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The Massachusetts Economic Policy Analysis Model

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CONTENTS IN BRIEF *

SUPPLEMENTS

* An outline of Chapters 1-6 and a list of Tables can be found starting on page 116.

CHAPTER 1

INTRODUCTION

The Massachusetts Economic Policy Analysis (MEPA) Model is an instrument for testing alternative state economic policy proposals and for making economic forecasts. It has been developed with public funds and is the successor to the Massachusetts Econometric Model[1] that has been used for state forecasting and policy simulation since June 1975. The MEPA model is a computerized representation of the major relationships in the Massachusetts economy. The most likely future for the Massachusetts economy is set forth in a control forecast made with the model. This control forecast serves as a standard of comparison against which forecasts that are based on alternative state policies can be evaluated.

The state policy variables in the model are divided into five major categories: (1) Direct consumer tax rates, (2) Personal tax rates and exemptions, (3) Government spending decisions, (4) Business taxes and credits and (5) Fuel cost variables.[2] In addition to testing policies by direct manipulation of the policy instruments in the model, other policy alternatives can be tested if the <u>direct</u> effects of the alternative policies on the economic variables in the model can be calculated.

The MEPA model is unique among current state models. It includes the relationships that make up regional input-output models at the same time it allows

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[1]Ann F. Friedlaender, George Treyz and Richard Tresch, "An Overview of a Quarterly Econometric Model of Massachusetts and Its Fiscal Structure", <u>The New England Journal of Business Economics</u>, Vol. 3, No. 1, Fall 1976, pp. 57-73. The forecast record for this model is given in Chapter 5.

[2]See Chapter 2, Section VII for a list of the variables in each category.

for substitution among factors of production based on relative factor costs. It also explains the location of regional export production on the basis of relative regional costs. As a by-product of the model structure, it is possible to calculate the total cost of production in Massachusetts relative to the total cost in the U.S. for each sector of the economy, and it is possible to identify the number of jobs in each sector that depend directly on exports from Massachusetts.

Since articles[1] explaining the MEPA model structure are only now being prepared for professional economic journals, it is too early to report on the reception of the model by other economists. However, even at this early stage it is possible to report that the MEPA model apparently represents a synthesis of the major techniques used to date by others for regional analysis as well as breaking new ground in the estimation of regional export-dependent employment and relative regional costs. Thus, the MEPA model represents more than a series of regression equations. It represents an integrated economic model that is based on causal relationships that are derived mathematically from basic assumptions and from data from many sources.

A non-technical explanation of the model is given in the first five pages of Chapter 2. A reader who is not interested in the technical description of the model given in the remainder of that chapter should then skip to Chapter 3 which introduces a control forecast. In Chapter 4 some of the tables are given for the control forecast. The forecasting record for the June 1975 Econometric Model is presented in Chapter 5. A sample of the kind of policy simulations that can be done with the MEPA model is set forth in Chapter 6. The supplements listed in the table of contents will be prepared as soon as time (and in some cases financial support) permits.

[1] Treyz, George I., Ann F. Friedlaender and Benjamin H. Stevens "The Employment Sector of a Regional Policy Simulation Model," The Review of Economics and Statistics, forthcoming.

CHAPTER 2

THE MASSACHUSETTS ECONOMIC POLICY ANALYSIS MODEL

The Massachusetts Economic Policy Analysis (MEPA) Model has the following important features:

(1) The structure of the model is derived from, and is consistent with, an explicit list of assumptions.[1]

(2) The labor intensity of Massachusetts production, relative to U.S. production, is calculated quarterly on the basis of long-term relative factor costs. This means that a bridge between quantities of output and employment is established. Thus, policy simulations will include the effect of tax policy changes on the labor intensity of production.[2]

(3) Employment that depends on local use is estimated for each of 25 sectors.[3]

(4) The amount of Massachusetts employment in each sector that depends on exports from Massachusetts and on import substitution after the base period is forecast quarterly. This employment depends on U.S.

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[1]These are set forth in section I, 2(a) on page 21 below.

[2]Counting all of the cost factors and all of the lagged values, over 2,500 values enter into the labor intensity calculation for each sector.

[3]These predictions use 25 regional purchase coefficients based on transportation and other data in the base period. They also use values that are updated quarterly for 396 input-output coefficients, 319 long term factor substitution parameters and 25 labor intensities.

demand for output from that sector and on changes in Massachusetts long-term business costs (including tax costs, wage costs, fuel costs, and intermediate input costs) relative to national business costs.[4]

(5) State government policy instruments are explicitly included in the model and policy simulations can be run by simply changing the value of any one of these instruments.[5]

The combination of the above features in a single model constitutes a new model form. It is especially suitable for policy simulations and for gauging the regional impacts of interregional changes in the cost of inputs such as energy.

Since the MEPA model integrates, into a general comprehensive model, techniques that have been previously used in isolation in the analysis of regional behavior, particular examples of previous work would be found to be special cases of the MEPA model, if certain simplifying changes were made. Thus, the work done by Isard et. al. (6) (8), Stevens et. al. (10) (11) and others, is duplicated in the MEPA model for the special case in which all relative regional tax, labor, fuel and other costs are held constant. The MEPA model in this special case would capture only the secondary intraregional employment impacts of both nation and region, serving economic activity in the same way that a regional input-output model would. The MEPA model also draws on the above work in its use of a regional purchase coefficient which is a measure of the proportion of local use that is locally supplied. However, the MEPA model utilizes a refinement of this coefficient not included in

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[4] Over 40 cost factors are combined for each quarter over the last five years to calculate this measure.

[5] There are 36 explicit levers of state policy in the model. They are listed in Section VII on page 75.

the above work. Another special case of the MEPA model would be demonstrated if some of the parameters were set in such a way that the effect of changes in local demand on Massachusetts output were left out of the model. This would be accomplished by setting the regional purchase coefficients equal to zero. The June '75 Massachusetts econometric specification (2) of most of the manufacturing employment equations would be included as a simplified version of this special case. The MEPA model also includes some elements of comparative cost analysis as developed by Isard (7) for the prediction of industrial location and location shifts, as well as the work of Borts and Stein (1) on regional factor shares in an open economy.

A simplified view of the structure of the MEPA model is given in Diagram 1 on the next page. Each of the major parts shown in Diagram 1 is assigned a roman numeral. A brief introductory explanation is given below. The discussion in the remainder of this chapter will describe each part of the model in detail.

In the MEPA model the Massachusetts economy is divided into 25 different sectors. In each of these sectors output is divided into two categories: that dependent directly on exports from Massachusetts, and that dependent on demand from within Massachusetts for intermediate inputs and for final use. The quantity of exports from Massachusetts for each sector depends on the national demand for that output (as forecast by DRI[6]) and on the long-run Massachusetts business costs relative to those of the rest of the United States. These costs include labor costs, tax costs, fuel costs and the costs of intermediate goods. The local demand for the output of any one of the sectors depends 1) on the local demand from each sector that uses local intermediate inputs from that sector, and

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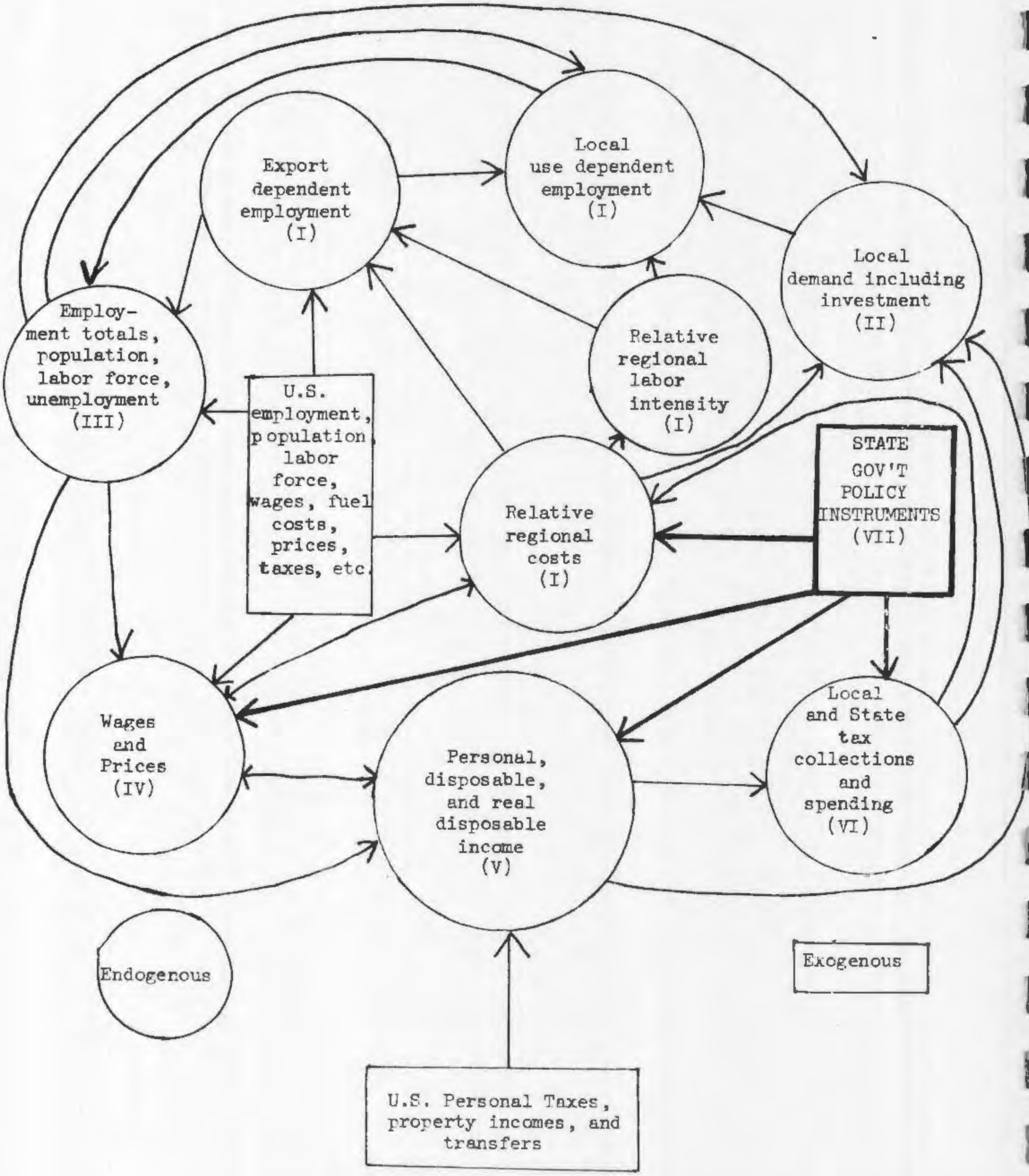
[6]Data Resources Incorporated: A private vendor of computer services and national economic forecasts.

DIAGRAM 1



Local use dependent employment (I)
Export dependent employment (I)
Local demand including investment (II)
Employment totals, population, labor force, unemployment (III)
U.S. employment, population, labor force, wages, fuel costs, prices, taxes, etc.
Relative regional labor intensity (I)
Relative regional costs (I)
STATE GOV'T POLICY INSTRUMENTS (VII)
Wages and Prices (IV)
Personal, disposable, and real disposable income (V)
Local and State tax collections and spending (VI)
Endogenous
Exogenous
U.S. Personal Taxes, property incomes, and transfers

2) on local final demand. In order to determine the amount of employment demand that is generated for each sector, we combine the output forecast for that sector with a forecast of the labor intensity of production in Massachusetts. This labor intensity forecast depends on the long-term cost of labor in Massachusetts relative to our costs for the other factors of production.

The size of the Massachusetts population and of the Massachusetts labor force is based on Massachusetts employment conditions relative to those elsewhere and on demographic factors. The number of unemployed is found by subtracting the number employed from the labor force.

Our forecast of the price level in Massachusetts (as measured by the Boston consumer price index) depends on the U.S. consumer price index (as forecast by DRI) and on all of the relevant costs in Massachusetts relative to the U.S. Thus, the effects of all cost factors in Massachusetts--including the direct effects of the 13 Massachusetts consumer taxes and the indirect effects of all other Massachusetts taxes--are reflected with their appropriate weights in the price index forecast. The wage rates for each sector of the Massachusetts economy depend on the past wage level for each sector and on the movement of a fixed-weight wage index that we have constructed for Massachusetts. The MEPA model equation forecasts changes in this index by using the DRI forecast for a similar index for the U.S., and by explaining movements in the Massachusetts index relative to the U.S. index. The Massachusetts wage changes relative to the U.S. have been positively related to relative labor market tightness. The Massachusetts relative wage is negatively related to changes in the amount of constant dollar disposable income per dollar of pre-tax nominal income. This indicates that labor supply in the state is reduced when our consumer taxes or personal income taxes go up faster than they increase elsewhere.

Employment and wages are combined with forecasts of property, transfer, and other income to determine Massachusetts personal income. Massachusetts real disposable income is found by subtracting the relevant taxes from personal income and then deflating with the Boston consumer price index.

Investment demand is determined by an equation based on the same profit maximizing business behavior assumption and production function that are used in deriving the specification of our employment equations. In essence, our investment regression equations show that Massachusetts investment follows U.S. investment in the current period, but that our investment will be modified by the tendency to bring the actual capital stock in line with the optimal capital stock (which is determined by factor costs and the amount of production in Massachusetts). We predict local property tax revenues on the basis of total local spending minus state aid. Local spending depends on income and the proportion of the population in primary and secondary schools.

In the MEPA model, total state spending minus welfare expenditure is treated as an exogenous variable so that it can serve as one of the policy instruments. State taxes for 16 revenue categories are predicted by first predicting the tax base and then multiplying by the tax rate.

Of course all of the values in the model have to be determined simultaneously because most of the variables are interdependent. For example, if the state were to increase a state income tax rate and simultaneously increase state spending, we would think first of the direct effects. These effects would include: (1) less disposable income for people paying the tax and thus less consumer spending, (2) less disposable income per dollar of wages and thus a reduction in labor supply as workers move elsewhere, (3) increases in state and private employment to provide additional goods and services to the state. However, in addition to these impacts, there would be second-round effects which would include, (1) reduced production in the state in the long run due to increased business costs resulting from the higher wage costs, (2) decreased employment due to the substitution of capital for labor when labor costs increase, (3) increased demand for capital and thus increased investment demand as capital is substituted for labor and, (4) increased activity in the construction industry in response to the higher investment. In short, the ramifications of any policy change go well beyond the immediate and direct effects. Thus a simultaneous solution of the entire model is required to take into account all the direct and indirect effects of a policy change.

