+r_N) \qquad 0<\sigma<1 \qquad (6.23)$$

$$u_k = \ln p_k + \sigma \ln(1+\phi) \qquad k\epsilon\psi_e \qquad (6.24)$$

Note that the first order derivative $\partial S_{Lj}/\partial \ln p_e$ is available from (6.17) and that the second term on the right hand side of (6.22) is zero because of the zero-homogeneity of the share equation with respect to factor prices. To evaluate the derivatives at u we first insert (6.23) - (6.24) into the share equation of the energy model (Halvorsen, 1978)

$$S_{e/E}^j = \gamma_{eo}^E + \sum_{k\epsilon\psi} \gamma_{ek}^E \ln p_k \qquad (6.25)$$

and

$$S_{e/E}^j(u) = \gamma_{eo}^E + \sum_{k\epsilon\psi} \gamma_{ek}^E \ln u_k$$

$$= S_{e/E}^j + \sigma\gamma_{ee}^E \ln(1+r) + \sigma\Big(\sum_{k\epsilon\psi}\gamma_{ek}^E\Big)\ln(1+\phi) \qquad (6.26)$$

Because $\sum_{k\epsilon\psi} \gamma_{ek}^E = 0$ we obtain

$$S_{e/E}^j(u) = S_{e/E}^j + \sigma\gamma_{ee}^E \ln(1+r) \qquad (6.27)$$

Next, by inserting (6.26) into (6.17), and then (6.17) into (6.22), we obtain

$$\Delta S_{Lj} = \gamma_E^{Lj} S_{e/E}^j \ln(1+r) + \sigma\gamma_E^{Lj}\gamma_{ee}^E\big(\ln(1+r)\big)^2 \qquad (6.28)$$

where $\sigma = 1/2$ has been shown in Schinnar and Chao (1985), and where γ_E^{Lj} are parameters of the KLEM model and γ_{ee}^E are parameters of the energy model. The labor cross-price elasticities used in the STARLOC model are given in Table 6.2.

To obtain the change in the labor coefficients, we draw on equation (6.18) to conclude that Δa_{oj} is but a scalar multiple of (6.28). Hence the changes in labor coefficients are obtained via

$$\Delta a_{oj} = \left(\frac{1}{p_{Lj}}\right)\Delta S_{Lj} \tag{6.29}$$

<u>Comment</u>. Having obtained the change in all energy sectors and wage bills through own- and cross-price elasticities (equations (6.3)-(6.6) and (6.28)), we adjust the remaining technical coefficients in the input-output table by redistributing the residuals across all other sectors (except imports)

$$\Delta S_{mj} = -(\Delta S_{Lj} + \sum_k \Delta S_{kj}) \tag{6.30}$$

where $k = e,g,f,c$.

<u>Commercial and Government Elasticities</u>. Studies with estimates of elasticities for non-manufacturing sectors are few (see Bohi, 1981). The few estimates available are at the aggregate service sector level (see Table 6.1). We followed the procedure outlined for the industrial elasticities, specifically equations (6.9) and (6.10), to obtain industry specific γ_e^{ej} parameters. Although these figures appear reasonable on average, as sector-specific "estimates" they leave much to be desired. However, information on

the service sector in general has only taken on priority in recent years and very little detailed information is presently available.

In regards to government, no estimates could be found. We proceeded to estimate demand equations for the City of Philadelphia with data on energy consumption for the years 1972 through 1984. Data included annual consumption levels and prices of electricity (e), natural gas (g), fuel oil (f), and steam (s). Because of limited data and severe collinearity problems, the final model estimated was

$$\ln Q_k = \gamma_o^{Gk} + \gamma_e^{Gk}\ln(p_e/p_g) + \gamma_f^{Gk}\ln(p_f/p_s) + \gamma_L^{Gk}\ln p_{LG} \qquad (6.31)$$

where p_{LG} is the government wage rate. The estimated parameters are given in Table 6.3.

Derivation of the elasticities and expenditures closely follow the steps taken in equations (5.6) - (5.20) for the residential demand equations in Section V. Here we focus instead on expenditure levels rather than shares; hence by adding $\ln p_k$ to both sides of equation (6.31) we obtain for the electricity expenditure equation

$$\ln(p_e Q_e) = (1 + \gamma_e^{Ge})\ln p_e + Z_e^G \qquad (6.32)$$

or with a new price hike

$$\ln(p_e^* Q_e^*) = (1 + \gamma_e^{Ge})\ln p_e^* + Z_e^G \qquad (6.33)$$

By subtracting (6.32) from (6.33), incorporating inflation as in (4.1) - (4.7), and solving for $\Delta Exp^G(e)$, the change in government expenditures on electricity

$$\Delta Exp^G(e) = p_e^* Q_e^* - p_e Q_e = (p_e Q_e)[(1 + r)^{(1 + \gamma_e^{Ge})} - 1] \qquad (6.34)$$

Similarly, for natural gas, fuel oil and steam, we obtain

$$\Delta Exp^{G}(g) = p_g(Q^*_g - Q_g) = (p_g Q_g)[(1 + r)^{\gamma_e^{Gg}} - 1] \quad (6.35)$$

$$\Delta Exp^{G}(f) = p_f(Q^*_f - Q_f) = (p_f Q_g)[(1 + r)^{\gamma_e^{Gf}} - 1] \quad (6.36)$$

$$\Delta Exp^{G}(s) = p_s(Q^*_s - Q_s) = (p_s Q_s)[(1 + r)^{\gamma_e^{Gs}} - 1] \quad (6.37)$$

The residual change in expenditures, (i.e., $-\sum_k \Delta Exp^{G}(k)$) was allocated proportionately among other non-energy categories of the government's final demand. For further discussion on the government energy demand elasticities see the forthcoming STARLOC Report 4.

VII. Conclusion

This adaptation of the Philadelphia STARLOC Model to simulate energy price policy is but one possible application of the model to regional policy analysis. A number of extensions are currently under consideration, designed to serve local government and the business community in evaluating various economic issues of public concern. Possible applications include government revenue forecasting, wage tax impact on location of business enterprises, employment multipliers of commercial development in the City, and analysis of the economic impact of fare or rate increases of various local utilities and services. Of special interest are the growth and cost of the local health sector, the impact of federal fiscal policy (such as tax reform) on the regional job market, and the impact of local prices on interregional trade flows.

In its present form, the Philadelphia STARLOC Model has been used to evaluate the economic impact of PECO's pending request for electric rate increases. A summary of the analysis is available in the form of a testimony submitted to the PUC on January 14, 1986 (see also STARLOC Report 2, forthcoming). It should be noted, however, that in its present form the model does not portray the economic consequences of PECO's failure to secure the necessary revenues or the city government's possible response to the additional financial burden it might face as a consequence of the electric rate increase (see Figure 7.1). Two additional components in the model would address these issues.

The first is a representation which links PECO's performance in the capital market with its performance as a local electric utility. For example, although much of the risk associated with ratebasing of Limerick units is already reflected in the current values of PECO's stock and bond issues, it is possible that lower than expected revenues will increase investors perceived risk, thus necessitating an increase in the rate of return for PECO's units, which in turn could lead to higher electricity rates. It would be useful to have a component added to the model that simulates these effects.

A second addition would link the change in City government revenues and expenditures (resulting from loss of job growth, higher electric bills, and increased demand for public services by the lower income households) to the City's tax policy. For example, the prospect of a City budget deficit may force the City to raise its taxes, thus increasing the cost of doing business in Philadelphia and further compounding the adverse effect that a price hike may have on the attractiveness of the City to the business community.