I. The Employment Sector

The employment equation for the typical sector depends on about 15 simultaneously determined variables and up to 52 lagged values for about 50 other variables. In order to provide a general orientation we first describe the i^{th} employment equation in section 1 and then show how it can be derived in section 2. In section 3 we present the estimated parameters for the employment equations.

1. The Employment Equation

(a) The equation

The equation for the i^{th} employment sector has the following form:

$$E_{i,t} = \sum_{\substack{j=1 \\ j \neq i}}^{n} e_{i,j,t} E_{j,t} + \sum_{j=n+1}^{m} d_{i,j,t} D_{j,t} + E^{X}_{i,t} \qquad (1)$$

where

t = time period.

$E_{i,t}$ = the number of regional employees in the i^{th} industry.

$e_{i,j,t}$ = the number of regional employees required in the i^{th} sector for each regional employee in the j^{th} sector.

n = the number of employment sectors.

$d_{i,j,t}$ = the number of regional employees required in the i^{th} sector for each regional unit of final demand in the j^{th} final demand sector.

m = the number of employment sectors plus the number of final demand sectors.

$D_{j,t}$ = the regional final demand in the j^{th} final demand sector.

$E^X_{i,t}$ = the number of regional employees in the i^{th} employment sector whose employment depends directly on regional exports.

In the form shown in equation (1) the link between our employment equation specification and regional input-output models is apparent. However, in the determination of the e's, d's and E^X's we add to the input-output approach in such a way that the other elements mentioned in the introduction are brought into the analysis. The determinations of the e's and d's include input-output relationships, regional labor and other factor input intensities relative to the nation, national employment data that reflects technological and other changes, and a measure that shows the proportion of regional use that is supplied from within the region. The specification of the term explaining export-dependent employment (E^X_i) reflects relative regional costs, regional labor intensity relative to the nation, current technology and national demand. We now consider the e's, d's and E^X's in detail.

(b) Regional employment dependent on regional users of intermediate inputs (e's)

$$e_{i,j,t} = \kappa_{i,j} \cdot l_{i,t} \cdot \frac{E_{u,i,t}}{E_{u,j,t}} \cdot b_{i,j} \cdot \rho_i \qquad (2)$$

where

$e_{i,j,t}$ = see equation 1 above.

$\kappa_{i,j}$ = the proportion of the i^{th} sector's output that is delivered to the j^{th} sector as shown in the most recent national input-output table.

$l_{i,t}$ = the regional labor intensity relative to the national labor intensity for the i^{th} sector.

$E_{u,i,t}$ = national employment in the i^{th} industry. In general the subscript u will denote a national concept which corresponds to a previously defined regional concept.

$b_{i,j}$ = a 13 year moving average ratio of the national to the regional cost of the i^{th} commodity multiplied by the relative regional wage in the j^{th} industry.

ρ_i = the proportion of the regional use of the i^{th} commodity that is supplied from within the region. This is called the Regional Purchase Coefficient.

Since relative labor intensity ($l_{i,t}$) is impossible to observe directly, due to the absence of the necessary regional data, the $l_{i,t}$ values must be estimated. This can be accomplished with available data if we assume that firms maximize profits and that a Cobb-Douglas Constant Returns Production Function can be used to represent the production process. Under these assumptions we will show in section 2 below that

$$l_{i,t} = 1 \div \left[\sum_{h=1}^{v} \left(\frac{W_{i,t-h}}{W_{u,i,t-h}} \right)^{\lambda_{k,i} + \lambda_{o,i} + \sum_{p=1}^{n} \lambda_{p,i}} \right.$$

$$\cdot \left(\frac{C_{u,i,t-h}}{C_{i,t-h}} \right)^{\lambda_{k,i}} \cdot \left(\frac{F_{u,i,t-h}}{F_{i,t-h}} \right)^{\lambda_{o,i}} \cdot \left(\frac{Y_{u,i,t-h}}{Y_{i,t-h}} \right)^{\lambda_{1,i}}$$

$$\left. \cdot \left(\frac{Y_{u,2,t-h}}{Y_{2,t-h}} \right)^{\lambda_{2,i}} \cdots\cdots\cdots \left(\frac{Y_{u,n,t-h}}{Y_{n,t-h}} \right)^{\lambda_{n,i}} \right] \qquad (3)$$

where

$\frac{W_{i,t-h}}{W_{u,i,t-h}}$ = the hourly cost of labor (including unemployment insurance taxes) in the region relative to the nation.

$\frac{C_{u,i,t-h}}{C_{i,t-h}}$ = the rental cost of capital in the nation relative to the region (shown starting in the middle of page 13).

$\frac{F_{u,i,t-h}}{F_{i,t-h}}$ = the cost of fuel in the nation relative to the region.

$\frac{Y_{u,j,t}}{Y_{j,t}}$ = the cost of the j^{th} input in the nation relative to the region (where regional purchases include a certain proportion of regionally produced output).

$\lambda_{k,i}$; $\lambda_{o,i}$; $\lambda_{j,i}$ = the share of total factor costs of capital, fuel and other input costs ($j=1,2,....n$), respectively.

v = the average life of equipment.

Thus, in response to an increase in labor costs in a region relative to the nation, the regional labor intensity will decrease until a new equilibrium is reached after all the equipment designed for the old relative factor costs has been replaced. The opposite response occurs when a region experiences an increase in capital costs relative to the nation.

In section 2 we show that the relative regional rental cost of capital is:

$$\frac{C_{i,t}}{C_{u,i,t}} = \left(\frac{C_{eq,t}}{C_{u,eq,t}}\right)^{\xi_{eq,i}} \left(\frac{C_{inv,t}}{C_{u,inv,t}}\right)^{\xi_{inv,i}} \left(\frac{C_{str,t}}{C_{u,str,t}}\right)^{\xi_{str,i}} \quad (4)$$

where

$\frac{C_{i,t}}{C_{u,i,t}}$ = the relative regional cost of capital for the i^{th} industry.

eq, inv, str = equipment, inventories and structures, respectively.

$\xi_{j,i}$ = the share of the j^{th} kind of capital in total capital for the i^{th} sector.

and

$$C_{eq,t} = \left[(R_t + \delta_{eq}) \cdot B_t + \frac{(R_t + \delta_{eq})}{(1-T_{f,t})(1-T_{s,t})} \cdot (1-B_t)\right.$$

$$+ \frac{(R_t + \delta_{eq}) \, ((-T_{f,t} - T_{s,t} + T_{f,t} \cdot T_{s,t}) \cdot Z_t \cdot (1 - A_t \cdot I'_{f,t}) - I'_{f,t})}{(1 - T_{f,t}) \, (1 - T_{s,t})}$$

$$+ T_{eq,t} \, [(e^{-5(R_t + \delta_{eq})} - e^{-(1 \div \delta_{eq})(R_t + \delta_{eq})}) \, H_t + (1 - H_t)]$$

$$\left. + \frac{(R_t + \delta_{eq}) \, I'_{s,t}}{(1 - T_{s,t})} \right] \cdot Y_{eq,t} \qquad (5)$$

where

$C_{eq,t}$ = the rental cost of equipment.

R_t = the interest rate.

δ_{eq} = the rate of economic depreciation for equipment.

B_t = the proportion of business capital financed by loans and bonds.

$T_{f,t}$ = the federal corporate profits tax rate.

$T_{s,t}$ = the regional corporate profits tax rate.

Z_t = the present value of tax depreciation allowances.

A_t = 0 when the Long amendment is in effect, and 1 otherwise. The (Senator) Long amendment allows corporations to depreciate the full cost of equipment even when it was purchased using the investment tax credit.

$I'_{f,t}$ = the value of the federal investment tax credit.

$T_{eq,t}$ = the regional tax rate on equipment.

e = the base of natural logarithms.

H_t = 1 when a five year exemption from the equipment tax is available, and 0 otherwise.

$I'_{s,t}$ = the value of the regional tax credit in the t^{th} period.

$Y_{eq,t}$ = the cost of purchasing a unit of equipment in the region.

The form of the capital costs for structures and for inventories is similar to the capital cost for equipment, with the appropriate substitutions and deletions. The derivation of the cost of capital will be discussed in Section 2 below.

We will now consider the next component of equation 2. The $(E_{u,i,t}/E_{u,j,t})$ expression is a scaling term. Thus, if $l_{i,t} = \rho_i = b_{i,j} = 1$ and if $E_{u,i,t} \div E_{u,j,t} = .5$, and $\kappa_{i,j} = .1$ then the value of $e_{i,j,t}$ would be (.05) (1x.1x .5) In this case, for each 20 regional employees in the j^{th} sector, one (.05 x 20) regional employee would be required in the i^{th} sector to supply the inputs for the j^{th} sector. This term has the effect of updating the e's and d's by distributing any technological or other changes that affect the $\kappa_{i,j}$ across these coefficients. Thus, if a new method of producing i is discovered, such that the labor input per unit of output is cut by twenty percent and all of the quantities of output remain the same, then the value of .5 for $E_{u,i,t} \div E_{u,j,t}$ above would be reduced by twenty percent to .4. In this case one regional employee (.04 x 25) in the i^{th} sector would be required for each 25 regional employees in the j^{th} sector, rather than one for each 20.

The next term we will consider is the $b_{i,j}$ term. This term is necessary to compensate for changes in relative regional production input proportions that occur in response to relative regional factor costs.

$$b_{i,j} = \sum_{h=1}^{52} \frac{W_{j,t-h}}{W_{u,j,t-h}} \frac{Y_{u,i,t-h}}{Y_{i,t-h}} \qquad (6)$$

where

$\frac{Y_{u,i}}{Y_i}$ = the cost of the i^{th} input in the nation relative to the region.

The $b_{i,j}$ term demonstrates that when the cost of the i^{th} input in the region increases relative to its cost in the nation, then over time there will be a regional substitution away from that input. The $b_{i,j}$ term also shows that when the relative regional cost of the labor input in the j^{th} industry increases for a given output, then regional labor use will be reduced. This reduction in E_j must be offset when calculating the necessary inputs required by the j^{th} industry from the i^{th} industry.

The regional purchase coefficient (ρ_i) is the remaining term in equation (2) to be discussed. The regional purchase coefficient (ρ_i) has been used in other work; however, our method for calculating its value is new. We measure the ρ_i value as follows:

$$\rho_i = S_{i,t_o} \cdot \frac{Q_{i,t_o}}{\sum_{j=1}^{n} Q_{j,t_o}} \div \frac{U_{i,t_o}}{\sum_{j=1}^{n} U_{j,t_o}} \qquad (7)$$

S_{i,t_o} = the proportion of the i^{th} regional output that was shipped less than 100 miles in the same year that is used for the input-output coefficients (t_o).

$$\frac{Q_{i,t_o}}{\sum_{j=1}^{n} Q_{j,t_o}}$$ = the proportion of total output of the region in period t_o produced by the i^{th} sector.

$$\frac{U_{i,t_o}}{\sum_{j=1}^{m} U_{j,t_o}}$$ = the proportion of the regional use of all commodities in period t_o represented by the i^{th} commodity.

Suppose that the regional production of the i^{th} output represents three percent of total regional output, and that regional use of the i^{th} commodity represents three percent of the regional use of all commodities. In this case, if fifty percent of the commodity is shipped to destinations within the region ($S_{i,o} = .5$), then the regional purchase coefficient (ρ_i) will also be .5. Therefore, any regional increase in the use of the i^{th} commodity will increase the demand for the regional production of that commodity by fifty percent of the total increase. However, if $S_{i,o} = .5$, and the regional output of the i^{th} commodity represents three percent of its total regional output as above, but regional use of the i^{th} commodity represents five percent of its use of all commodities instead of three percent as above, then the regional purchase coefficient (ρ_i) would be .30 ($.5x(3 \div 5)$) instead of .5. In this case only thirty percent of any increase in regional demand would be supplied locally instead of the fifty percent in the first case. In both cases it is assumed that the ρ_i in the base year will persist.

As a practical consideration in the above explanation of equation 2, three variables have been introduced for which there is no regional data.

These variables are the U's, Q's and Y's. In section 2 below, we will show that the following proxies can be used.

$$\frac{U_{i,t}}{U_{u,i,t}} = \sum_{\substack{j=1 \\ j\neq i}}^{n} \kappa_{i,j} \cdot b_{i,j} \cdot \frac{Q_{j,t}}{Q_{u,j,t}} + \sum_{j=n+1}^{m} \kappa_{i,j} \frac{D_{j,t}}{D_{u,j,t}} \tag{8}$$

$$\frac{Q_{i,t}}{Q_{u,i,t}} = \frac{E_{i,t}}{E_{u,i,t}} \div l_{i,t} \tag{9}$$

$$\frac{Y_{i,t}}{Y_{u,i,t}} = (1-\rho_i) + \rho_i \left[\left(\frac{C_{i,t-1}}{C_{u,i,t-1}}\right)^{\lambda_{k,i}} \cdot \left(\frac{F_{i,t-1}}{F_{i,t-1}}\right)^{\lambda_{o,i}} \cdot \left(\frac{W_{i,t-1}}{W_{u,i,t-1}}\right)^{1-\lambda_{k,i}-\lambda_{o,i}-\sum_{p=1}^{n}\lambda_{p,i}} \cdot \left(\frac{Y_{i,t-1}}{Y_{u,1,t-1}}\right)^{\lambda_{1,i}} \cdot \left(\frac{Y_{2,t-1}}{Y_{u,2,t-1}}\right)^{\lambda_{2,i}} \cdots\cdots \left(\frac{Y_{u,n,t-1}}{Y_{n,t-1}}\right)^{\lambda_{n,i}} \right] \tag{10}$$

where all of the terms are defined above.

(c) Regional employment dependent on regional final use (d's)

We now consider the d coefficient appearing in equation 1

$$d_{i,j,t} = \rho_i \cdot \kappa_{i,j} \cdot l_{i,t} \cdot \frac{E_{u,i,t}}{D_{u,j,t}} \tag{11}$$

where all of the terms have been defined above.

If $\rho_i = l_{i,t} = 1$, then the value of $d_{i,j,t}$ would be the proportion of the output of commodity i going into the final demand sector (D) in the national input-output table ($\kappa_{i,j}$), scaled to reflect the current number of employees in the i^{th} sector per unit of final demand in the j^{th} sector nationally ($E_{u,i,t}/D_{u,j,t}$). In addition to scaling, this last term also reflects technological and other changes that may alter the number of employees that are required in the i^{th} sector for all units of final demand and employment sectors taken together. In our work there are four sectors of final demand--investment, state and local government, federal government and consumption. Deflated values are used for investment and state and local government spending. Federal employment is used to measure federal government demand. Since consumption is not measured regionally we assume that consumption will be closely related to real disposable income.