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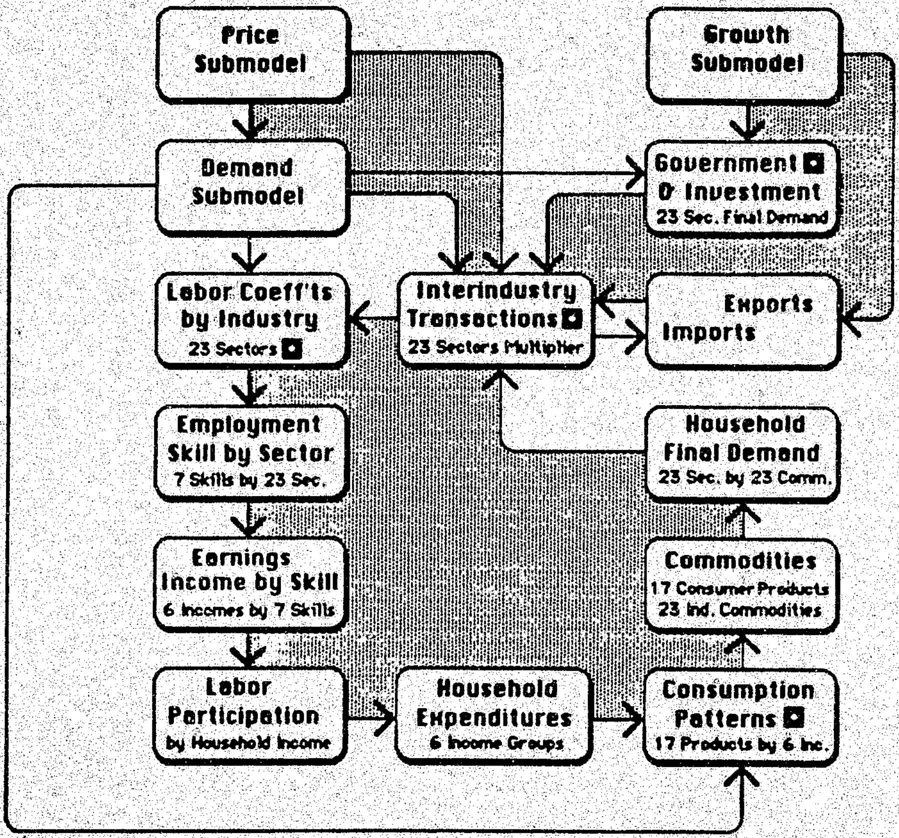

Price Submodel
Growth Submodel
Demand Submodel
Government & Investment
23 Sec. Final Demand
Labor Coeff'ts by Industry
23 Sectors
Interindustry Transactions
23 Sectors Multiplier
Exports
Imports
Employment Skill by Sector
7 Skills by 23 Sec.
Household Final Demand
23 Sec. by 23 Comm.
Earnings Income by Skill
6 Incomes by 7 Skills
Commodities
17 Consumer Products
23 Ind. Commodities
Labor Participation
by Household Income
Household Expenditures
6 Income Groups
Consumption Patterns
17 Products by 6 Inc.

figure 1.1

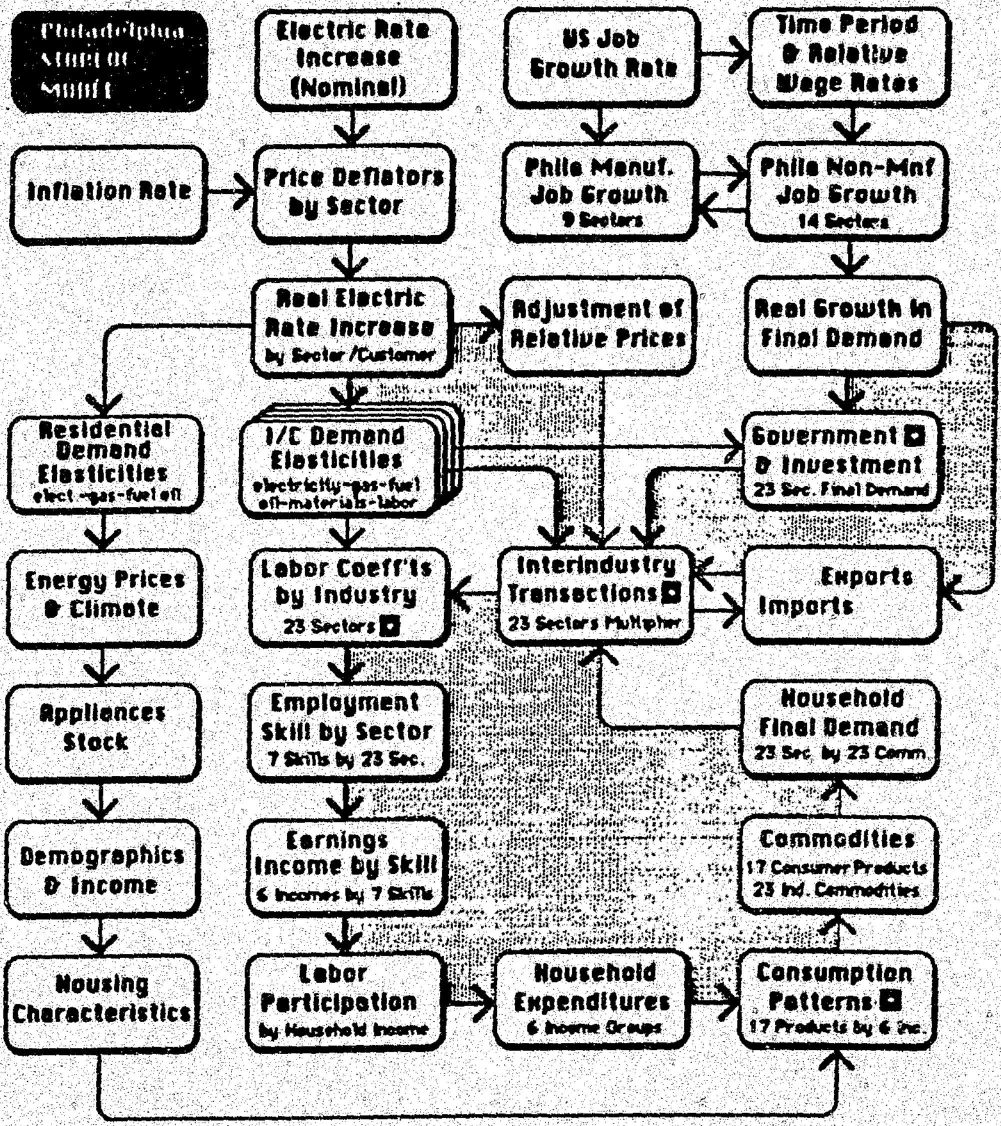


figure 1.2 The STARLOC Model

TABLE 2.1

Philadelphia Starloc Model
Policy Modeling Workshop

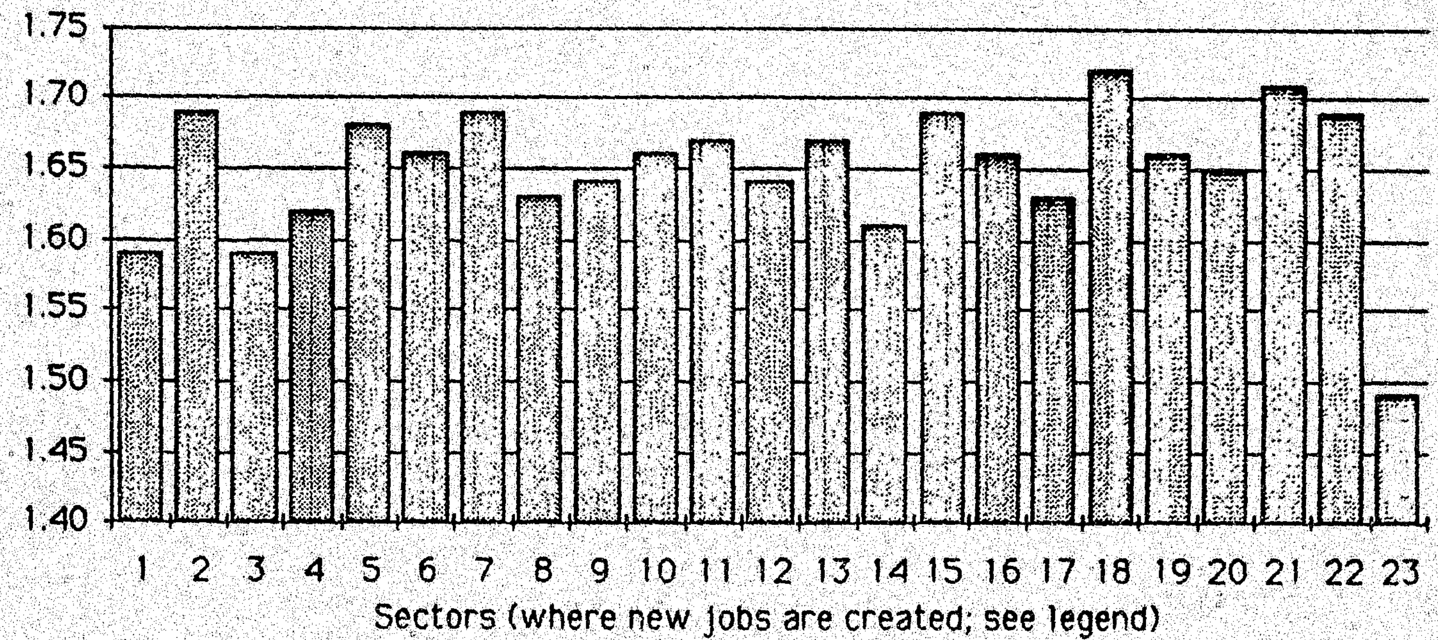
ECONOMIC SECTORS	SIC numbers
1. Agriculture and mining	01,02,07 through 14
2. Contract construction	15,16,17
Manufacturing	
3. Food; tobacco; textiles; apparel & fabrics	20,21,22,23
4. Lumber and wood, furniture and fixtures	24,25
5. Paper and allied products; printing and publishing	26,27
6. Chemicals, rubber and plastics; leather and leather products	28,30,31
7. Petroleum and coal products	29
8. Stone, clay and glass; miscellaneous manufacturing	32,39
9. Fabricated and primary metals	33,34
10. Machinery and electrical equipment	35,36
11. Transportation equipment and instruments	37,38
Non-manufacturing	
12. Transportation and communications, excluding railroads	41 through 48
13. Wholesale trade	50,51
14. Retail trade	52 through 59
15. Finance, Insurance and real estate	60 through 67
16. Advertising and business services	73
17. Health services	80
18. Educational services	82
19. Other services (personal care, legal, etc.); government enterprises; water supply and sanitary service	72,75 through 79,81,83,84,86, 88,89,91 through 97,494,495
20. Railroads and related	40
21. Electric utilities	491
22. Gas utilities	492
23. Hotels and lodging places	70

figure 2.1

Philadelphia SMSA Starloc Model

Job Multipliers by Sector

(Total gain in employment per each new job created)



Wharton PMW 11.4.1985 □ University of Pennsylvania

TABLE 2.2

Philadelphia Starloc Model
Policy Modeling Workshop
Wharton School of the University of Pennsylva
January, 1986

		Output by Sector (millions)	Employmen by Sector
(1)	Ag & Mining	854.89	17782
(2)	Const	5888.57	105380
(3)	FdTexApp	7010.94	82067
(4)	LumbFurn	510.54	8032
(5)	PapPrt	4480.87	62749
(6)	ChRubPlL	6587.51	54285
(7)	Petro Coal	11148.14	13292
(8)	StCy Misc	1649.81	23632
(9)	Metals	4986.83	64850
(10)	ElecEqMa	6140.39	100962
(11)	InsTrEq	2856.39	51938
(12)	TC	4023.83	84749
(13)	WT	6203.82	122474
(14)	RT	8295.23	321800
(15)	FIR	13782.21	146398
(16)	AdvBuSv	2708.04	85671
(17)	HealthSv	4855.6	146807
(18)	EducSv	1286.09	65664
(19)	OthSvGov	11037.87	468775
(20)	R & R	760.13	20060
(21)	ElecUtils	2500.68	11800
(22)	GasUtils	995.27	3883
(23)	Hotels	327.69	13033
	Total	104436.8	2076087

TABLE 2.3

Philadelphia Starloc Model
Policy Modeling Workshop
Wharton School of the University of Pennsylvania
January, 1986

Relative Occupational Distribution
by Sector

Occupation

		Prof & Tech	Mgrs, Adm Cler	Sales	Craft & Kindred	Operative & Laborer	Service Wkers	Farm Wkers
(1)	Ag & Mini	0.009	0.003	0.001	0.003	0.015	0.001	1
(2)	Const	0.01	0.029	0.003	0.232	0.062	0.003	0
(3)	FdTexApp	0.009	0.022	0.017	0.043	0.143	0.008	0
(4)	LumbFurn	0.001	0.002	0.001	0.008	0.011	0.001	0
(5)	PapPrt	0.022	0.028	0.03	0.066	0.04	0.003	0
(6)	ChRubPlL	0.028	0.021	0.02	0.03	0.051	0.005	0
(7)	Petro Coa	0.009	0.005	0.001	0.01	0.009	0.001	0
(8)	StCy Misc	0.005	0.008	0.005	0.018	0.03	0.002	0
(9)	Metals	0.013	0.019	0.006	0.069	0.079	0.006	0
(10)	ElecEqMa	0.052	0.035	0.009	0.069	0.106	0.007	0
(11)	InsTrEq	0.028	0.018	0.004	0.044	0.047	0.004	0
(12)	TC	0.016	0.047	0.007	0.05	0.091	0.008	0
(13)	WT	0.019	0.084	0.146	0.054	0.07	0.006	0
(14)	RT	0.022	0.178	0.443	0.09	0.11	0.273	0
(15)	FIR	0.022	0.147	0.236	0.007	0.005	0.019	0
(16)	AdvBuSv	0.05	0.055	0.044	0.018	0.011	0.055	0
(17)	HealthSv	0.152	0.049	0.001	0.015	0.008	0.169	0
(18)	EducSv	0.1	0.022	0.001	0.004	0.004	0.032	0
(19)	OthSvGov	0.424	0.206	0.021	0.117	0.082	0.367	0
(20)	R & R	0.002	0.009	0	0.025	0.019	0.002	0
(21)	ElecUtils	0.005	0.005	0.001	0.02	0.003	0.001	0
(22)	GasUtils	0.001	0.002	0	0.005	0.001	0	0
(23)	Hotels	0.001	0.006	0	0.001	0.001	0.029	0
	Total	394520	672760	128738	257476	338456	278240	5896

TABLE 2.4

Philadelphia Starloc Model
Policy Modeling Workshop
Wharton School of the University of Pennsylvania
January, 1986

Occupation by Income Group
Coefficients

Occupation

Income Groups ($1000)	Prof & Tech	Mgrs, Adm Cler	Sales	Craft & Kindred	Operative & Laborer	Service Wkers	Farm Wkers
0-5	0.102	0.151	0.233	0.08	0.18	0.41	0.329
5-10	0.104	0.192	0.146	0.104	0.204	0.251	0.236
10-15	0.155	0.183	0.12	0.16	0.199	0.136	0.179
15-20	0.21	0.155	0.136	0.255	0.216	0.116	0.11
20-25	0.138	0.093	0.099	0.179	0.113	0.054	0.049
25+	0.291	0.226	0.266	0.222	0.089	0.034	0.097

TABLE 2.5

Philadelphia Starloc Model
Policy Modeling Workshop
Wharton School of the University of Pennsylvania

January, 1986

Inter-Industry Multiplier
(scaled by factor of 100)

(1)	AgMing	108.7	0.3	1.7	0.2	0.1	0.6	0.2	1.6	0.4	0.1	0	0.2	0.1	0.3	0.1	0	0.2	0.5	0.1	0.1	1.3	0.1	0.4
(2)	Const	1.3	100.3	0.5	0.6	0.9	1.4	1.7	1.3	1.4	0.6	0.6	2.2	0.7	1.2	4.2	0.9	2.6	3.1	0.8	14.7	6.6	2.9	4
(3)	FdTexApp	1	0	102.2	0.3	0.1	0.1	0	0.1	0	0	0.1	0	0	0.8	0	0	0.3	0	0	0	0	0	0.1
(4)	LumbFurn	0	0	0	100.4	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5)	PapPrt	0.2	0	0.5	0.3	103.7	0.3	0	0.8	0.2	0.2	0.1	0.7	0.2	0.2	0.2	1.1	0.2	0.5	0.1	0.1	0.1	0	0.3
(6)	ChRubPlL	0.4	0	0.2	0.4	0.3	102	0.2	0.8	0.3	0.2	0.2	0.1	0	0	0	0.1	0.2	0	0.1	0.1	0.1	0	0.1
(7)	Petro Co	2.3	0.1	0.5	0.5	1	2.3	112.8	1.3	0.7	0.6	0.5	2.8	1	0.7	0.5	0.7	0.8	1.4	0.4	3.2	4.9	0.1	1.5
(8)	StCy Mis	0.1	0	0.3	0.8	0.1	0.3	0.1	102.7	0.4	0.4	0.3	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0	0	0.1
(9)	Metals	0.1	0	0.1	1.4	0	0.1	0	0.3	103.5	0.9	0.9	0	0	0	0	0	0	0	0	0.1	0	0	0
(10)	ElecEqMa	0.1	0	0	0.1	0	0.1	0	0.2	0.5	101.1	0.8	0	0	0	0	0.2	0	0	0	0.1	0	0	0
(11)	InsTrEq	0	0	0	0	0	0	0	0	0	0	100.4	0.1	0	0	0	0	0.1	0	0.3	0.2	0	0	0
(12)	TC	1.1	1.2	1.2	1.1	3.4	1.4	0.7	2.6	1.3	1.1	0.9	106.2	2.1	0.9	0.9	2	1	1.1	0.7	3.1	1.4	0.2	0.9
(13)	WT	3.5	4.7	5.2	5.7	3.4	3.2	0.5	4.6	4.3	4	3.4	1.6	102.2	2.8	0.7	1.3	2.4	1.1	1.3	2.1	2	0.3	1.6
(14)	RT	0.7	4.4	0.4	0.6	0.8	1.3	0.2	0.8	0.6	1.1	1.4	1.1	1.6	100.5	1.3	0.8	1.2	1	1	1.2	0.8	0.3	1.3
(15)	FIR	7.1	3	2.7	3.9	5.9	5.3	1.3	6	2.9	5.2	2.8	7.3	6.4	11.3	125.9	6.5	9.8	17.5	5.2	5.5	4.4	1.9	24.9
(16)	AdvBuSv	2	1.3	2	1.7	3.1	5.1	0.7	3.1	1.4	2	1.9	2.9	3.6	3.2	2.7	103.5	2.5	3.2	1.5	1.7	1.6	0.5	4.8
(17)	HealthSv	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	101.5	0	0	0	0	0	0
(18)	EducSv	0	0	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	100	0.1	0	0	0	0
(19)	OthSvGov	2.4	4.6	1.7	2	2.8	3.4	0.6	3.3	2.1	2.6	3	4.6	5.5	3.5	3.4	4	5	4	104.6	3.7	2.8	4.5	6.6
(20)	R & R	0.2	0.4	0.3	0.6	0.6	0.5	0.1	0.9	0.9	0.1	0.2	0.1	0	0.1	0	0.1	0.1	0.1	0.1	103.5	0.8	0	0.1
(21)	ElecUtil	1.3	0.3	1	0.7	1.6	1.8	0.8	2.5	2.8	1.4	1.3	1.9	0.7	3.1	1.9	0.9	2.9	1.9	1.4	5.8	107	0.4	6
(22)	GasUtils	0.5	0.1	0.5	0.6	0.5	0.7	1.4	1.7	1.2	0.3	0.3	0.3	0.2	0.5	0.3	0.2	0.9	0.9	0.2	0.7	6.2	130.2	1.5
(23)	Hotels	0	0	0	0	0.1	0	0	0	0	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	100