(d) Regional employment dependent on regional exports ($E^X_{i,t}$)

$$E^X_{i,t} = \hat{\gamma}_i \, P_{i,t}^{\hat{\varepsilon}} \, l_{i,t} \cdot E_{u,i,t} + V_{i,t} \qquad (12)$$

where

$P_{i,t}$ = the average cost of producing one unit of the i^{th} commodity in the region relative to the nation.

$l_{i,t}$ = the relative regional labor intensity as defined above.

$E_{u,i,t}$ = national employment in the i^{th} sector.

$\hat{\varepsilon}$ = the elasticity of response of the proportion of national use supplied by the region in question to changes in relative production costs, (i.e., the location responsiveness of export production).

$V_{i,t}$ = the error term.

$\hat{\gamma}_i$ = the value that minimizes the sum of squares of $V_{i,t}$ in the sample period for the i^{th} industry.

The $\hat{\varepsilon}$ value is calculated by performing the non-linear regression that minimizes the following sum of squares:

$$SS = \sum_{i=1}^{m} \sum_{t=1}^{w} \left(\frac{E^X_{i,t}}{E_{u,i,t} \cdot l_{i,t}} \cdot \overline{E_{u,i} \cdot l_i} - \hat{\gamma}_i \, P_{i,t}^{\hat{\varepsilon}} \right)^2 \qquad (13)$$

where

$$\overline{E_{u,i} \cdot l_i} = \sum_{t=1}^{w} \frac{1}{w} \cdot E_{u,i,t} \cdot l_{i,t} \qquad (14)$$

and where m is the number of sectors, w is the length of the sample period and $\hat{\gamma}_i' = \hat{\gamma}_i \cdot \overline{E_{u,i} \cdot l_i}$.

The value for P, based on profit maximizing firms and a Cobb-Douglas Constant Returns to Scale Production Function is shown in Section 2 to be:

$$P_{i,t} = \sum_{h=1}^{g} \frac{1}{g} \left(\frac{C_{i,t-h}}{C_{u,i,t-h}} \right)^{\lambda_{k,i}} \cdot \left(\frac{F_{t-h}}{F_{u,t-h}} \right)^{\lambda_{o,i}} \cdot \left(\frac{W_{i,t-h}}{W_{u,i,t-h}} \right)^{1-\lambda_{k,i}-\lambda_{o,i}-\sum_{p=1}^{n}\lambda_{p,i}}$$

$$\left(\frac{Y_{1,t-h}}{Y_{u,i,t-h}} \right)^{\lambda_{1,i}} \cdot \left(\frac{Y_{i,t-h}}{Y_{u,i,t-h}} \right)^{\lambda_{2,i}} \cdots \left(\frac{Y_{n,t-h}}{Y_{u,n,t-h}} \right)^{\lambda_{n,i}} \qquad (15)$$

g= the length of the average time required to return to a locational equilibrium.

It should be noted that the total change in regional export employment in response to a change in relative factor costs will differ from the value of ε . This is because the regional labor intensity($l_{i,t}$) is also a function of all the factor costs. Thus, if regional capital costs are increased relative to the nation, the regional locational response (ε) decreases employment (P increases but is raised to the negative power ε) while the factor substitution effect ($l_{i,t}$) will be an increase in employment. However, if the regional labor costs are increased, both the location effect and the factor substitution effect will be decreased employment.

2. The Derivation of the Employment Equation

(a) Introduction and assumptions

In this section we set forth the assumptions that underlie the employment equation in Section 1. Then we derive each of the terms in the employment equation from our assumptions.

The four assumptions on which our employment equation is based are:

1. The typical business firm seeks to maximize profits.

2. Regional and national production processes, including the state of technological advancement in the i^{th} industry, are the same. A full input Cobb-Douglas production function with constant returns to scale and factor-neutral technological change can be used to represent this production process.

3. The marketing cost advantage of local production for local use in any particular region is sufficiently stable and important that the proportion of the local use of the i^{th} commodity that is supplied locally will remain constant over time, even if there are changes in relative regional production costs.

4. The location of the production of the goods and services that are exported from the region will respond to changes in relative regional production costs. In the absence of locational changes the export regional share of national production will be maintained.

Our four assumptions require some discussion. The profit maximization motive, assumption (1), must be one of the dominant factors in business decisions for our model structure to be valid. Variables that affect working and living in Massachusetts such as personal taxes and the cost of living in Massachusetts are taken into account, but personal intangibles such as a preference for life in Massachusetts are not explicitly in the model. These personal intangibles are included in the initial conditions and are assumed to remain constant over the sample and forecast period. Business intangibles (such as "the business climate") are expected to follow the quantitative measures that influence business profitability.

The Cobb-Douglas production function,assumption (2),could be changed to a more general production function for later work. However, the Cobb-Douglas function has received support from Griffen and Gregory (4, p. 855) in regard to the substitutability between fuel and other inputs (but not for substitutability between capital and labor). Unpublished work by Che Tsao of the Economics Department at the University of Massachusetts has shown that the Cobb-Douglas production function provides the best fit of those tested for the majority of U.S. 2-digit manufacturing industries. In any case the production function literature has been inconclusive up to this point, especially with regard to non-manufacturing. Therefore, the choice of the Cobb-Douglas form with full inputs would appear to be a reasonable simplifying assumption at this juncture.

The marketing cost assumption (3) allows us to separate production for local use from the location to minimize production cost. Instead of the dichotomous distinction between export industries and local supply industries that has been used in other work, our method allows for a recognition that industries are in fact on a continuum that runs from production almost entirely for local use to almost entirely for export. Based on an observed value of production for local use, we argue that some proportion of the use of each commodity must be supplied locally. Examples of commodities where a high percentage are supplied locally would be haircuts, special textile runs for a neighboring apparel firm owned by a family member, and a machine shop doing special order work for local firms.

The dependence of the export share of national production on relative cost assumption (4), rests on the proposition that the location of the production of export goods and services can be moved in response to cost advantages that develop in other regions. The independence of export production from local use demand enables it to be "footloose" in the long run and to respond to changes in relative input costs.

Regional employment in the i^{th} sector can be divided into employment that depends on local use of the output and employment that depends on exports from the region.

$$E_{i,t} = E^L_{i,t} + E^X_{i,t} \tag{16}$$

where the superscripts L and X denote local and export employment respectively.

In this section we first derive an equation to explain $E^L_{i,t}$ and then one to explain $E^X_{i,t}$. Next we derive the relative regional production cost (P) and then the implicit rental cost of capital (C). These derivations in combination with equation 16 complete the derivation of the employment equation presented in Section 1.

(b) Derivation of an equation for $E^L_{i,t}$

The problem is to show that:

$$E^L_{i,t} = \sum_{j=1}^{n} \kappa_{i,j} \cdot \rho_i \cdot l_{i,t} \cdot \frac{E_{u,i,t}}{E_{u,j,t}} \cdot b_{i,j} \cdot E_{j,t} + \sum_{j=n+1}^{m} \kappa_{i,j} \cdot \rho_i l_{i,t} \cdot \frac{E_{u,i,t}}{D_{u,j,t}} D_{j,t} \cdot \tag{17}$$

From assumption (3) we can write:

$$\frac{Q^L_{i,t}}{Q_{u,i,t}} = \sum_{\substack{j=1 \\ j \neq i}}^{n} \kappa_{i,j} \cdot \rho_i \cdot \frac{X_{j,i,t}}{X_{u,j,i,t}} + \sum_{j=n+1}^{m} \kappa_{i,j} \cdot \rho_i \cdot \frac{D_{j,t}}{D_{u,j,t}} \tag{18}$$

where

$\frac{X_{j,i,t}}{X_{u,j,i,t}}$ = the ratio of the regional to the national use of the i^{th} input by the j^{th} sector.

While the national relationships are employed to estimate the proportion of output going to each use, the $\kappa_{i,j}$'s are only used as weights and will not introduce a bias unless the special conditions required for the index number problem exist. In order to verify equation 18 we add up across regions where r denotes the r^{th} region and where there are z regions.

$$\frac{\sum_{r=1}^{z} Q^{L}_{r,i,t}}{Q_{u,i,t}} = \sum_{\substack{j=1 \\ j\neq 1}}^{n} \kappa_{i,j} \sum_{r=1}^{z} \rho_{r,i} \frac{X_{r,j,i,t}}{X_{u,r,j,i,t}} + \sum_{j=n+1}^{m} \kappa_{i,j} \sum_{r=1}^{z} \rho_{r,i} \frac{D_{r,j,t}}{D_{u,j,t}} \quad (19)$$

when $\rho_{1,i} = 1$ for all r, then equation 19 reduces to 1=1. However, when $\rho_{r,i} \neq 1$, then equation 19 reduces to

$$\frac{\sum_{r=1}^{z} Q^{L}_{r,i,t}}{Q_{u,i,t}} = \rho_i^* \quad (20)$$

where ρ_i^* is the weighted average of the regional purchase coefficients. Thus, ρ_i^* is the proportion of the i^{th} output nationally that is used in the same region in which it is produced.

From assumption 2 we can write the following production function:

$$Q_{j,t} = O_j(t) \cdot \left(E_{j,t}\right)^{1-\lambda_{k,j}-\lambda_{o,j}-\sum_{p=1}^{n}\lambda_{p,j}} \cdot \left(K_{j,t}\right)^{\lambda_{k,j}} \cdot \left(O_{j,t}\right)^{\lambda_{o,j}} \cdot$$

$$\left(X_{j,1,t}\right)^{\lambda_{1,j}} \cdots\cdots \left(X_{j,n,t}\right)^{\lambda_{n,j}} \quad (21)$$

$\theta_j(t)$ = factor neutral changes in technology in the j^{th} sector.

$K_{j,t}$ = the regional capital stock in the j^{th} sector.

$O_{j,t}$ = the regional fuel input in the j^{th} sector.

$X_{j,i,t}$ = the regional input of the i^{th} commodity into the j^{th} sector.

Using assumption 1 we can obtain the following first order conditions:

$$\frac{\partial Q_{j,t}}{\partial E_{j,t}} = (1-\lambda_{k,j}-\lambda_{o,j}-\sum_{p=1}^{n} \lambda_{p,j}) \frac{Q_{j,t}}{E_{j,t}} = \frac{W_{j,t}}{Y_{j,t}} \tag{22}$$

$$\frac{\partial Q_{j,t}}{\partial K_{j,t}} = \lambda_{k,i} \frac{Q_{j,t}}{K_{j,t}} = \frac{C_{j,t}}{Y_{j,t}} \tag{23}$$

$$\frac{\partial Q_{j,t}}{\partial O_{j,t}} = \lambda_{o,i} \frac{Q_{j,t}}{O_{j,t}} = \frac{F_{j,t}}{Y_{j,t}} \tag{24}$$

$$\frac{\partial Q_{j,t}}{\partial X_{j,1,t}} = \lambda_{1,j} \frac{Q_{j,t}}{X_{j,1,t}} = \frac{Y_{1,t}}{Y_{j,t}} \tag{25.1}$$

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$$\frac{\partial Q_{j,t}}{\partial X_{j,n-1,t}} = \lambda_{n-1,j} \frac{Q_{j,t}}{X_{j,n-1,t}} = \frac{Y_{n-1,t}}{Y_{j,t}} \tag{25.n-1}$$

$$\frac{\partial Q_{j,t}}{\partial X_{j,n,t}} = \lambda_{n,j} \frac{Q_{j,t}}{X_{j,n,t}} = \frac{Y_{n,t}}{Y_{j,t}} \tag{25.n}$$

dividing equation 25.n by equations 22 through 25.n-1 respectively we get:

$$E_{j,t} = \frac{Y_{n,t}}{W_{j,t}} \cdot \frac{1-\lambda_{k,j}-\lambda_{o,j}-\sum_{p=1}^{n} \lambda_{p,j}}{\lambda_{n,j}} \cdot X_{j,n,t} \tag{26}$$

$$K_{j,t} = \frac{Y_{n,t}}{C_{j,t}} \cdot \frac{\lambda_{k,j}}{\lambda_{n,j}} \cdot X_{j,n,t} \tag{27}$$

$$O_{j,t} = \frac{Y_{n,t}}{F_{j,t}} \cdot \frac{\lambda_{o,j}}{\lambda_{n,i}} \cdot X_{j,n,t} \tag{28}$$

$$X_{j,1,t} = \frac{Y_{n,t}}{Y_{1,t}} \cdot \frac{\lambda_{1,j}}{\lambda_{n,j}} \cdot X_{j,n,t} \tag{29.1}$$

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$$X_{j,n-1,t} = \frac{Y_{n,t}}{Y_{n-1,t}} \cdot \frac{\lambda_{n-1,j}}{\lambda_{n,j}} \cdot X_{j,n,t} \tag{29.n-1}$$

When we substitute equations 26 through 29.n-1 into 21, solve for $X_{j,n,t}$ and then take the ratio to a similar function for the U.S., we find that

$$\frac{X_{j,n,t}}{X_{u,j,n,t}} = \frac{Q_{j,t}}{Q_{u,j,t}} \cdot \left(\frac{W_{j,t}}{W_{u,j,t}}\right)^{1-\lambda_{k,j}-\lambda_{o,j}-\sum_{p=1}^{n}\lambda_{p,j}} \cdot \left(\frac{Y_{u,n,t}}{Y_{n,t}}\right)^{1-\lambda_{n,j}} \cdot$$

$$\left(\frac{C_{j,t}}{C_{u,j,t}}\right)^{\lambda_{k,j}} \cdots\cdots \left(\frac{Y_{1,j}}{Y_{u,1,j}}\right)^{\lambda_{1,j}} \cdot \left(\frac{Y_{2,j}}{Y_{u,2,j}}\right)^{\lambda_{2,j}} \cdots\cdots \left(\frac{Y_{n-1,t}}{Y_{u,n-1,t}}\right)^{\lambda_{n-1,j}} \tag{30}$$

More generally this equation can be written for any commodity i instead of specifically for the n^{th} commodity.

When we repeat the above procedure for $E^{L}_{j,t}$ instead of $X_{j,n,t}$ (i.e., divide equation 22 by equations 23-25.n then substitute into 21 and then take the ratio to a similar function for the U.S.), we find that

$$\frac{Q_{j,t}}{Q_{u,j,t}} = \frac{E_{j,t}}{E_{u,j,t}} \cdot \left(\frac{W_{j,t}}{W_{u,j,t}}\right)^{\lambda_{k,j}+\lambda_{o,j}+\sum_{p=1}^{n}\lambda_{p,j}} \left(\frac{C_{u,j,t}}{C_{j,t}}\right)^{\lambda_{o,j}}$$

$$\left(\frac{F_{u,i,t}}{F_{i,t}}\right)^{\lambda_{o,j}} \left(\frac{Y_{u,1,t}}{Y_{1,t}}\right)^{\lambda_{1,j}} \cdot \left(\frac{Y_{u,2,t}}{Y_{2,t}}\right)^{\lambda_{2,j}} \cdots\cdots \left(\frac{Y_{u,n,t}}{Y_{n,t}}\right)^{\lambda_{n,j}} \tag{31}$$

If this expression is true for all Q it is also true for production for local markets. Thus, we can write the same expression with the local super-scripts for $Q_{j,t}$ and $E_{j,t}$.

$$\frac{Q^L_{i,t}}{Q_{u,i,t}} = \frac{E^L_{i,t}}{E_{u,i,t}} \cdot \left(\frac{W_{i,t}}{W_{u,i,t}}\right)^{\lambda_{k,i} + \lambda_{o,i} + \sum_{p=1}^{n} \lambda_{p,i}} \left(\frac{C_{u,i,t}}{C_{i,t}}\right)^{\lambda_{k,i}}$$

$$\left(\frac{F_{u,i,t}}{F_i}\right)^{\lambda_{o,i}} \cdot \left(\frac{Y_{u,i,t}}{Y_{1,t}}\right)^{\lambda_{1,i}} \cdots\cdots \left(\frac{Y_{u,n,t}}{Y_{n,t}}\right)^{\lambda_{n,i}} \qquad (32)$$

Substituting 31 into 30 then substituting this expression and equation 32 into equation 18 and solving for $E_{i,t}$ we find that

$$E_{i,t} = \frac{1}{\left(\frac{W_{i,t}}{W_{u,i,t}}\right)^{\lambda_{k,i} + \lambda_{o,i} + \sum_p \lambda_{p,i}} \cdot \left(\frac{C_{u,i,t}}{C_{i,t}}\right)^{\lambda_{k,i}} \cdot \left(\frac{F_{u,i,t}}{F_{i,t}}\right)^{\lambda_{o,i}} \left(\frac{Y_{u,i,t}}{Y_{1,t}}\right)^{\lambda_{1,i}} \cdots \left(\frac{Y_{u,n,t}}{Y_{n,t}}\right)^{\lambda_{n,i}}}$$

$$\sum_{\substack{j=1 \\ j \neq i}}^{n} \kappa_{i,j} \cdot \rho_i \left[\left(\frac{W_{j,t}}{W_{u,j,t}}\right)^{\lambda_{k,j} + \lambda_{o,j} + \sum_{p=1}^{n} \lambda_{p,j}} \left(\frac{C_{u,j,t}}{C_{j,t}}\right)^{\lambda_{k,j}} \cdot \left(\frac{F_{u,j,t}}{F_{j,t}}\right)^{\lambda_{o,i}}\right.$$

$$\left(\frac{Y_{u,1,t}}{Y_{1,t}}\right)^{\lambda_{1,j}} \cdot\cdot \left(\frac{Y_{u,i,t}}{Y_{i,t}}\right)^{\lambda_{i,j}} \cdots \left(\frac{Y_{u,n,t}}{Y_{n,t}}\right)^{\lambda_{n,j}} \quad \left(\frac{W_{j,t}}{W_{u,j,t}}\right)^{1-\lambda_{k,j}-\lambda_{o,j}-\sum_{p=1}^{n}\lambda_p}$$

$$\left.\left(\frac{Y_{u,i,t}}{Y_{i,t}}\right)^{1-\lambda_{i,j}} \cdot \left(\frac{C_{j,t}}{C_{u,t}}\right)^{\lambda_{k,j}} \cdot \left(\frac{Y_{i,t}}{Y_{u,1,t}}\right)^{\lambda_{1,j}} \cdots \left(\frac{Y_{n,t}}{Y_{u,n,t}}\right)^{\lambda_{n,j}}\right]$$

$$\frac{E_{u,i,t}}{E_{u,j,t}} \cdot E_{j,t} + \sum_{j=n+1}^{m} \kappa_{i,j} \cdot \rho_i \frac{D_{j,t}}{D_{u,j,t}} \qquad (33)$$

The first term in equation 33 becomes $1_{i,t}$ if we assume that equilibrium factor intensities are only realized as new equipment replaces old equipment. All of the terms in the brackets after ρ_i cancel except the following product: $(W_{j,t}/W_{u,j,t}) \cdot (Y_{u,i,t}/Y_{i,t})$. If we again assume that equilibrium is achieved as new equipment is installed, the terms after ρ_i in the above expression become $b_{i,j}$ (see equation 6 above). The economic reason why almost all the terms cancel is that the increase in the price of an input leads to a proportionate increase in all other inputs. Since both $E_{j,t}$ and $Q_{i,t}$ are other inputs, the proportionate increase in $Q_{i,t}$ is already included, because $E_{j,t}$ is in the explanatory variable set. The situation is different only in the instance where either W_j or Y_i is increased. In the former case, there will be a substitution away from E_j but not from Q_i. In the latter, there will be a substitution away from Q_i but not from E_j. With the substitution of $l_{i,t}$ and $b_{i,j}$ equation 33 reduces to equation 17, which is the equation that we are deriving from the assumptions.

(c) Derivation of an equation for $E^X_{i,t}$.

The problem is to show that equation 12 is consistent with our assumptions. Using assumption 4 we can write

$$\frac{Q^X_{i,t}}{Q_{u,i,t}} = \gamma_i P^{\varepsilon}_{i,t} + V'_{i,t} \tag{34}$$

where $V'_{i,t}$ is an intermediate error term.

If we use a superscript X instead of L in equation 32 and then substitute for the dependent variable in equation 34, we can then solve for $E^X_{i,t}$ and obtain

$$E^X_{i,t} = \gamma_i \, P^{\varepsilon}_{i,t} \, l_{i,t} E_{u,i,t} + V'_{i,t} E_{u,i,t} l_{i,t} \tag{35}$$

which is the same as equation 12 above if $V_{i,t}$ is defined as

$$V_{i,t} = V'_{i,t} E_{u,i,t} \, l_{i,t} \tag{36}$$

(d) Derivation of a moving average of relative regional costs ($P_{i,t}$).

The problem is to show that equation 15 can be derived from our assumptions. Using assumptions 3 and 4 we now derive the moving average of the relative production cost ($P_{i,t}$) for the i^{th} industry. We start with total cost

$$TC_{i,t} = W_{i,t} \cdot E_{i,t} + C_{i,t} \cdot K_{i,t} + F_{i,t} \cdot O_{i,t} + Y_{1,t} \cdot X_{i,1,t} + \dots\dots + Y_{n,t} \cdot X_{i,n,t} \tag{37}$$

where $TC_{i,t}$ = the total regional production cost for the i^{th} industry and where the other terms are defined above.

By dividing equation 22 by equations 23 through 25.n and then substituting into equation 19 we find that:

$$E_{i,t} = Q_{i,t} \cdot \theta_i(t)^{-1} (\lambda_i\text{'s})^{-\lambda_i\text{'s}} \cdot \left(\frac{W_{i,t}}{C_{i,t}}\right)^{-\lambda_{k,i}} \cdot \left(\frac{W_{i,t}}{F_{i,t}}\right)^{-\lambda_{o,i}} \cdot \left(\frac{W_{i,t}}{Y_{1,t}}\right)^{-\lambda_{1,i}} \left(\frac{W_{i,t}}{Y_{2,t}}\right)^{\lambda_{2,i}} \dots\dots\dots \left(\frac{W_{i,t}}{Y_{n,t}}\right)^{\lambda_{n,i}} \tag{38}$$

By again dividing equation 22 by equations 23 through 25.n, substituting into equation 37, and simplifying, we obtain:

$$TC_{i,t} = E_{i,t} \cdot W_{i,t} \cdot \frac{1}{1-\lambda_{k,i}-\lambda_{o,i}-\sum_p \lambda_{p,i}} \tag{39}$$

If we now express total cost as $AC_{i,t} \cdot Q_{i,t}$ where $AC_{i,t}$ is average cost , and substitute equation 38 into equation 39 and solve for $AC_{i,t}$ we find that:

$$AC_{i,t} = \theta_i(t)^{-1} \cdot (\lambda_i's)^{-\lambda_i's} \cdot \left(W_{i,t}\right)^{1-\lambda_{k,i}-\lambda_{o,i}-\sum_{p=1}^{n}\lambda_{p,i}} \cdot \left(C_{i,t}\right)^{\lambda_{k,i}}$$

$$\cdot \left(F_{i,t}\right)^{\lambda_{o,i}} \cdot \left(Y_{1,t}\right)^{\lambda_{1,i}} \cdots \left(Y_{n,t}\right)^{\lambda_{n,i}} \tag{40}$$

Now if we divide 40 by the similar expression for the nation, and again employ the part of assumption 2 that says that the λ and $\theta(t)$ values are the same in the region as in the nation, we obtain:

$$\frac{AC_{i,t}}{AC_{u,i,t}} = \left(\frac{W_{i,t}}{W_{u,i,t}}\right)^{1-\lambda_{k,i}-\lambda_{o,i}-\sum_{p=1}^{n}\lambda_{p,i}} \left(\frac{C_{i,t}}{C_{u,i,t}}\right)^{\lambda_{k,i}} \cdot \left(\frac{F_{i,t}}{F_{u,i,t}}\right)^{\lambda_{o,i}}$$

$$\left(\frac{Y_{1,i}}{Y_{u,1,t}}\right)^{\lambda_{1,i}} \cdot \left(\frac{Y_{2,t}}{Y_{u,2,t}}\right)^{\lambda_{2,i}} \cdots\cdots \left(\frac{Y_{n,t}}{Y_{u,n,t}}\right)^{\lambda_{n,i}} \tag{41}$$

This value, when averaged over the time required for a new equilibrium to be established, becomes equation 15.

(e) Derivation of the implicit rental cost of capital ($C_{j,t}$).

In equation 4 the treatment of the three different types of capital is directly analogous to the treatment of the multiple input costs in equation 41, and therefore does not have to be discussed here. Our problem is to show that equation 5 can be derived from our assumptions.

Our derivation of the implicit rental cost of capital is adapted from Hall and Jorgenson (5, pp. 391-414). We derive the cost of capital for a piece of equipment purchased in period t ($C_{eq,t}$). However, we start with the after tax cost in period t of the services of the piece of equipment purchased in period t_o,

$$C'_{eq,t_o,t} = C_{eq,t_o,t} - TAX_{f,t} - TAX_{eq,t} - TAX_{s,t}. \qquad (42)$$

where

$C'_{eq,t_o,t}$ = the after tax return in period t of a piece of equipment purchased in period t_o.

$C_{eq,t_o,t}$ = the pre-tax return in the t^{th} period from a piece of equipment purchased in period t_o.

$TAX_{f,t}$ = federal profits tax collections in the t^{th} period.

$TAX_{s,t}$ = regional profits tax collections in the t^{th} period.

The equation for ·' federal profits tax collections is

$$TAX_{f,t} = T_{f,t} \Big[C_{eq,t_{o,t}} - TAX_{s,t} - TAX_{eq,t}$$

$$-D_{eq,t} \cdot (1-A \cdot I'_{f,t}) Y_{eq,t_o} - R_t \cdot Y_{eq,t_o} \cdot B_t \Big] - I'_{f,t} \cdot Y_{eq,t_o} \qquad (43)$$

where

$D_{eq,t}$ = the depreciation allowed for federal taxes in the t^{th} period,

Y_{eq,t_o} = the price of the piece of equipment in period t_o,

and the other terms are defined after equations 5 and 42 above.

The equation for the regional profits tax is

$$TAX_{s,t} = T_{s,t} \Big[C_{eq,t_o,t} - D_{eq,t}(1-A.I'_{f,t}) \cdot Y_{eq,t_o} - R_t \cdot Y_{eq,t_o} \cdot B_t \Big] - TAX_{eq,t} \quad -I'_{s,t} \cdot Y_{eq,t_o} \tag{44}$$

The equation for the regional tax on the value of equipment when no special exemptions is applicable is

$$TAX_{eq,t} = T_{eq,t} \cdot Y_{eq,t_o} \tag{45}$$

If we substitute into equation 42 from equations 43, 44 and 45, and make the appropriate simplifications, we find that:

$$\begin{aligned} C'_{eq,t_o,t} = {} & (1 - T_{f,t} + T_{f,t} \cdot T_{s,t} - T_{s,t})\, C_{eq,t_o,t} \\ & - (T_{f,t} \cdot T_{s,t} - T_{f,t} - T_{s,t})\, D_{eq,t}(1-A \cdot I_{f,t}) \cdot Y_{eq,t_o} \\ & - (T_{f,t} \cdot T_{s,t} - T_{f,t} - T_{s,t})\, R_t Y_{eq,t_o} \cdot B_t \\ & - (T_{f,t} T_{s,t} - T_{f,t} - T_{s,t} + 1)\, T_{eq,t} \cdot Y_{eq,t_o} \\ & + (1-T_{s,t})\, I'_{s,t} \cdot Y_{eq,t_o} + I'_{f,t} \cdot Y_{eq,t_o} \end{aligned} \tag{46}$$

In equilibrium the firm will equate the present value of net returns from equipment investment to its purchase price.

$$Y_{eq,t_o} = \int_{t_o}^{\infty} \left(e^{-(R_t + S_{eq}).t} \, C'_{eq,t_o,t} \right) dt \tag{47}$$

Substituting equation 46 into equation 47, performing the integration under static tax and price assumptions, dividing through by Y_{eq,t_o} and solving for $C_{eq,t_o}/Y_{eq,t_o}$ we find that:

$$\frac{C_{eq,t_o}}{Y_{eq,t_o}} = (R_t + \delta_{eq})\ B_t + \frac{(R_t+\delta_{eq})\ (1-B_t)}{(1-T_{f,t})\ (1-T_{s,t})}$$

$$+ \frac{(R_t+\delta_{eq})\ (-T_{f,t}-T_{s,t}+T_{f,t}.T_{s,t})\ .\ Z_t\ .\ (1-A_t.I'_{f,t})-I'_{f,t}}{(1-T_{f,t})\ (1-T_{s,t})}$$

$$+ T_{eq,t} + \frac{(R_t+\delta_{eq})\ I'_{s,t}}{(1-T_{s,t})} \tag{48}$$

where $C_{eq,t_o}/Y_{eq,t_o}$ = the rental cost of equipment purchased in period t_o and where the terms are defined after equation 5 above. Here

$$Z_{t_o} = \int_o^{\infty} D_{eq,t}\ e^{-(R_t+\delta_{eq})t}\ dt \tag{49}$$

In order to reflect the five year exemption of equipment from the equipment tax, we perform the following integration

$$\frac{TAX_{eq,t_o}}{Y_{eq,t_o}} = \int_o^{(1+\delta_{eq})} e^{-(R_t+\delta_{eq})t}\ T_{eq,t}dt - \int_o^5 e^{-(R_t+\delta_{eq})t}\ T_{eq,t}dt \tag{50}$$

Solving for $TAX_{eq,t_o}/Y_{eq,t_o}$ when the equipment five year exemption is in force (H_t=1), we find that

$$\frac{TAX_{eq,t_o}}{Y_{eq,t_o}} = (e^{-5(R_t + \delta_{eq})} - e^{-(1-\delta_{eq})\,(R_t + \delta_{eq})})\, T_{eq,t} \qquad (51)$$

Using 51 and H and replacing $C_{eq,t_o}/Y_{eq,t_o}$ with $C_{eq,t}/Y_{eq,t}$ in equation 48 we obtain equation 5.