TABLE 2.6

Philadelphia Starloc Model
Policy Modeling Workshop
Wharton School of the University of Pennsylvania
January, 1986

Relative Distribution of
Consumer Expenditures by Income Group

Income Group ($1000)

Commodities	0-5	5-10	10-15	15-20	20-25	25+
1 Food	0.23	0.22	0.2	0.19	0.18	0.16
2 Alc Beverage	0.03	0.03	0.03	0.03	0.03	0.02
3 Shelter	0.21	0.19	0.17	0.16	0.16	0.16
4 Fuel,Utills,Pubser	0.09	0.08	0.08	0.07	0.07	0.05
5 Household Operatio	0.01	0.03	0.01	0.01	0.01	0.02
6 HH Furniture&Equip	0.03	0.04	0.04	0.04	0.05	0.05
7 Apparel&Serv	0.06	0.06	0.06	0.06	0.06	0.07
8 Transportation	0.12	0.14	0.17	0.17	0.17	0.16
9 Health Care	0.07	0.07	0.06	0.05	0.05	0.04
10 Entertaiment	0.04	0.04	0.04	0.04	0.05	0.05
11 Personal Care	0.01	0.01	0.01	0.01	0.01	0.01
12 Reading	0.01	0.01	0.01	0.01	0.01	0.01
13 Education	0.03	0.01	0.01	0.01	0.01	0.02
14 Tobacco	0.02	0.02	0.02	0.02	0.01	0.01
15 Miscellaneous	0.02	0.02	0.02	0.02	0.02	0.02
16 Cash Contributions	0.01	0.01	0.01	0.01	0.01	0.02
17 Personal Ins. & Pe	0.02	0.04	0.06	0.09	0.1	0.12
18 Total Expenditures	7829.77	10920.44	14115.82	17342.51	20775.38	30240.62

Table 3.1

Parameter estimates of growth model

(t-value)

$$\beta - \alpha = 0.0870 - \underset{(-7.35)}{1.345\,\delta} - \underset{(-2.08)}{0.0015\,T}, \qquad R^2 = 0.79$$

$$\gamma = 0.605 + \underset{(9.07)}{0.751\,\delta} - \underset{(-3.52)}{0.0019\,T} - \underset{(-4.14)}{0.565\,W}, \qquad R^2 = 0.90$$

Table 3.2

Growth Model Parameter Solutions for 1965 and 1983

		δ U.S. Growth	T Time
Manufacturing	1965	1.63	-0.000892
	1983	1.825	-0.000675
Non-manufacturing	1965	0.285	-0.00239
	1983	0.48	-0.00218