3. The Quantitative Results for Massachusetts

We have implemented our regional employment equation structure for Massachusetts using quarterly data from the first quarter of 1954 through the third quarter of 1975. The above specification was used without modification for 23 employment sectors. It was also used with the exception of the export term for contract construction and transportation and utilities. Alternative specifications were used for the three government sectors.

We will discuss the parameter values that were found as a result of selecting values to minimize squared error before we present the values from other sources. The values found to minimize sample period squared employment error over all industries were (1) the location response of export production to changes in Massachusetts costs relative to those in the nation (ε), (2) the length of the location response time (g), and (3) the relationship of the Massachusetts share of export production to demand for export employment (γ_1) when the location elasticity is ε. That is we expressed the squared error of employment summed over both 23 sectors and over the 35 perioda available to us as a function of (ε, g, γ_1) and we found the values of ε, g, and γ_i that minimized this function (see equation 13).

Our computer algorithm started with arbitrary values of ε and g and then for each sector found the γ_i values that minimized squared error. Then the value of ε or g was changed and the process was repeated until we found the values of ε and g that minimized the average squared error over all periods over all industries. The length of the location response period (g) that minimized squared error was 5 years. The elasticity of location response (ε) that minimized squared error was -4.28. The sum of squares for our 805 observations was .00828 (this compares with a sum of squares of .01015 when ε was 0). The reduction in squared error required for significance in an F test at the 1% level, is only .00011. Thus, the drop in the sum of squares from when $\varepsilon = o$ was 17 times as great as necessary for statistical significance at the one percent level if the errors were independent.

The input-output values ($\kappa_{i,j}$'s) were taken from the U.S. 1967 input-output table. The shares of equipment ($\xi_{eq,i}$), inventory ($\xi_{inv,i}$) and structures ($\xi_{str,i}$) used in arriving at the capital cost variable (equation 4), are .52, .34 and .14 respectively for manufacturing, and .47, .07 and .47 respectively for non-manufacturing. The values of depreciation for equipment (δ_{eq}), structures (δ_{str}) and inventory (δ_{inv}) are 1/13, 1/35 and 0 respectively. The other employment sector values are shown in Table 1. Since transportation data for non-manufacturing is not available, the regional purchase coefficients were set at the highest value that would insure exports greater than zero during the sample period, with a maximum value of 1.00.

4. Government Employment Equations

In addition to the equations for the private sector wage and salary employment, we have three categories of government employment: Federal, State and Local.

TABLE 2-1
EMPLOYMENT SECTOR PARAMETERS

	Regional Purchase Coefficient ρ_i	$\hat{\gamma}_i$	Proportion of Employment Dependent On Exports 1975:3	Proportion of the i^{th} Sectors Costs Attributable To: Labor $1-\lambda_{k,i}-\lambda_{o,i}-\sum_{p=1}^{n}\lambda_{p,i}$	Capital $\lambda_{k,i}$
Manufacturing					
Durables					
Ordnance(19)	.63	.053	.87	.40	.18
Lumber(24)	.09	.006	.62	.48	.22
Furniture(25)	.25	.016	.68	.45	.15
Stone,Clay,etc.(32)	.41	.013	.49	.48	.19
Primary Metals(33)	.17	.008	.62	.42	.19
Fabricated Metals(34)	.28	.019	.75	.31	.13
Non-elec. Machines(35)	.33	.030	.83	.32	.15
Elect. Equipment(36)	.14	.043	.92	.41	.15
Trans. Equip(non-M.V.)(370)	.03	.017	.95	.33	.15
Motor V. & Parts(371)	.01	.007	.96	.30	.14
Instruments(38)	.28	.066	.91	.41	.26
Non-durables					
Food(20)	.36	.010	.37	.22	.11
Textiles(22)	.31	.027	.62	.38	.14
Apparel(23)	.36	.030	.70	.38	.11
Paper(26)	.65	.025	.49	.42	.19
Printing(27)	.52	.022	.55	.44	.18
Chemicals(28)	.19	.013	.65	.29	.25
Rubber(30)	.55	.039	.65	.44	.16
Leather(31)	.68	.123	.74	.57	.21
Other Durables(39)	.56	.052	.72	.48	.21
Non-Manufacturing					
Contract Constructn(C)	1.00			.38	.05
Transport & Utilities(R)	.74			.42	.29
Wholesale & Retail Trade(T)	1.00	.003	.05	.63	.13
Finance,Ins. & Real Estate(FIR)	1.00	.005	.07	.35	.43
Service & Misc.(SV&)	1.00	.008	.20	.49	.06

(Continued)

TABLE 2-1 (Cont.)

EMPLOYMENT SECTOR PARAMETERS

Proportion Attributable to the j[th] Sector (column) of the i[th] Sectors (row) Costs

$(\lambda j,i)$

Manufacturing	F	19	24	25	32	33	34	35	36	370	371	38	20	22	23	26	27	28	30	31	39	C	R	T	FIR	SV&	A	MI
Durables																												
Ordnance (19)	.008		.01			.09	.03	.03	.06	.14		.02				.01		.03	.01									
Lumber (24)	.029			.01	.01		.03									.01		.03	.01				.05				.12	
Furniture (25)	.010		.12		.01	.06	.07							.06		.02		.02	.05									
Stone, Clay, etc. (32)	.063		.01			.01	.01	.02						.01		.04		.03	.02				.07					.07
Primary Metals (33)	.056	.01					.03	.04	.01		.01							.02					.06	.05		.03		.08
Fabricated Metals (34)	.010				.01	.33		.04	.01		.01					.01	.01	.02	.01				.03	.03	.02	.03		
Non-elec. Machines (35)	.007				.01	.17	.06		.09	.01	.01	.01							.01				.02	.05	.03	.03		
Elect. Equipment (36)	.008	.01		.01	.02	.10	.05	.04		.01	.01	.01				.01		.02	.02				.02	.04	.03	.04		
Trans. Equip. (non-M.V.)	.006	.02	.02		.01	.12	.06	.10	.05		.01	.02							.01				.02	.04		.04		
Motor V. & Parts (371)	.006				.02	.13	.13	.07	.04			.01		.01	.02			.01	.03				.03	.03		.05		
Instruments (38)	.006				.01	.07	.05	.02	.08					.01		.03		.04	.02		.01							
Nondurables																												
Food (20)	.012				.01		.03									.04	.01	.01	.01				.04	.05	.02	.05	.38	
Textiles (22)	.022				.01										.02	.01		.21	.01				.03	.05			.11	
Apparel (23)	.005													.39		.01		.03	.01		.02		.01	.04				
Paper (26)	.045		.08				.02	.01						.01			.01	.06	.02				.06	.04		.04		
Printing (27)							.01							.01		.18		.03	.01				.03		.06	.06		
Chemicals (28)	.036				.01	.02	.03	.01					.02			.04			.02				.04	.04	.05	.11		.03
Rubber (30)	.020				.01		.02							.06		.03		.23			.01		.02					
Leather (31)	.011		.01											.06	.02	.02			.09		.01							
Other Non-Durables (39)	.009		.02		.01	.08	.03							.03		.05		.04	.05									
Non-Manufacturing																												
Contract Constructi'n (C)	.030		.05	.01	.07	.04	.11	.02	.03									.02	.01				.03	.08	.01	.05		.01
Transport & Utilities (R)	.124								.01	.01												.03		.02	.04	.05		
Wholesale & Retail Trade (T)	.032												.01			.01			.01				.02		.07	.07		
Finance, Ins. & Real Est. (FIR)	.026																					.05	.02	.02		.07	.02	
Service & Misc. (SV&)	.028						.02	.01	.01		.01	.01	.03			.01	.09	.02	.01		.01	.01	.08	.04	.07			

F: Fuel

A: Agriculture

MI: Mining

TABLE 2-1 (Concluded)

EMPLOYMENT SECTOR PARAMETERS

Proportion of the i^{th} Sectors (rows) Output used by the j^{th} Sector (columns)

$(\kappa_{i,j})$

Manufacturing	19	24	25	32	33	34	35	36	370	371	38	20	22	23	26	27	28	30	31	39	C	R	T	FIR	SV&	CONS	IE	ICNR	IC	GF	GS&L
Durables																															
Ord nance(19)							.01	.02	.05																.00	.03				.89	
Lumber(24)	.01		.10	.01	.02	.02	.01	.01	.03	.01		.01			.13		.01	.00	.01	.02	.55		.02			.03				.01	
Furniture(25)		.01				.01		.04	.01	.01											.08		.01			.54		.24		.02	.04
Stone,Clay,etc.(32)		.01	.01		.01	.02	.03	.06	.01	.04	.01	.08	.01				.02	.01		.00	.58	.00	.02	.00	.03	.05					.01
Primary Metals(33)	.02	.01		.00		.31	.19	.10	.07	.10	.02						.02			.02	.12	.01			.01					.01	
Fabricated Metals(34)	.01	.01	.02	.00	.03		.07	.05	.04	.11	.01	.07			.01	.01	.03	.01		.01	.33	.01	.02		.07	.04	.04			.02	
Non-elec. Machines(35)	.01			.01	.04	.04	.	.03	.05	.05	.00	.01			.00		.01				.05	.01	.01	.01	.04	.02	.54			.05	.02
Electric Equipment(36)	.01				.02	.01	.10		.03	.03	.02										.07	.01	.01	.01	.04	.24	.18			.22	.01
Trans. Equip(non-M.V.)(370)	.06					.01	.02	.02														.04	.00			.06		.29		.51	
Motor V. & Parts(371)					.01	.01	.02	.01	.01																.05	.54		.31		.03	.03
Instruments(38)	.02				.01	.01	.03	.04	.04	.02						.02	.01				.03	.01	.03	.01	.14	.18		.23		.13	.03
Non-durables																															
Food(20)																	.01						.01		.05	.91				.01	.01
Textiles(22)	.02		.03	.01					.01	.01	.01			.61	.02	.01	.00	.06	.02	.02			.01	.00	.01	.15		.01		.01	
Apparel(23)										.03		.01	.01						.00			.01	.01		.01	.89				.02	
Paper(26)	.00	.01	.01	.03		.03	.01	.03		.01	.01	.16	.01	.02		.22	.07	.02	.01	.03	.02	.01	.10	.02	.06	.10				.01	.01
Printing(27)						.01	.01					.03			.01							.01	.02	.03	.62	.22				.01	.05
Chemicals(28)	.01	.01	.00	.01	.03	.02	.01	.02		.01	.01	.03	.01	.02	.04	.02		.10		.01	.05	.01	.02	.02	.08	.28				.07	.03
Rubber(30)	.01	.00	.03	.02	.01	.02	.05	.06	.02	.07	.01	.06	.01	.01	.03	.01	.06		.03	.03	.06	.03	.06	.01	.08	.18				.03	.02
Leather(31)														.02				.01		.01			.01		.06	.88				.01	
Other Non-durables (39)				.01	.00	.01	.01	.01	.00		.01			.04		.00	.00	.01	.01		.02		.03	.00	.19	.54		.07		.01	.02
Non-Manufacturing																															
Contract Construction(C)																						.03	.01	.07	.01				.55	.05	.28
Transport & Utilities(R)		.01		.01	.04	.01	.01	.01	.01	.01		.04	.01	.00	.01	.01	.02	.01			.03		.06	.04	.15	.37			.02	.06	.05
Wholesale & Retail Trade(T)					.01	.01	.01	.01	.00	.01		.02	.00	.01	.00		.01				.06	.01		.01	.03	.73			.04	.01	
Finance, Ins. & Real Est.(FIR)						.00	.01	.01				.01				.01	.01				.01	.02	.01		.07	.73			.02	.00	.01
Service & Misc.(SV&)					.01	.01	.01	.01	.01	.01		.03			.00	.01	.03				.04	.03	.09	.07		.57				.05	.04

CONS: Final Personal consumption expenditures
IE: Investment in equipment
ICNR: Investment in non-residential structures
IC: Investment in residential and non-residential structures
GF: Federal government purchase of final goods and services
GS&L State and local government purchases of goods and services

Federal employment is forecast exogenously. State government employment and local government employment are related to real spending by the respective governments. The equations are:

$$E_s = 1.3 \ G_s^{.65} \tag{52}$$

$$E_l = 3.6 \ G_l^{.55} \tag{53}$$

where

E_s = state government employment

E_l = local government employment

G_s = real state government spending less local aid, welfare payments (but including welfare administration), pension fund and debt service.

G_l = real local government spending

The regression results are shown below.

(a) The Local Government Employment Regression

Ordinary least squares

Frequency quarterly
Interval 58: 1 to 74:2
Left-hand variable: LEMGL

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	1.27971	.951975E-01	13.4427
LRLGE	0.550084	.137144E-01	40.1101

R-Bar Squared: 0.9611
Durbin-Watson statistic (adjusted for 0. gaps): 0.8953
Standard error of the regression: .266462E-01

LEMGL = $\log(E_{l,t})$ = the log of local government employment in Massachusetts.

LRLGE = $\log(G_l)$ = log of local government spending in Massachusetts divided by the U.S. deflator for state and local government spending.

(b) The State Government Employment Regression

Ordinary least squares

Frequency quarterly

Interval 69: 1 to 73.2

Left-hand variable: LEMGS

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	0.269518	1.27454	0.211464
LRCSEW	0.650217	0.203630	3.19313

R-bar squared: 0.3510

Durbin-Watson statistic (adjusted for 0. gaps): 0.9961

Standard error of the regression: .565984E-01

where

LEMGS = $\log(E_s)$ = the log of state government in Massachusetts.

LRCSEW = $\log(G_s)$ = the log of state government spending less local aid, welfare payments, pension fund and debt service, divided by the U.S. deflator for state and local government spending.

A complete list of the equations in the employment sector as they are programmed for computer simulation can be found in Chapter 7 below.

II. Local Demand, Including Investment Demand.

1. The Specification

The regional data for local final demand is very weak and in some cases non-existent. Therefore, we have used real disposable income as a proxy for personal consumption expenditures. We have used real government spending to measure state and local government demand. Despite the weakness of local investment data, we have modeled it explicitly for manufacturing investment, nonresidential structures and residential structures.

Dividing equation 23 by equations 22 through 25.n respectively, we obtain:

$$E_{i,t} = \frac{(1-\lambda_{k,i}-\lambda_{o,i}-\sum_{p=1}^{n}\lambda_{p,i})}{\lambda_{k,i}} \frac{C_{i,t}}{W_{i,t}} \cdot K_{i,t} \tag{54}$$

$$O_{i,t} = \frac{\lambda_{o,i}}{\lambda_{k,i}} \cdot \frac{C_{i,t}}{F_{i,t}} \cdot K_{i,t} \tag{55}$$

$$X_{i,1,t} = \frac{\lambda_{1,i}}{\lambda_{k,i}} \cdot \frac{C_{i,t}}{Y_{1,t}} \cdot K_{i,t} \tag{56.1}$$

$$X_{i,2,t} = \frac{\lambda_{2,i}}{\lambda_{k,i}} \cdot \frac{C_{i,t}}{Y_{2,t}} \cdot K_{i,t} \tag{56.2}$$

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$$X_{i,n,t} = \frac{\lambda_{n,i}}{\lambda_{k,i}} \cdot \frac{C_{i,t}}{Y_{n,t}} \cdot K_{i,t} \tag{56.n}$$

Substituting these equations into equation 21 and taking the ratio to a simular equation for the U.S., we find that:

$$\frac{Q_{i,t}}{Q_{u,i,t}} = \frac{K_{i,t}}{K_{u,i,t}} \cdot \left(\frac{C_{i,t}}{C_{u,i,t}}\right)^{1-\lambda_{k,i}} \cdot \left(\frac{W_{u,i,t}}{W_{i,t}}\right)^{1-\lambda_{k,i}-\lambda_{o,i}-\sum_p \lambda_{p,i}}$$

$$\cdot \left(\frac{F_{u,t}}{F_t}\right)^{\lambda_{o,i}} \cdot \left(\frac{Y_{u,1,t}}{Y_{1,t}}\right)^{\lambda_{1,i}} \cdot \left(\frac{Y_{u,2,t}}{Y_{2,t}}\right)^{\lambda_{2,i}} \cdots\cdots \left(\frac{Y_{u,n,t}}{Y_{n,t}}\right)^{\lambda_{n,i}} \qquad (57)$$

Solving this equation for $K_{i,t}$ and substituting equation 31 for $(Q_{i,t}/Q_{u,i,t})$, we find that:

$$K_{i,t} = \left(\frac{C_{u,i,t}}{C_{i,t}}\right)^{1-\lambda_{k,i}} \cdot \left(\frac{W_{i,t}}{W_{u,i,t}}\right)^{1-\lambda_{k,i}-\lambda_{o,i}-\sum_p \lambda_{p,i}} \cdot \left(\frac{F_{u,t}}{F_t}\right)^{-\lambda_{o,i}} \cdot$$

$$\left(\frac{Y_{u,1,t}}{Y_{1,t}}\right)^{-\lambda_{1,i}} \cdots \left(\frac{Y_{u,n,t}}{Y_{n,t}}\right)^{-\lambda_{n,i}} \left(\frac{W_{i,t}}{W_{u,i,t}}\right)^{\lambda_{k,i}+\lambda_{o,i}+\sum_{p=1}^{n} \lambda_{p,i}} \cdot$$

$$\left(\frac{C_{u,i,t}}{C_{i,t}}\right)^{\lambda_{k,i}} \cdot \left(\frac{F_{u,t}}{F_t}\right)^{\lambda_{o,i}} \cdot \left(\frac{Y_{u,1,t}}{Y_{1,t}}\right)^{\lambda_{1,i}} \cdots \left(\frac{Y_{u,n,t}}{Y_{n,t}}\right)^{\lambda_{n.i}} \cdot$$

$$\frac{E_{i,t}}{E_{u,i,t}} \cdot K_{u,i,t} \qquad (58)$$

As was the case for equation 33, many of the terms cancel out and equation 58 can be reduced to:

$$K_{i,t} = \frac{C_{u,i,t}}{C_{i,t}} \cdot \frac{W_{i,t}}{W_{u,i,t}} \cdot \frac{E_{i,t}}{E_{u,i,t}} \cdot K_{u,i,t} \tag{59}$$

In this form equation 59 implies that the Massachusetts capital stock will be at its optimum and will embody factor intensities exactly in line with current relative labor and capital costs. In order to develop an equation that reflects the time required to change the capital stock and to embody optimum factor intensities, we begin by substituting $I^n_{i,t} + K_{i,t-1}$ for $K_{i,t}$ in equation 59, (where $I^n_{i,t}$ is net real investment) and we take into account our assumption that factor intensities are embodied in equipment at the time of purchase.

$$I^n_{i,t} = \frac{C_{u,i,t}}{C_{i,t}} \cdot \frac{W_{i,t}}{W_{u,i,t}} \cdot \frac{E_{i,t}}{E_{u,i,t}} \cdot I^n_{u,i,t} + \sum_{h=1}^{52} \frac{C_{u,i,t-h}}{C_{i,t-h}}$$

$$\frac{W_{i,t-h}}{W_{u,i,t-h}} I_{u,i,t-h} \frac{E_{i,t-1}}{E_{u,i,t-1}} - K_{i,t-1} \tag{60}$$

If we used the equation in this form the capital stock would come in line with the optimum stock very quickly. For example, if Massachusetts employment increased by five percent last period, then investment equal to five percent of our factor intensity-adjusted capital stock would be added to our share of national investment this period. Such an adjustment is obviously too rapid. Additionally, only gross investment series are available and we would have difficulty accurately estimating the net investment series. In order to compensate for this data problem and to estimate the adjustment time econometrically, we have estimated manufacturing equipment and non-residential structures equations in the following form:

$$I_{i,t} - \frac{C_{u,i,t}}{C_{i,t}} \; \frac{W_{i,t}}{W_{u,i,t}} \; \frac{E_{i,t}}{E_{u,i,t}} \; I_{u,i,t} = \alpha_o +$$

$$\alpha_i \left[\frac{E_{i,t-1}}{E_{u,i,t-1}} \cdot \sum_{h=2}^{53} \frac{C_{u,i,t-h}}{C_{i,t-h}} \; \frac{W_{i,t-h}}{W_{u,i,t-h}} \; I_{u,i,t-h} - K_{i,t-1} \right] \tag{61}$$

The value of α_1 was found to be .07 for manufacturing equipment and .08 for non-residential structures. By including this last term in the equation we will reflect the stock adjustment process in our forecasts and in our policy simulations. This acceleration effect may play an important role in determining the effect of alternative policies on the economy. To our knowledge it has not been included in other regional econometric models.

2. The Regression Equations

The Manufacturing Equipment Regression

Cochrane-Orcutt iterative technique

Left-hand variable: IMR

Mean of dependent variable is -.151991

Final value of rho = .9023010

Number of iterations = 4

Standard error of rho = .1016128

T-statistic for rho = 8.8797942

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	-.179951	.077906	-2.30986
IMGR	.068252	.072404	.94265

R-squared = .9254 Corrected R-squared = .9207

F-statistic(1., 16.) = 198.433396

Durbin-Watson statistic (adjusted for 0. gaps) = .5579

Number of observations = 18

Sum of squared residuals = .002745

Standard error of the regression = .013098

$$IMR = I_{eq,t} - \frac{C_{u,eq,t}}{C_{eq,t}} \cdot \frac{W_t}{W_{u,t}} \cdot \frac{E_{mfg,t}}{E_{u,mfg,t}} \cdot I_{u,eq,t}$$

$$IMGR = \sum_{h=2}^{53} \frac{C_{u,eq,t-h}}{C_{eq,t-h}} \cdot \frac{W_{t-h}}{W_{u,t-h}} I_{u,\ eq,\ t-h} \cdot -K_{eq,t-1}$$

where

$I_{eq,t}$ = gross equipment investment in Massachusetts deflated by the U.S. deflator for equipment.

$C_{eq,t}$ = the implicit rental cost of equipment in Massachusetts.

W_t = the fixed weight wage index for Massachusetts.

$E_{mfg,t}$ = manufacturing employment in Massachusetts.

$K_{eq,t}$ = the capital stock of equipment in Massachusetts.

u = the subscript indicating a corresponding U.S. variable.

The Non-residential Construction Regression

Cochrane-Orcutt iterative technique

Left-hand variable: INRSMIR

Mean of dependent variable is -.087799

Final value of rho = .6316740

Number of iterations = 2

Standard error of rho = .1000823

T-statistic for rho = 6.3115452

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	-.264103	.147331	-1.792580
INRSMGR	.076163	.058459	1.302847

R-squared = .3870 Corrected R-squared = .3764

F-statistic(1., 58.) = 36.610999

Durbin-Watson statistic (adjusted for 0. gaps) = 2.3663

Number of observations = 60

Sum of squared residuals = 2.377569

Standard error of the regression = .20247

$$INRSMIR = I_{nr,t} - \frac{C_{u,s,t}}{C_{s,t}} \cdot \frac{W_t}{W_{u,t}} \cdot \frac{E_t}{E_{u,t}} \cdot I_{u,nr,t}$$

$$INRSMGR = \sum_{h=2}^{53} \frac{C_{u,s,t-h}}{C_{s,t-h}} \cdot \frac{W_{t-h}}{W_{u,t-h}} I_{u,nr,t-h} \frac{E_{t-1}}{E_{u,t-1}} \cdot K_{nr,t-1}$$

where

$I_{nr,t}$ = investment in non-residential structures deflated by the U.S. deflator for non-residential construction.

$C_{s,t}$ = the implicit rental cost of non-residential structures in Massachusetts.

E_t = total non-agricultural wage and salary employment in Massachusetts.

The t statistic for α_1 is significant at the 10% level for non-residential construction but not for manufacturing equipment. The Cochrane-Orcutt technique was used to estimate the equations because the Durbin-Watson statistic showed significant autocorrelation of the residuals when the coefficients were estimated by ordinary least squares.

The equation for residential construction has the following form:

$$I_{r,t} = \hat{\alpha}_o + \hat{\alpha}_1 \left[\frac{\sum_{h=1}^{4} RYD_{t-h}}{\sum_{h=1}^{4} RYDU_{t-h}} \right] \cdot I_{r,t} + \hat{\alpha}_2 \left[\frac{\sum_{h=2}^{5} RYD_{t-h}}{\sum_{h=2}^{5} RYDU_{t-h}} \cdot K_{u,r,t-1} - K_{r,t-1} \right] \quad (62)$$

where

$I_{r,t}$ = residential investment in constant dollars.

RYD = real disposable income.

The estimated values for $\hat{\alpha}_o$, $\hat{\alpha}_1$, $\hat{\alpha}_2$ are -.08, .66, and .02 respectively. This equation also includes a stock adjustment process. The regression results are given below, and the programmed equations for all the investment equations and for the capital stocks, are given in Chapter 7.

The Residential Construction Regression

Cochrane-Orcutt iterative technique

Left-hand variable: RBAN72

Mean of dependent variable is .913478

Final value of rho = .4276631

Number of iterations = 2

Standard error of rho = .1166979

T-statistic for rho = 3.6647020

Right-hand variable	Estimated Coefficient	Standard error	T-statistic
Constant	-.79018	.304754	-.259283

Right-hand variable	Estimated coefficient	Standard error	T-statistic
IRSMR	.657242	.117705	5.583789
IRSMGR	.024900	.056444	.441147

R-squared = .6652 Corrected R-squared = .6534

F-statistic(2., 57.) = 56.622606

Durbin-Watson statistic (adjusted for 0. gaps) = 2.0214

Number of observations = 60

Sum of squared residuals = .814878

RBAN72 = residential construction in Massachusetts divided by the U.S. deflator for residential investment.

IRSMR = the average of the last four quarters of Massachusetts real disposable income relative to U.S. times U.S. residential investment.

IRSMGR = the average of the last four quarters of Massachusetts real disposable income relative to the U.S. (lagged one-quarter) times the U.S. residential capital stock, less the Massachusetts residential capital stock.

III. Employment totals, Populations, Labor Force and Unemployment

Total non-agricultural wage and salary employment on a seasonally adjusted basis is found by simply adding up the 20 manufacturing, 5 private non-manufacturing and 3 government employment forecasts. This total is the seasonally adjusted version of the total published in the "Employment Review" by the Division of Employment Security. The corresponding non-seasonally adjusted values are found in the model by applying our seasonal factors in reverse and then by adding up the non-seasonally adjusted forecasts.

In order to find the total number of jobs in Massachusetts two other series must be predicted, the "All other non-agricultural employment" and the "Agricultural employment" series. Since agricultural employment is such a small part of Massachusetts employment, and since it is difficult to relate changes in Massachusetts agricultural employment to either U.S. agricultural employment or to conditions in the Massachusetts economy, it is forecast exogenously. The "All other non-agricultural" series is made up mainly of self-employed. To predict it, we fi estimate the proportion of each employment sector that is made up of self-employed by finding the ratio of proprietors income to total personal income in that sector. Then we use these proportions on the latest historical data to arrive at a total estimate of "All other non-agricultural employment." The ratio of the reported value for "All other non-agricultural employment" to this estimate is used to adjust each of the proportions. Future values of "All other non-agricultural employment" are projected by applying these adjusted proportions to the respective employment series forecasts.

The "Total Massachusetts Jobs" series that we obtain differs in two ways from "Total Employment" reported by the Division of Employment Security in "Trends." It is on a place-of-work basis rather than a place-of-residence basis, and it counts a person who holds two jobs twice. We find the historical series for the net of these two factors by simply subtracting "Total Employment" from "Total Massachusetts Jobs." We project this adjustment forward by multiplying the last observed ratio of its non-seasonally adjusted value to our last observed value of "Total Massachusetts Jobs," by our prediction of "Total Massachusetts Jobs." In the forecast period the predicted adjustment is subtracted from our forecast value of "Total Massachusetts Jobs" to predict a value for total employment.