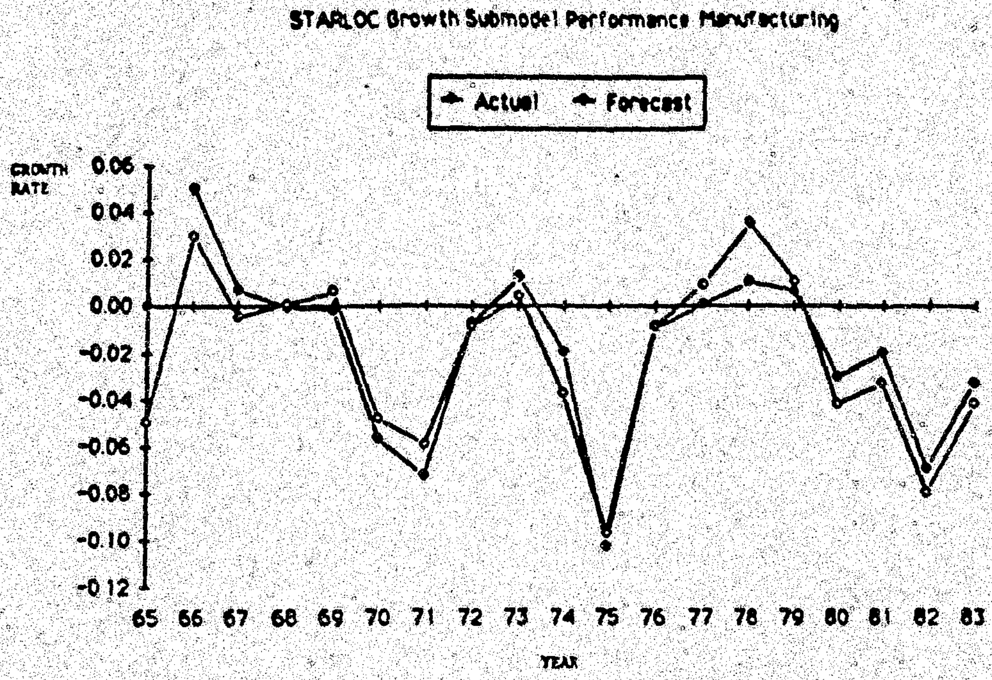


figure 3.1

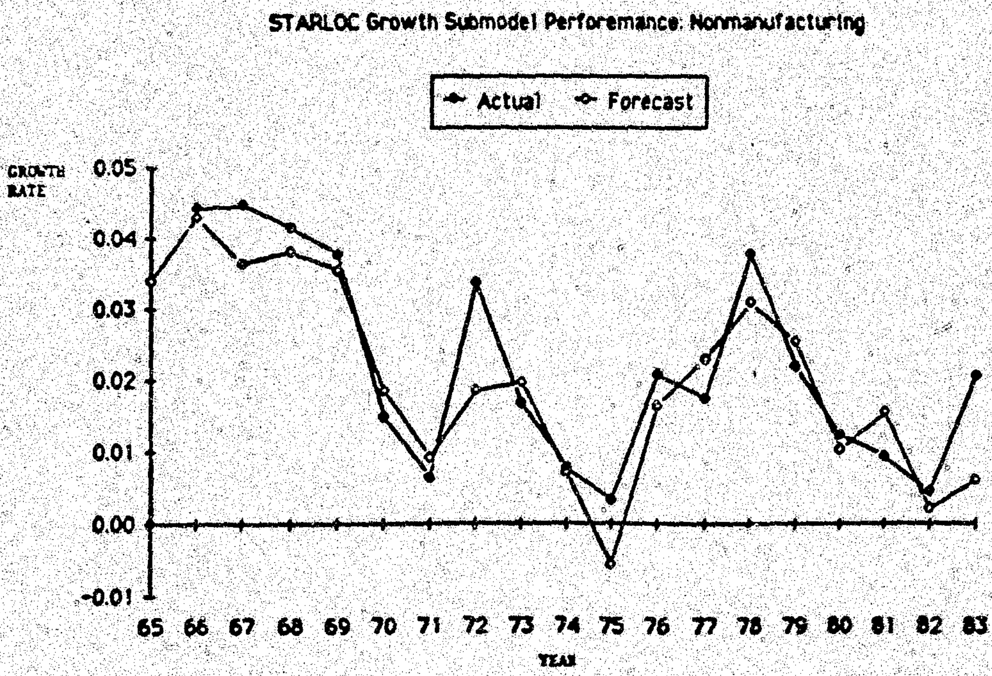


figure 3.2

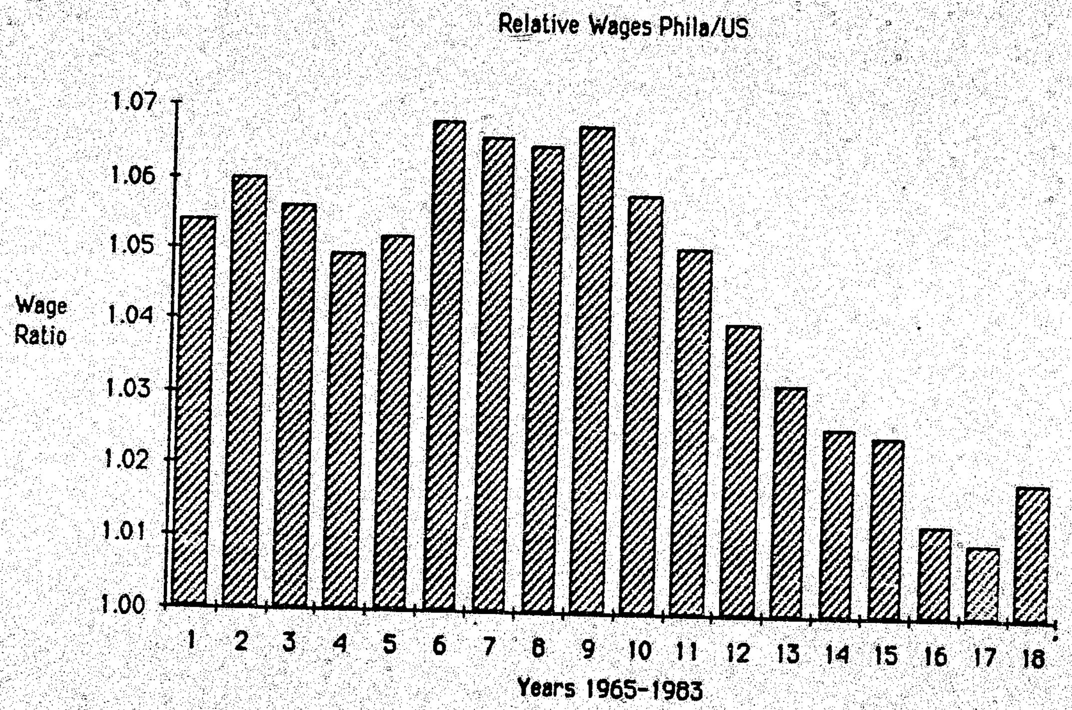

Relative Wages Phila/US
Wage Ratio
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Years 1965-1983

figure 3.3

TABLE 3.3

Parameter Estimates of Sector Specific Growth Equations
(t-value)

Economic Sector	Employment Manuf.	Employment Nonmanuf.	Employment Total	Time Trend	R^2
sector2			**3.786**	**-.035**	**0.67**
			(4.11)	(-5.07)	
sector3	**.801**			**-.023**	**0.99**
	(4.81)			(-5.66)	
sector4			**3.528**	**-.034**	**0.70**
			(4.23)	(-5.36)	
sector5	**.635**			**.008**	**0.89**
	(5.58)			(2.76)	
sector6	**.530**			**-.002**	**0.93**
	(3.45)			(-.39)	
sector7	**.673**			**-.014**	**0.88**
	(1.58)			(-1.36)	
sector8	**.492**			**-.021**	**0.92**
	(1.26)			(-2.24)	
sector9	**1.074**			**-.008**	**0.94**
	(3.14)			(-.90)	
sector10	**1.176**			**.003**	**0.91**
	(3.71)			(.36)	
sector11			**3.700**	**-.015**	**0.51**
			(2.90)	(-1.58)	
TCU(12,20,21,22)		**1.868**		**-.039**	**0.94**
		(6.33)		(-7.83)	
Wholesale (sector 13)		**1.814**		**-.017**	**0.90**
		(2.79)		(-1.56)	
Retail (sector 14)		**1.078**		**-.006**	**0.93**
		(2.51)		(-.73)	
FIR (sector 15)		**1.607**		**-.007**	**0.99**
		(5.06)		(-1.33)	
Services (sector 16,17,18,19,23)		**.920**		**.020**	**0.99**
		(2.73)		(3.56)	
Government (sector 19)		**-.846**		**.023**	**0.58**
		(-.84)		(1.32)	

TABLE 5.1

Philadelphia Starloc Model
Policy Modeling Workshop

Demand Elasticities of Residential Rate-Payers
with respect to Changes in Electric Rates

5a. Elasticities of Demand for Electricity

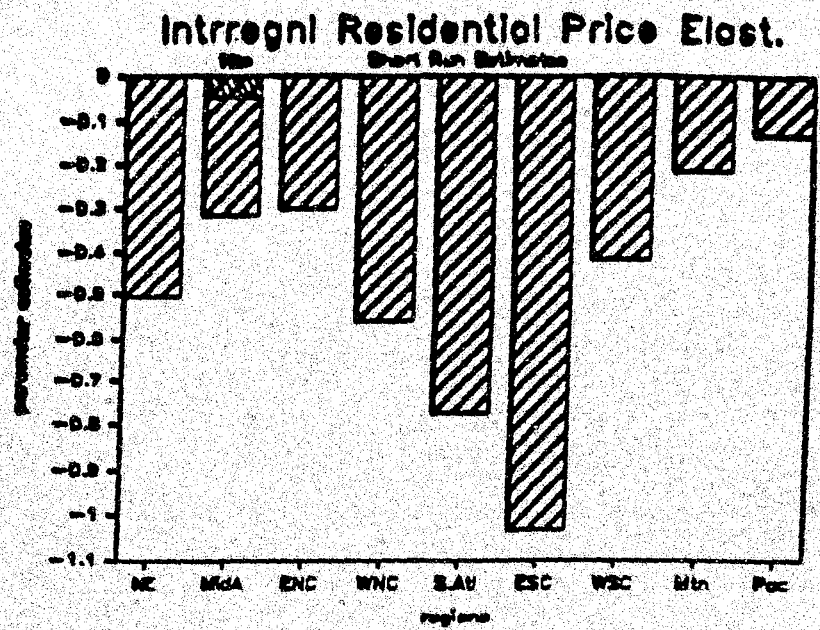
Income Group 1981 dollars	Short-term	Long-term
0 - $5,000	-.2262	-.6227
5 - 10,000	-.2848	-.6891
10 - 15,000	-.3047	-.7070
15 - 20,000	-.2914	-.7321
20 - 25,000	-.2847	-.6937
25,000 or more	-.3000	-.7367
Total Average:	-.3078	-.7293

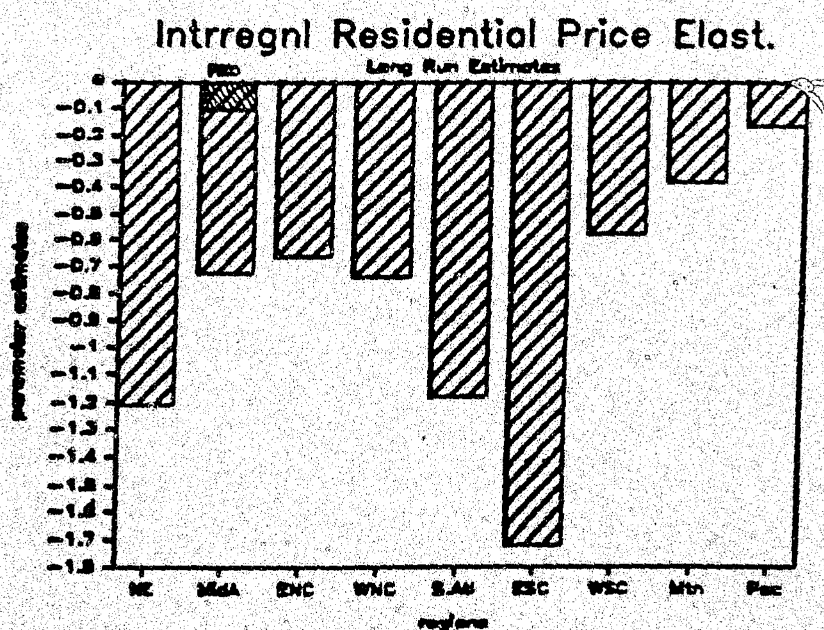
5b. Cross-Elasticities of Demand for Gas

Income Group 1981 dollars	Short-term	Long-term[a]	Long-term[b]
0 - $5,000	.2791	2.3219	0.7737
5 - 10,000	.2494	2.1677	0.7504
10 - 15,000	.1775	2.1058	0.6281
15 - 20,000	.2326	2.2093	0.7484
20 - 25,000	.2813	2.1264	0.7676
25,000 or more	.1720	2.0912	0.6289
Total Average:	.2037	2.0900	0.6753