Our next task is to predict the Massachusetts population and labor force. Economists have not been very successful in relating interstate migration to economic conditions. The importance of population projections for a state would suggest that the population should be broken into demographic groups and that the natural growth as well as the migration response of each group to economic factors should be estimated. In our case we have related the size of the Massachusetts population to the size of the U.S. population with some changes in our share explained by changes in our wage and salary employment relative to the nation. We relate the size of the Massachusetts labor force to 1) the product of our 18&over population and the ratio of the U.S. full employment labor force to the corresponding U.S. population, and 2) to our ratio of employment to the 18&over population in the last 3 quarters. The regression equations are given in below:

(a) The Massachusetts Labor Force Regression

Ordinary least squares

Frequency quarterly
Interval 62: 1 to 74: 4
Left-hand variable: LLCM

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	-.526155E-01	0.287715	-0.182874
LPOPMAUSPR	1.04135	.335109E-01	31.0750
A$1	-.220196E-01	0.409554	-.537648E-01
A$2	-0.797532	0.984492	-0.810095

R-bar squared: 0.9746
Durbin-Watson statistic (adjusted for 0. gaps): 0.1934
Standard error of the regression: .100458E-01

Distributed lag interpretation

Lag	Coefficient	Standard error
LEPOP(0)	0.13302	0.12662
LEPOP(-1)	0.18837	.51043E-01
LEPOP(-2)	0.14403	.84223E-01

Mean lag: 1.02366

Standard error: 0.494227

Sum of lag coefficients: 0.465428

Standard error: 819787E-01

LLCM = log of Massachusetts labor force.

LPOPMAUSPR = log of Massachusetts population 18 and over times the full employment labor force for the U.S. divided by the U.S. population over eighteen.

LEPOP(0) = log of Massachusetts employment divided by the Massachusetts population 18&over in the current period. [(-1) lagged one period etc.

(b) The Massachusetts Population Regression

Ordinary least squares

Frequency quarterly

Interval 61: 1 to 73: 4

Left-hand variable: LPOPMAN

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	-4.20528	.447874E-01	-93.8944
A$1	.162570	0.337396	0.481837
A$2	0.101053	0.811537	0.124520

R-bar squared: 0.7963

Durbin-Watson statistic (adjusted for 0. gaps): 0.0962

Standard error of the regression: .418458E-02

Distributed lag interpretation

Lag	Coefficient	Standard error
$E(0)/E_u(0)$	0.10298	0.10100
$E(-1)/E_u(-1)$	.56022E-01	.34502E-01
$E(-2)/E_u(-2)$	.21695E-01	.67874E-01

Mean lag: 0.550159

Standard error: 0.964419

Sum of lag coefficients: 0.180697

Standard error: .128090E-01

LPOPMAN = log of the Massachusetts population divided by the U.S. population.

$E(0)/E_u(0)$ = the non-agricultural wage and salary employment in Massachusetts divided by the corresponding U.S. variable, all in the current period.

Both of the equations unfortunately have Durbin-Watson statistics that indicate significant auto correlation . The equations were estimated using a polynomial distributed lag program. The labor force equation implies that an increase in Massachusetts employment of two people will increase the size of the Massachusetts labor force by one person. The population equation implies that an increase in Massachusetts employment of 1% while U.S. employment stayed constant would lead to an increase in our population of .2%

The remainder of this sector is very straightforward. The seasonally adjusted unemployment is calculated by subtracting seasonally adjusted total employment from the seasonally adjusted labor force. Thus, our seasonally adjusted series differs from those based on a direct seasonal adjustment of the number unemployed on a non-seasonally adjusted basis. We find the non-seasonally adjusted values by applying our seasonal factors in reverse to the seasonally adjusted employment and labor force series and then calculating unemployment by subtraction.

The unemployment rate is not known until the spring following the calendar year in question. We do not attempt to predict, nor do we use as observations, the preliminary unemployment rate estimates based on the 70 step procedure.

In addition to the unemployment rate we have constructed an employment rate which is the proportion of the 16&over population employed. We also report this as an index for Massachusetts and as an index relative to the U.S. with a value of 100 in 1973 for both indexes.

IV. Wages, Prices and Hours

We have constructed a fixed weight wage index for Massachusetts similar to the fixed weight index for the U.S., with the following minor differences. We have fixed the weights at the 2-digit level for Massachusetts, in contrast to the 3-digit level fixed weights for the U.S., and we have used employment as weights, whereas the U.S. index uses full labor input weights. We have then divided the Massachusetts index by the U.S. index, using 1967 as the base year for both indexes. The creation of this index has made it possible for us to estimate a very important wage equation. We found that the Massachusetts relative wage responds positively when our labor market conditions index, measured by the proportion of the population 18&over that is employed, increases faster than it does in the U.S.; and that our relative wage responds negatively when the ratio of our real disposable to personal income increases faster than the corresponding U.S. ratio. This last term means that increases in personal taxes or in Massachusetts prices relative to the nation carry over into our wage levels.

The estimated equation is shown below.

The Massachusetts Wage Index Regression

Cochrane-Orcutt iterative technique

Left-hand variable: LWMIW

Mean of dependent variable is -.013676

Final value of rho = .8359367

Number of iterations = 2

Standard error of rho = .0740037

T-statistic for rho = 11.2958810

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	1.912213	1.293491	1.478869
LERMERL	.494729	.139752	3.540046
LDPPRL	-.868163	.568615	-1.526811

R-squared = .8814 Corrected R-squared = .8768

F-statistic(2., 52.) = 193.134154

Durbin-Watson statistic (adjusted for 0. gaps) = 2.0065

Number of observations = 55

Sum of squared residuals = .001612

Standard error of the regression = .005567

where

LWMIW = the log of the Massachusetts fixed-weight wage index relative to the corresponding U.S. index.

$$LERMERL = \log \sum_{h=1}^{6} (E_{t-h}/N^{18+}_{t-h}) / (E_{u,t-h}/N^{18+}_{u,t-h})$$

$$LDPPRL = \log \sum_{h=1}^{6} (RYD_{t-h}/YP_{t-h}) / (RYD_{u,t-h}/YP_{u,t-h})$$

where N^{18+} = the population 18&over in Massachusetts.

RYD = real disposable income in Massachusetts.

YP = personal income in Massachusetts.

In the relative wage regression the estimated coefficients on labor market conditions is significant at the 99% level and the coefficient on dollars of real disposable income per dollar of personal income is significant at the 90% level.

Wages are predicted for all of the wage categories, except federal government, by multiplying the last observed wage by one plus the percentage increase in the fixed weight wage index since the last observed wage value. The federal government wage in Massachusetts is predicted to change as the national federal wage changes.

Hours are predicted for each manufacturing industry on the basis of the percentage change in employment in the current period and on the basis of the lagged dependent variable. The regression equations are reported in Table 2. In the majority of cases the coefficients are significant at the one percent level and the Durbin-Watson statistics show no evidence of auto-correlated residuals. Since our theory would lead us to expect hours to be adjusted in the same direction as employment changes due to partial adjustment through longer hours and partial adjustment through more hiring, we have made hours exogenous for industries 25 and 37 where the regression results showed a negative coefficient on employment.

The Consumers Price Index is a weighted average of many components. The weights and the categories used can be found in the BLS Handbook of Methods (U.S. Dept. of Labor, 1976, pp. 91-92). Using these weights along with input-output, personal income and tax collection information one can determine the weight of various costs and direct taxes in the index. The Boston consumer price index should move in line with the U.S. consumer price index unless 1) our direct taxes move in a way that is different from those in the nation

TABLE 2-2

THE AVERAGE WEEKLY HOURS REGRESSIONS

(Number of Observations = 55)

The Industry (i)	The Constant Term	The Coefficient for $\frac{E_{i,t}}{E_{i,t-1}} - 1$	The T-Statistic for $\frac{E_{i,t}}{E_{i,t-1}} - 1$	The Coefficient for $H_{i,t-1}$	The T-Statistic for $H_{i,t-1}$	The Durbin-Watson Statistic	Corrected R^2	Standard Error
19	18.2	.9	.4	.6	4.8	1.9	.28	.69
20	8.7	7.2	1.9	.8	7.9	2.0	.53	.41
22	16.1	18.7	6.0	.6	7.9	2.1	.70	.39
23	18.7	21.0	3.1	.5	4.1	2.4	.37	.61
24	8.5	1.1	.2	.8	9.0	2.5	.59	.86
26	23.0	11.2	1.3	.5	3.7	2.3	.30	.70
27	23.2	18.2	3.0	.4	3.3	2.3	.34	.45
28	22.1	7.3	1.4	.5	3.8	1.9	.20	.57
30	22.6	3.4	1.4	.5	3.6	1.9	.25	.43
31	23.2	17.4	3.6	.4	3.2	2.0	.26	.68
32	12.2	21.3	4.9	.7	10.0	1.8	.78	.60
33	10.6	12.9	2.5	.7	8.7	2.0	.69	.80
34	12.5	14.7	3.4	.7	7.9	2.3	.71	.41
35	10.2	12.8	3.7	.8	10.5	1.9	.78	.41
36	29.9	4.3	1.8	.3	1.9	2.0	.12	.38
38	12.1	7.3	1.6	.7	5.6	1.7	.51	.57

or 2) our costs (including the influence of indirect taxes) move differently from those in the nation. Therefore, our equation for the Boston consumer price index predicts that Boston prices will change by the same percentage as the U.S. consumer price index, unless our direct taxes or our costs, including indirect taxes, change differently than they do in the U.S. The forecasting equations includes 13 direct taxes and costs from the 17 sectors that feed directly to final demand. The weights were obtained for one part of the index at a time and then aggregated.

The percentage effect of a one percentage point increase in any of the following taxes on the Boston consumer price index is shown in Table 2-3.

TABLE 2-3

Tax Rates in the Boston Consumer Price Index Equation

		The percentage change in the Boston consumer price index due to a one percentage point change in the tax
1.	Sales Tax (from 5% to 6%)	.29524
2.	Property Tax (from 2.03% to 3.03%)	1.20141
3.	Meals Tax (from 8% to 9%)	.04204
4.	Room Occupancy Tax (from 5.6% to 6.6%)	.00180
5.	Motor Fuel Tax (from 16.5% to 17.5%)	.02618
6.	Cigarette Tax (from 53.8% to 54.8%)	.01131
7.	Malt Beverage Tax (from 3.8% to 4.8%)	.01021
8.	Sparkling Wine Tax (from apx. 13.8% to 14.8%)	.00011
9.	Still Wine Tax (from apx. 13.8% to 14.8%)	.00129
10.	Liquor Less than 15% (from apx. 13.8% to 14.8%)	.00011
11.	Liquor Between 15-50% (from apx. 13.8% to 14.8%)	.01227
12.	Liquor Over 50% (from apx. 13.8% to 14.8%)	.00010
13.	Deeds Tax (from 1.14% to 2.14%)	.00198

The percentage effect of a one percent increase in the Massachusetts cost of production relative to the nation in each of the following industries will have the following effect on the consumer price index (only the cost of the percent supplied locally (ρ_1) is increased):

TABLE 2-4

Massachusetts Production Costs in the Boston Consumer Price Index

SECTOR	The Percentage Change in the Boston Consumer Price Index due to a one percentage point change in the Massachusetts cost of production
Manufacturing	
Durables	
Furniture (25)	.002125
Electrical Equipment (36)	.002086
Autos & Parts (371)	.000232
Instruments (38)	.001344
Nondurables	
Food (20)	.050760
Textiles (22)	.001953
Apparel (23)	.016704
Printing (27)	.004576
Chemicals (28)	.003287
Rubber (30)	.001155
Leather (31)	.005168
Other Durables (39)	.008792
Non-Manufacturing	
Contract Construction	.087200
Transport & Utilities	.022718
Wholesale & Retail Trade	.132500
Finance, Insurance & Real Estate	.070900
Service & Miscellaneous	.145300

The above industry cost increase effects are only the first round effects. Thus, they include the effect of an increase in textile costs on consumer purchases weighted by the percent of textiles purchased in Massachusetts that come from Massachusetts. They do not include the effect that an increase in textile costs have on apparel costs which in turn increase consumer costs. The second and further round effects will of course be captured in a simultaneous solution of the model.

The direct effect of a one percentage point increase in Massachusetts consumer fuel costs would be a percentage change of .0344 in the Boston consumer price index.

V. Personal, Disposable and Real Disposable Income

The function of this sector is to draw together the forecasts from other sectors and those for U.S. variables, to forecast the components of personal income in Massachusetts, and then to make the adjustments necessary to obtain real disposable income in Massachusetts.

For the manufacturing sector we use the product of average weekly hours, average hourly wages, employment, and 52 to obtain wage and salary estimates for each manufacturing industry. We then combine industries to obtain durable and non-durable wage and salary disbursements totals. We use changes in these two estimates to determine the changes in total wage and salary disbursements for the durable and the non-durable parts of manufacturing personal income in the forecast period. For the non-manufacturing sectors our "wage" series are simply the wage and salary disbursements component for each sector, divided by employment in that sector. Therefore, after we have predicted employment and the "wage," we simply multiply the two together to obtain the personal income wage and salary disbursements component.

In addition to wage and salary disbursements we must also predict "other labor income" and proprietors income in order to be able to determine Personal Income.

We find proprietors income in Massachusetts using a three-step procedure. First, we find the parameter that would have yielded the last annual observed Massachusetts proprietors income for each sector if it had been multiplied by the product of the Massachusetts share of the national output for that industry, times total U.S. proprietors income. Second, all of the parameters obtained in this fashion are adjusted so they would have yielded the latest available quarterly value of total proprietors income for Massachusetts if they had been used in the equation. Finally, these new parameters are multiplied by the Massachusetts quantity share for each sector times total U.S. proprietors income to obtain forecasts for sectoral proprietors income. Total proprietors income for Massachusetts is the sum of the sectoral values.

Other labor income for each sector is the difference between total labor and proprietors income for that sector, and wage and salary disbursements plus proprietors income from that sector. Other labor income increases as the product of the Massachusetts share of employment for each sector times U.S. other labor income increases.