5c. Cross-Elasticities of Demand for Fuel Oil

Income Group 1981 dollars	Short-term	Long-term
0 - $5,000	-.1781	-.1516
5 - 10,000	-.1772	-.1388
10 - 15,000	-.2086	-.1926
15 - 20,000	-.1642	-.1362
20 - 25,000	-.2372	-.2135
25,000 or more	-.1529	-.1340
Total Average:	-.1906	-.1597





NE	Northeast Region	ESC	East South Central Region
MidA	Mid-Atlantic Region	WSC	West South Central Region
ENC	East North Central Region	Mtn	Mountain Region
WNC	West North Central Region	Pac	Pacific Region
S.ATl	South Atlantic Region		

figure 5.1

Table 6.2

Short-Run Labor Cross Price Elasticities

sector 1	0.004
sector 2	0.003
sector 3	0.010
sector 4	0.004
sector 5	0.008
sector 6	0.009
sector 7	-0.004
sector 8	0.010
sector 9	0.013
sector 10	0.008
sector 11	0.007
sector 12	0.012
sector 13	0.004
sector 14	0.017
sector 15	0.022
sector 16	0.006
sector 17	0.013
sector 18	0.007
sector 19	0.008
sector 20	0.027
sector 21	0.070
sector 22	0.009
sector 23	0.025

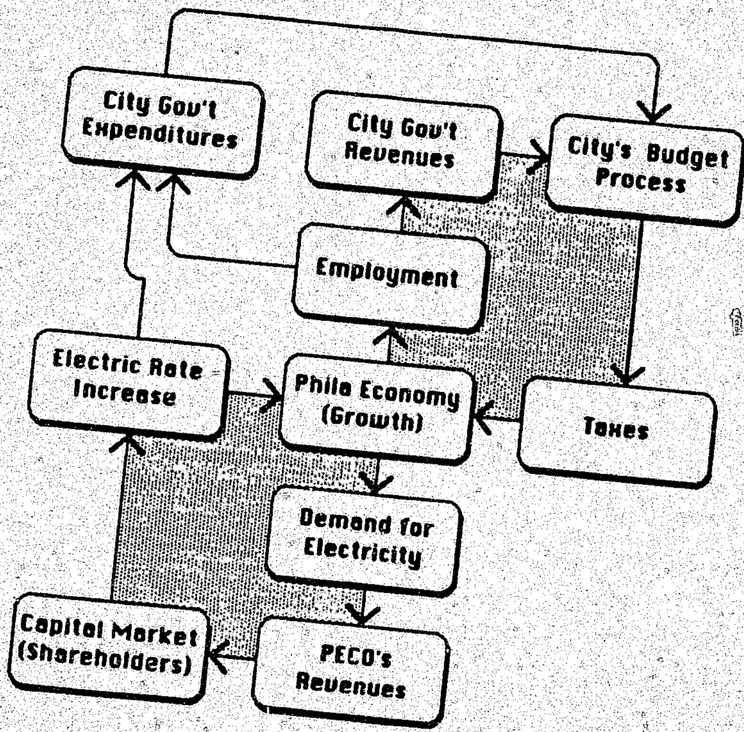

City Gov't Expenditures
City Gov't Revenues
City's Budget Process
Employment
Electric Rate Increase
Phila Economy (Growth)
Taxes
Demand for Electricity
Capital Market (Shareholders)
PECO's Revenues

figure 7.1

REC Ex 23
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PECO EXHIBIT NO. 23

Interrogatories of
Philadelphia Electric Company
Set VI

5. With respect to each matrix and co-efficient, specify the procedures used to update such matrices and co-efficients from the time period in the original source document to the present, including all assumptions and estimates employed.

A. 5. STARLOC Report 3 will contain a complete documentation of the updating procedures employed. Because early completion of the written report is impossible, Company experts are scheduled to consult with Dr. Schinnar regarding these matters at PMW on February 10, 1986.

PECO EXHIBIT NO. 24

Interrogatories of
Philadelphia Electric Company
Set VI

8. Refer to Tables 2.2, 2.3, 2.4, 2.5, and 2.6 of the Technical Report. With respect to each table:

a. State whether or not the table represents the base case or basic characterization for the Philadelphia SMSA. If not, please state what the table represents.

b. Specify in detail all procedures used to validate the table.

c. Provide a copy of the equivalent historical matrix against which the table was validated.

d. Provide comparable tables that include the PECO price increase. To the extent that the tables do not change due to PECO's price increase, so state.

A. 8. a. Yes, all tables represent the base case.

A. 8. b. Validation was based on detailed comparisons of similar data from different sources. See response A. 5. above

A. 8. c. Providing equivalent historical matrices for each period of validation imposes undue burden.

A. 8. d. The tables to change, and these changes are computed internally by the computer program. To generate these tables the computer program sub-routines would have to be modified, which would impose undue burden.

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1981 Dollar Deliveries of Fuel to Sector/
1981 Dollar Gross Output of Sector

Sector	Electricity
1	.0092
2	.0005
3	.0078
4	.0038
5	.0118
6	.0143
7	.0060
8	.0193
9	.0238
10	.0106
11	.0105
12	.0145
13	.0035
14	.0267
15	.0134
16	.0059
17	.0239
18	.0139
19	.0108
20	.0499
21	.0629
22	.0025
23	.0511

Copied from printout of STARLOC input/output model

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Interrogatories of
Philadelphia Electric Company
Set VI

3. Identify and document specifically the data sources for each matrix and co-efficient you have used, including but not limited to the matrices identified as A, S, R, N, M, H, and C.

A. 3. See attached, labeled IR-PECO-CITY-6-3 (2 pp.). See also PMW-8618, pages II-7, III-4, V-2, VI-1, VI-3, VI-4, VI-8; and Table 7 of City Statement No. 1.

Interrogatories of
Philadelphia Electric Company
Set VI

4. With respect to each matrix and co-efficient, identify the period of time with respect to which the matrix or co-efficient was derived in the original source document.

A. 4. See responses A. 3. above.

DATA SOURCES

1. Matrix K. Occupation-Specific and Sector-Specific Employment for Philadelphia SMSA. Source:

   - Regional Science Research Institute/Philadelphia Economic Monitoring Project.
   - BLS Geographic Profile of Employment and Unemployment, 1981. Bulletin No. 21-56, December 1982. Table 25: "Occupational Distribution of Employment by Sex, Age, . . ."
   - Employed persons by industry and occupation, 1981 (national). BLS Employment and Earnings, January 1982.
   - Establishment employment by sector for Philadelphia SMSA. BLS Employment and Earnings.
   - Proprietor and farm employment, 1981. BEA.

2. Output by Sector. Source:

   - Regional Science Research Institute
   - Census of Manufacturers 1977/1982
   - Census of Wholesale 1977/1982
   - Census of Retail 1977/1982
   - Census of Services 1977/1982
   - Census of Contract Construction 1977/1982

3. Matrix A. 23-Sector Interindustry Transactions Table for the Philadelphia SMSA. Source:

   - Regional Science Research Institute, 1981.
   - Philadelphia Economic Monitoring Project, Wharton School.

4. Wages by Sector. Source:

   - Regional Science Research Institute, 1981.
   - County Business Patterns, 1981.
   - Census of Manufacturing, Services, Wholesale, Retail and Contract Construction, 1977/1982.
   - BLS Employment and Earnings.
   - BEA Labor and Proprietors' Income.

Attachment IR-PECO-CITY-6-3

5. Matrix M, N. Regional Consumer Expenditures by Income Group. Source:

- BLS Consumer Expenditure Survey (Northeast and National), 1980-81.
- Survey of Current Business (Average Annual Expenditures).

6. Matrix S. Income/Earnings by Occupation. Source:

- U.S. 1980 Census: Table 222, "Occupation of the experienced civilian labor force by earnings in 1979."

7. Matrix R. Reciprocal of Labor Force by Income Group. Source:

- U.S. 1980 Census: Table 244, "Household income in 1979 by household size and composition."
- U.S. 1980 Census: Table 222 (see #6 above).

8. Residential Energy Consumption Survey, 1981. Source:

- Bureau of Economic Analysis (BEA).

9. Matrix C. National Input-Output Table, 1979. Source:

- Bureau of Economic Analysis (BEA).

10. Matrix H. Mapping of 17 commodities of the Consumer Expenditure Survey to commodities in the Survey of Current Business, and mapping of Survey of Current Business to 17 commodity final demand sectors of the National Input-Output Table, 1979. Source:

- Consumer Expenditure Survey (see #5 above).
- Survey of Current Business (see #9 above).
- National Input-Output Table (see #9 above).

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Interrogatories of
Philadelphia Electric Company
Set II

Q.7. Reference p. 6, l. 23-24. Provide Mr. Schinnar's basis for the statement that "[Dr. Summer's] asessment did not, however, include or reflect the magnitude of PECO's rate proposal." Provide specific references to and copies of all documents or workpapers relied upon in reaching this conclusion.

A.7. Dr. Summers' Rebuttal Testimony: Docket No. I-840381, PECO Statement No. 34, page 3A-6: "During my cross-examination I stated that I did not specifically consider the impact of prospective electric price increases on employment in preparing my testimony."

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TERRITORY COVERED BY THIS TARIFF

BERKS COUNTY
Boroughs of Robesonia, Shillington, Sinking Spring, Wernersville, West Lawn, Womelsdorf, Wyomissing and Wyomissing Hills.
Townships of Caernarvon, Cumru, Heidelberg, Lower Heidelberg, South Heidelberg and Spring.

BUCKS COUNTY
Boroughs of Richlandtown, Sellersville, Silverdale, Telford and Trumbauersville.
Townships of East Rockhill, Haycock, Hilltown, Milford, Richland, Springfield and West Rockhill.

CARBON COUNTY
Boroughs of Beaver Meadows, Bowmanstown, East Side, Jim Thorpe, Lansford, Nesquehoning, Palmerton, Parryville, Summit Hill and Weissport.
Townships of Banks, East Penn, Franklin, Kidder, Lausanne, Lehigh, Lower Towamensing, Mahoning, Packer, Penn Forest and Towamensing.

CHESTER COUNTY
Boroughs of Atglen, Elverson and Honey Brook.
Townships of Honey Brook, West Nantmeal and West Sadsbury.

CLINTON COUNTY
City of Lock Haven.
Boroughs of Avis, Flemington, Loganton, Mill Hall, Renovo and South Renovo.
Townships of Allison, Bald Eagle, Castanea, Chapman, Colebrook, Crawford, Dunnstable, Gallagher, Greene, Grugan, Logan, Noyes, Pine Creek, Wayne and Woodward.

COLUMBIA COUNTY
Town of Bloomsburg.
Boroughs of Ashland, Benton, Berwick, Briar Creek, Centralia, Millville, Orangeville and Stillwater.
Townships of Beaver, Benton, Briar Creek, Catawissa, Cleveland, Conyngham, Fishing Creek, Franklin, Greenwood, Hemlock, Jackson, Locust, Madison, Main, Mifflin, Montour, Mount Pleasant, North Centre, Orange, Pine, Roaring Creek, Scott, South Centre and Sugarloaf.

CUMBERLAND COUNTY
Boroughs of Camp Hill, Carlisle, Lemoyne, Mechanicsburg, New Cumberland, Newville, Shiremanstown, West Fairview and Wormleysburg.
Townships of Dickinson, East Pennsboro, Hampden, Lower Allen, Middlesex, Monroe, North Middleton, North Newton, Penn, Silver Spring, South Middleton, South Newton, Upper Allen and West Pennsboro.

DAUPHIN COUNTY
City of Harrisburg.
Boroughs of Berrysburg, Dauphin, Elizabethville, Gratz, Halifax, Highspire, Hummelstown, Lykens, Millersburg, Paxtang, Penbrook, Pillow, Steelton, and Williamstown.

DAUPHIN COUNTY (Continued)
Townships of Derry, East Hanover, Halifax, Jackson, Jefferson, Lower Paxton, Lower Swatara, Lykens, Middle Paxton, Mifflin, Reed, Rush, South Hanover, Susquehanna, Swatara, Upper Paxton, Washington, Wayne, West Hanover, Wiconisco and Williams.

JUNIATA COUNTY
Boroughs of Mifflin, Mifflintown, Port Royal and Thompsontown.
Townships of Delaware, Fayette, Fermanagh, Greenwood, Milford, Monroe, Susquehanna, Turbett and Walker.

LACKAWANNA COUNTY
Cities of Carbondale and Scranton.
Boroughs of Archbald, Blakely (part), Clarks Green, Clarks Summit, Dalton, Dickson City, Dunmore, Jermyn, Jessup, Mayfield, Moosic, Moscow, Old Forge, Olyphant (part), Taylor, Throop and Vandling.
Townships of Abington, Benton, Carbondale, Clifton, Covington, Elmhurst, Fell, Glenburn, Greenfield, Jefferson, La Plume, Lehigh, Madison, Newton, North Abington, Ransom, Roaring Brook, Scott, South Abington, Spring Brook and West Abington.

LANCASTER COUNTY
City of Lancaster.
Boroughs of Adamstown (part), Akron, Christiana, Columbia, Denver, East Petersburg, Elizabethtown, Ephrata (part), Lititz, Manheim, Marietta, Millersville, Mount Joy, Mountville, New Holland, Quarryville, Strasburg and Terre Hill.
Townships of Bart, Brecknock, Caernarvon, Clay, Colerain, Conestoga, Conoy, Drumore, Earl, East Cocalico, East Donegal, East Drumore, East Earl, East Hempfield, East Lampeter, Eden, Elizabeth, Ephrata, Fulton, Lancaster, Leacock, Little Britain, Manheim, Manor, Martic, Mount Joy, Paradise, Penn, Pequea, Providence, Rapho, Sadsbury, Salisbury, Strasburg, Upper Leacock, Warwick, West Cocalico, West Donegal, West Earl, West Hempfield and West Lampeter.

LEBANON COUNTY
Borough of Richland.
Townships of Heidelberg and Millcreek.

LEHIGH COUNTY
Cities of Allentown and Bethlehem.
Boroughs of Alburtis, Catasauqua, Coopersburg, Coplay, Emmaus, Fountain Hill, Macungie, and Slatington.
Townships of Hanover, Heidelberg, Lower Macungie, Lower Milford, Lowhill, North Whitehall, Salisbury, South Whitehall, Upper Macungie, Upper Milford, Upper Saucon, Washington and Whitehall.

TERRITORY COVERED BY THIS TARIFF (CONTINUED)

LUZERNE COUNTY
Cities of Hazleton, Pittston and Wilkes-Barre.
Boroughs of Ashley, Avoca, Conyngham, Dupont, Duryea, Exeter, Freeland, Hughestown, Jeddo, Laflin, Laurel Run, Nescopeck, Nuangola, Penn Lake Park, West Hazleton, West Pittston, White Haven and Yatesville.
Townships of Bear Creek, Black Creek, Buck, Butler, Dennison, Dorrance, Exeter, Fairview, Foster, Hanover, Hazle, Hollenbach, Jenkins, Nescopeck, Pittston, Plains, Rice, Salem, Slocum, Sugarloaf, Wilkes-Barre and Wright.

LYCOMING COUNTY
City of Williamsport.
Boroughs of Duboistown, Hughesville, Jersey Shore, Montgomery, Montoursville, Muncy, Picture Rocks, Salladasburg and South Williamsport.
Townships of Anthony, Armstrong, Bastress, Brady, Clinton, Eldred, Fairfield, Franklin, Hepburn, Jordan, Limestone, Loyalsock, Lycoming, Mifflin, Mill Creek, Moreland, Muncy, Muncy Creek, Nippenose, Old Lycoming, Penn, Piatt, Porter, Shrewsbury, Susquehanna, Upper Fairfield, Washington, Watson, Wolf and Woodward.

MONROE COUNTY
Boroughs of East Stroudsburg (part), Mount Pocono and Stroudsburg (part).
Townships of Barrett, Chestnuthill, Coolbaugh, Eldred, Jackson, Paradise, Pocono, Polk, Price, Smithfield, Stroud, Tobyhanna and Tunkhannock.

MONTGOMERY COUNTY
Boroughs of East Greenville, Pennsburg, Red Hill, Souderton and Telford.
Townships of Franconia, Hatfield and Upper Hanover.

MONTOUR COUNTY
Boroughs of Danville and Washingtonville.
Townships of Anthony, Cooper, Derry, Liberty, Limestone, Mahoning, Mayberry, Valley and West Hemlock.

NORTHAMPTON COUNTY
City of Bethlehem.
Boroughs of Freemansburg, Hellertown, Nazareth (part), North Catasauqua, Northampton, Pen Argyl (part), Stockerton, Tatamy and Walnutport.
Townships of Allen, Bethlehem, Bushkill, East Allen, Forks, Hanover, Lehigh, Lower Mount Bethel, Lower Nazareth, Lower Saucon, Moore, Palmer, Plainfield, Upper Nazareth, Washington and Williams.

NORTHUMBERLAND COUNTY
Cities of Shamokin and Sunbury.
Boroughs of Herndon, Kulpmont, Marion Heights, McEwensville, Milton, Mount Carmel, Northumberland, Riverside, Snydertown and Turbotville.
Townships of Coal, Delaware, East Cameron, East Chillisquaque, Jackson, Jordon, Lewis, Little Mahanoy, Lower Augusta, Lower Mahanoy, Mount Carmel, Point, Ralpho, Rockefeller, Rush, Shamokin, Turbot, Upper Augusta, Upper Mahanoy, Washington, West Cameron, West Chillisquaque and Zerbe.

PERRY COUNTY
Boroughs of Bloomfield, Landisburg, Liverpool, Marysville, Millerstown, New Buffalo and Newport.
Townships of Buffalo, Carroll, Centre, Greenwood, Howe, Juniata, Liverpool, Miller, Northeast Madison, Oliver, Penn, Rye, Saville, Southwest Madison, Spring, Tuscarora, Tyrone, Watts and Wheatfield.

PIKE COUNTY
Townships of Blooming Grove, Greene, Lackawaxen, Palmyra, Porter and Shohola.

SCHUYLKILL COUNTY
City of Pottsville.
Boroughs of Ashland, Auburn, Coaldale, Cressona, Deer Lake, Frackville, Gilberton, Girardville, Gordon, Landingville, Mahanoy City, McAdoo, Mechanicsville, Middleport, Minersville, Mount Carbon, New Philadelphia, New Ringgold, Orwigsburg, Palo Alto, Pine Grove, Port Carbon, Port Clinton, Ringtown, Shenandoah, Tamaqua, Tower City and Tremont.
Townships of Barry, Blythe, Branch, Butler, Cass, Delano, East Brunswick, East Norwegian, East Union, Eldred, Foster, Frailey, Hegins, Hubley, Kline, Mahanoy, New Castle, North Manheim, North Union, Norwegian, Pine Grove, Porter, Reilly, Rush, Ryan, Schuylkill, South Manheim, Tremont, Union, Upper Mahantongo, Walker, Washington, Wayne, West Brunswick, West Mahanoy and West Penn.

SNYDER COUNTY
Boroughs of Beavertown, Freeburg, McClure, Middleburg, Selinsgrove, and Shamokin Dam.
Townships of Adams, Beaver, Centre, Chapman, Franklin, Jackson, Middlecreek, Monroe, Penn, Perry, Spring, Union, Washington, West Beaver and West Perry.

TERRITORY COVERED BY THIS TARIFF (CONTINUED)

SUSQUEHANNA COUNTY
Boroughs of Forest City and Union Dale.
Townships of Clifford and Herrick.

UNION COUNTY
Boroughs of Hartleton and New Berlin.
Townships of Gregg, Hartley, Kelly, Lewis, Limestone, Union, West Buffalo and White Deer.

WAYNE COUNTY
Boroughs of Bethany, Hawley, Honesdale, Prompton and Waymart.
Townships of Berlin, Canaan, Cherry Ridge, Clinton, Damascus, Dreher, Dyberry, Lake, Lebanon, Lehigh, Mount Pleasant, Oregon, Palmyra, Paupack, Salem, South Canaan, Sterling and Texas.

WYOMING COUNTY
Borough of Factoryville.
Townships of Clinton, Nicholson, Overfield and Tunkhannock.

YORK COUNTY
Boroughs of East Prospect and Wrightsville.
Townships of Fairview, Hellam and Lower Windsor.

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change in the growth r  e for the economyQ :y or n
n
 electricity price changeQ :y or n"
y
enter the number of years that the forecast is for. for instance,
enter 3 for a rate change over 3 years.
L>
      3
enter the inflation rate for the economy. :1"
 a 4 percent inflation rate is entered as .04
L>
      .05
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
Pthe price changes that are entered are all in nominal termsP
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP


enter the industrial electricity rate change for all but the railroad
sector. :1"
L>
      .184
enter the electricity rate change for the railroad sector :1".
L>
      .184
Ha is in aprime


enter the electricity price change for the residential sector :1"
L>
      .184
the Hn are in nprime


enter the industrial electricity rate change for all but the railroad
sector. :1"
L>
      .184
enter the electricity rate change for the railroad sector :1".
L>
      .184
 the He are in eprime


input the change in the electricity price to the city government :1"
L>
      .184
the Hf are in fprime


enter the national growth rate. a 4 percent rate is entered as .04.
L>
      0
PPPPP we are now computing the total impact PPPPP


PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
employment by 7 sectors
```

city emp	suburbs emp	nj emp	total
@87	@163	@50	@300
@281	@171	@132	@585
@533	@442	@166	@1141
@242	@162	@63	@467
@174	@104	@51	@329
@387	@508	@236	@1131
@52	@144	@48	@244
@1757	@1693	@746	

change in total employment
@4196.350266
percent change in total employment> @0.2
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
10
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
employment by occupation

prof	mgt	sales	crafts	laborer	serv	farm	total
@765	@1493	@328	@434	@502	@658	@16	@4196

percent change in employmeny by occupation

prof	mgt	sales	crafts	laborer	serv	farm	total
@0.2	@0.2	@0.3	@0.2	@0.1	@0.2	@0.3	@0.2

PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
7
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
employmeny by income

0_5	5_10	10_15	15_20	20_25	25-	total
@780	@731	@692	@734	@447	@812	@4196

percent change in employment by income

0_5	5_10	10_15	15_20	20_25	25-	total
@0.21	@0.21	@0.20	@0.20	@0.20	@0.20	@0.20

PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
7

change in sector21 revenue is> 24.2
5

change in the growth rate for the economyQ :y or n"
y
enter the national growth rate. a 4 percent rate is entered as .04.
L>
.01
PPPPP we are now computing the total impact PPPPP

PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP

```
n
 electricity price changeQ :y or n"
y
enter the number of years that the forecast is for. for instance,
enter 3 for a rate change over 3 years.
L>
     3
enter the inflation rate for the economy. :1"
 a 4 percent inflation rate is entered as .04
L>
     .06
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
Pthe price changes that are entered are all in nominal termsP
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP


enter the industrial electricity rate change for all but the railroad
sector. :1"
L>
     .184
enter the electricity rate change for the railroad sector :1".
L>
     .184
Ha is in aprime


enter the electricity price change for the residential sector :1"
L>
     .184
the Hn are in nprime


enter the industrial electricity rate change for all but the railroad
sector. :1"
L>
     .184
enter the electricity rate change for the railroad sector :1".
L>
     .184
 the He are in eprime


input the change in the electricity price to the city government :1"
L>
     .184
the Hf are in fprime


enter the national growth rate. a 4 percent rate is entered as .04.
L>
     0
PPPPP we are now computing the total impact PPPPP


PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
employment by 7 sectors
```

PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
employment by 7 sectors
mf,gov,sv,fir,tcu,wr,cc,ag/min

city emp	suburbs emp	nj emp	total
23	43	13	80
76	46	36	158
144	119	45	307
65	44	17	126
47	28	14	88
104	137	64	304
14	39	13	66
473	456	201	

change in total employment
1129.479775
percent change in total employment> 0.1
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
10
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
employment by occupation

prof	mgt	sales	crafts	laborer	serv	farm	total
206	402	88	117	135	177	4	1129

percent change in employmeny by occupation

prof	mgt	sales	crafts	laborer	serv	farm	total
0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1

PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
7
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
employmeny by income

0_5	5_10	10_15	15_20	20_25	25-	total
210	197	186	197	120	219	1129

percent change in employment by income

0_5	5_10	10_15	15_20	20_25	25-	total
0.06	0.06	0.05	0.05	0.05	0.05	0.05

PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
7

change in sector21 revenue is> 27.6
5

change in the growth rate for the economyQ "y or n"
y
enter the national growth rate

RS 2-13-86
R-850152
Nb1

PECO EXHIBIT NO. 30

Interrogatories of
Philadelphia Electric Company
Set 2

Q.2. Please provide all previous testimony, reports, studies or papers prepared in whole or in part by Mr. Schinnar for the City of Philadelphia.

A.2. No previous reports or studies prepared by Dr. Schinnar for the City of Philadelphia were pertinent to electricity rates, energy policy or economic impacts. Studies done for the City dealt with productivity of street repair, fleet maintenance and Public Health services, and may be reviewed at the Wharton School, 3814 Walnut Street.

Interrogatories of
Philadelphia Electric Company
Set II

Q.5. Reference p. 6, l. 10-11. Has Mr. Schinnar analyzed or studied what revenue recovery PECO will need to attain in 1986 to be "a viable electric company"? In 1987? In 1988? In 1989? If so, provide these estimates and all workpapers, reports, or other documentation relied upon in preparing these estimates.

A.5. No special analysis was performed in regard to PECO's viability other than to rely on PECO's Rate Proposal, which includes a 29.2% rate increase and a six-year long phase-in/phase-out period during which the company agreed to forego carrying charges.