In order to report total labor and proprietors income by sector, proprietors and "other labor income" is added to the wage and salary disbursements for each sector. The sum of the above personal income by sectors yields total labor and proprietor income by place of work. The derivation of personal income by place of residence requires four other series. (1) Social insurance contributions. These are explained by the Massachusetts share of total non-agricultural wage and salary employment. (2) The residence adjustment. This is forecast using a simple time trend to reflect the long-run steady increase in suburban location outside of Massachusetts. (3) Property incomes. These are divided into dividend, interest and rental income on the basis of the most recent annual data. Again parameters are found in a multistage process to relate the Massachusetts variables to national dividends, national interest income and national rent each times the Massachusetts proportion of the U.S. capital stock. (4) Transfer payments. These are divided into unemployment insurance payments and other transfers. Changes in the former are forecast on the basis of the product of the Massachusetts unemployment rate and the average Massachusetts wage, and changes in the latter are forecast on the basis of Massachusetts' share of the national non-working population multiplied by national transfer payments. Labor and proprietors income by place of work, less item 1 above and plus items 2-4, is Massachusetts Personal Income by place of residence.

Disposable Income is found by subtracting four series from Personal Income: (1) Federal income taxes paid by Massachusetts residents. This is forecast to change as the product of the Massachusetts share of personal income times total personal income taxes paid in the nation changes. (2) Massachusetts state income taxes, predicted by equations explained in the next section. (3) Massachusetts inheritance taxes, also predicted by an equation in the next section, and (4) other state and local taxes. Changes in these are related to changes in the product of our share of personal income times national, state and local taxes. Real disposable income is found by dividing Massachusetts disposable income by the Boston consumer price index. This is converted to a per capita basis by dividing by the Massachusetts population.

VI. Local and State Tax Collections and Spending

1. Local Spending and Tax Collections

In this section we assume that local government revenues are equal to local government spending. However, we do not formally assume that state spending and state revenues will be equal, even though by statute the proposed state budget must be balanced. Our decision to make non-public assistance related state government spending exogenous was designed to allow us to determine whether or not state income would be adequate to meet anticipated state spending needs. For some policy simulations, and for long-term forecasting, it may be appropriate to introduce equations that will make state government spending endogenous and will restrict the size of state income less state spending.

The local spending equation is based on the demand for public services. Our argument is that the demand for local spending will increase as all spending increases. We measure this change in demand by measuring changes in real personal income. We also argue that as the percentage of the population that is primary and secondary school age increases, so will local government spending. In the following regression the dependent variable is real local spending plus state aid, and the explanatory variables are real personal income and the proportion of the population that is primary and secondary school age.

The Local Spending Regression

Ordinary least squares

Frequency quarterly
Interval 58: 1 to 74: 2
Left-hand variable: LRLGE

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	0.781357	1.72893	0.451932
LRYPMA	1.25885	0.207267	6.07356
LPP	0.225494	0.390243	0.577829

R-bar squared: 0.9482

Durbin-Watson statistic (adjusted for 0. gaps): 0.6977

Standard error of the regression: .548554E-01

LRLGE = the log of local property taxes plus state aid, deflated by the U.S. price index for state and local government spending.

LRYPMA = the log of Massachusetts personal income deflated by the Boston consumer price index.

LPP = the log of the proportion of the population that is elementary and secondary school age.

The Durbin-Watson statistic indicates positive correlation in the residuals. The coefficient on real personal income indicates that local public expenditures may be a luxury good! With the above equation the value of local property taxes can be found by subtracting state aid. This property tax is divided by the Massachusetts capital stock to obtain the average Massachusetts local property tax rate which then feeds back to the cost of capital for each sector.

2. State Tax Collections

State government spending, the amount of state aid to local government, the amount of state debt service and the amount put into the state pensions fund, are set exogenously. Public Assistance payments follow the changes in the transfers variable that is predicted in the personal income section.

The remainder of this sector consists of state tax revenue equations. While all tax <u>rates</u> must be known in order to solve the model simultaneously, the only tax collections that are required for a simultaneous solution of the model are those for seasonally adjusted income and estate taxes. Of course, the values of the other tax collections are of inherent interest to policy makers and must ultimately feed back to state spending decisions.

A detailed discussion of the tax equations and forecasts will be presented in Chapter 8 below. Here we will list, with minimal explanation, the equations used in determining each tax. To calculate state revenue collections we predict the seasonally adjusted tax receipts, and then we apply our seasonal factors in reverse before calculating the fiscal totals.

First we will present the income tax. Next we will discuss consumer taxes, starting with the sales tax and then explaining the remaining taxes in alphabetical order. Finally we will consider business taxes in alphabetical order.

(a) The Income Tax

State income tax revenue is divided into three categories: withholding, estimated and returns. Withholding taxes are calculated by multiplying the tax rate for earned income times wage and salary disbursements, less the share of deductions attributable to earned income. Deductions are based on the number of children under 18, the number of single returns, the number of joint returns, and the value of the respective personal deductions for each category. Estimated tax collections are based on a formulation that includes the tax rates on unearned, annuity, and proprietors income, as well as estimates of personal and business exemptions. Revenue from "returns" is positively related to the rate of change of personal income, and negatively related to the amount of estimated and withholding collections.

The Revenue from Tax Returns Regression

Ordinary least squares

Frequency quarterly

Interval 62: 1 to 71: 2 72: 3 to 72: 4

Left-hand variable: RETURNS

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	11.2502	6.35917	1.63303
GYPMA	259.845	105.359	2.46629
COL	-.864014E-01	.100004E-01	-0.63933

R-bar squared: 0.6599

Durbin-Watson statistic (adjusted for 1. gap): 0.8540

Standard error of the regression: 11.0319

where

RETURNS = a smoothed series of payments on tax returns expressed in millions of dollars at an annual rate.

GYPMA = $(YP_t - YP_{t-4}) / YP_{t-4}$.

COL = withholding plus estimated collections at seasonally adjusted annual rates.

YP = Massachusetts personal income.

(b) Consumer Taxes

In the current <u>sales</u> tax equation, sales tax revenue is the product of the sales tax rate and the estimated sales tax base. This base is estimated using the following equation.

Ordinary least squares

Frequency quarterly

Interval 67.1 to 72.4

Left-hand variable: SALES

Right-hand variables	Estimated coefficient	Standard error	T-statistic
Constant	-1456.70	653.099	-2.23044
YDMA	0.352938	.315686E-01	11.1800

R-bar squared: .8435

Durbin-Watson statistic (adjusted for 0. gaps): 2.7647

Standard error of the regression: 403.537

where

SALES = the sales tax base in seasonally adjusted annual rates in millions of dollars.

YDMA = personal disposable income in seasonally adjusted annual rates in millions of dollars.

The six alcoholic beverage revenue equations are all in the same form. The revenues are predicted by multiplying the rate by the base. The base is found using the result of regressing the base on real disposable income and the tax rate divided by the Boston CPI. The first term shows the income effect while the second shows the effect of substituting away from liquor purchase in Massachusetts when the real tax is increased. The Regression Results are given in Table 5 on page 68.

The cigarette tax base is forecast using the following equation:

Ordinary least squares

Frequency quarterly

Interval 60: 3 to 70: 1 70: 4 to 72: 4

Left-hand variable: CIGS

TABLE 2-5

THE ALCOHOLIC BEVERAGE TAX BASE REGRESSIONS
INTERVAL 63:1 TO 72:4

The Tax Base for	The Constant Term	The Coefficient for RYD	The Statistic for RYD	The Coefficient for $\frac{TR_i}{CPIB_i}$	The T-Statistic for $\frac{TR_i}{CPIB_i}$	The Durbin-Watson Statistic	The Corrected R^2	The Standard Error	Dependent Variable Units	Tax Rate Units
Malt beverages	2.0	.00016	10.3	-69.24	-2.6	1.40	.74	.1595	Barrels	$'s per Barrel
Sparkling wine	-1.5	.00016	11.3	-177.24	-1.9	.32	.80	.1308	Gallons	$'s per Gallon
Still wine	-.45	.00102	10.9	-2747.6	-5.3	.38	.75	.7471	Gallons	$'s per Gallon
Liquor - Less than 15 percent	-.22	.00004	10.7	-18.9	-1.9	2.11	.81	.2894	Gallons	$'s per Gallon
Liquor - Between 15 and 50 percent	3.59	.00077	13.8	-191.3	-4.3	1.20	.86	.4529	Gallons	$'s per Gallon
Liquor - Greater than 50 percent	-.007	.000002	11.4	-.57	-4.3	1.35	.78	.1347	Gallons	$'s per Gallon

where

RYD = real disposable income.

$TR_i/CPIB_i$ = the tax rate divided by the Boston consumer price index.

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	699.935	47.4561	14.7491
RYDMA	.749716E-03	.293236E-02	0.255669
D651&2	174.424	29.7594	5.86116
D67	-72.1196	21.6022	-3.33853

R-bar squared: 0.4902

Durbin-Watson statistic (adjusted for 1. gap): 1.9831

Standard error of the regression: 40.9495

where

CIGS = the cigarette tax base in packs of cigarettes per year.

RYDMA = real disposable income.

D651&2 = 1 during 65:1 and 65:2; 0 otherwise.

D67 = 1 during 1967; 0 otherwise.

The tax base for deeds is forecast using the following equation.

Ordinary least squares

Frequency quarterly

Interval 60: 2 to 74: 4

Left-hand variable: DEEDS

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	.556678E-01	0.472671	0.117773
YPMA	.249562E-03	.220870E-04	11.2990
QTDEEDR	-148.454	89.4729	-1.65920

R-bar squared: 0.7784

Durbin-Watson statistic (adjusted for 0. gaps): 0.8018

Standard error of the regression: 0.773929

where

DEEDS = the tax base for deeds in millions of dollars at a seasonally adjusted annual rate.

YPMA = Massachusetts personal income in millions of dollars at a seasonally adjusted annual rate.

QTDEEDR = the tax rate for deeds in percent divided by the Boston Consumer Price Index (when this equation is reestimated we plan to omit this variable!).

Our forecast for Inheritance and estate taxes is currently exogenous. The inheritance tax in Massachusetts has recently been changed to an estate tax.

Our prediction equation for the meals tax base is based on the following regression equation, plus an add factor to allow for the elimination of the one dollar exemption.

Ordinary least squares

Frequency quarterly
Interval 60: 3 to 72: 4
Left-hand variable: MEALS

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	-304.681	34.8298	-8.74771
YDMA	394178E-01	.201813E-02	19.5319

R-bar squared: 0.8859
Durbin-Watson statistic (adjusted for 0. gaps): 0.3038
Standard error of the regression: 59.8475

where

MEALS = the meals tax base in millions of dollars at seasonally adjusted annual rates.

YDMA = Massachusetts disposable income.

The prediction equation for the motor fuel tax base comes from the following regression:

Ordinary least squares

Frequency quarterly

Interval 60: 3 to 72: 4

Left-hand variable: FUEL

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	-760.932	187.377	-4.06097
RYDMA	0.162772	.114873E-01	14.1697

R-bar squared: 0.8030

Durbin-Watson statistic (adjusted for 0. gaps): 0.3915

Standard error of the regression: 167.474

where

FUEL = the base for the motor fuel tax in gallons of taxable fuel.

RYDMA = Massachusetts real disposable income.

The prediction equation for the Room Occupancy tax base comes from the following equation:

Ordinary least squares

Frequency quarterly

Interval 66: 3 to 66: 4 67: 3 to 72: 4

Left-hand variable: ROOM

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	-14.5950	11.9955	-1.21671
YDU	0.190501	.178079E-01	10.6976

R-bar squared: 0.8314

Durbin-Watson statistic (adjusted for 1. gap): 0.8497

Standard error of the regression: 7.99615

where

ROOM = the room occupancy tax base in millions of dollars.

YDU = U.S. disposable income in billions of dollars at seasonally adjusted annual rates.

(c) Business Taxes

The taxes on banks are divided into commercial bank and savings banks taxes. The following regression is the basis for predicting the commercial bank tax base:

Ordinary least squares

Frequency quarterly

Interval 60: 3 to 74: 4

Left-hand variable: NBINC

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	64.0011	11.2941	5.71989
YPMA	.259146E-02	.515482E-43	5.02776

R-bar squared: 0.2987

Durbin-Watson statistic (adjusted for 0. gaps): 0.4871

Standard error of the regression: 25.0374

where

NBINC = the tax base for commercial bank taxes in millions.

YPMA = Massachusetts personal income.

The following equation is used to predict savings bank tax revenues. Here we depart from our usual practice of predicting a tax by multiplying the appropriate tax rate times its base, because we have two rates in this case and no way to segregate the revenues.

Ordinary least squares

Frequency quarterly

Interval 61: 1 to 74: 4

Left-hand variable: SBREV

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	-10.4807	0.781558	-13.4100
YPMA	.852250E-03	.332522E-04	25.6299
QETRSBI	159.448	51.8502	3.07518
QETRSBD	249.715	121.760	2.05089

R-bar squared: 0.9811

Durbin-Watson statistic (adjusted for 0. gaps): 0.2151

Standard error of the regression: 0.805943

where

SBREV = tax collections from savings banks in millions of annual dollars.

YPMA = Massachusetts personal income.

QETRSBI = the savings bank tax rate on income.

QETRSBD = the tax rate on savings bank deposits.

Corporation taxes are levied both on corporate net income and on corporate equipment and inventory property. In addition there is an investment tax credit. We use the Massachusetts stock of non-residential structures and business equipment relative to the U.S., times a six quarter moving average of U.S. corporate profits, as an estimate of the income base. We use the corporate tax rate on property times our estimate of the value of the Massachusetts equipment and inventory stock as our property income estimate, and we use the investment tax credit times our predicted equipment investment to estimate the value of the investment tax credit deduction. We use changes in the sum of these three components to predict changes in tax collections from corporations.

We use the following equation to predict insurance company tax revenues. In this case we use an index of insurance tax rates times this equation in the forecast period to forecast revenues. The index is set at 1.00 for current tax rates.

Ordinary least squares

Frequency quarterly

Interval 61: 1 to 74: 4

Left-hand variable: INSREV

Right-hand variable	Estimated coefficient	Standard error	T-statistic
Constant	-17.4784	3.01332	-5.80036
YPMA	.258559E-02	.135931E-03	19.0213

R-bar squared: 0.8677

Durbin-Watson statistic (adjusted for 0 gaps): 0.1106

Standard error of the regression: 6.40747

where

INSREV = the value of insurance tax revenue collections

Public Utility and Miscellaneous tax revenues are predicted exogenously. For purposes of simulation the public utility tax projection is multiplied by an index of public utility taxes which is equal to one at current tax rates.

In addition to tax revenues there are other revenue categories. Racing tax revenues and lottery revenues are based on changes in Massachusetts disposable income. Motor vehicle revenues are based on an eight quarter average of Massachusetts disposable income. Fees and Assessments depend on changes in the consumer price index. Federal Reimbursements depend in part on changes in Massachusetts welfare payments. Revenue sharing depends on our share of U.S. personal tax collections and on contra cyclical payments.

After adding together revenue from all sources we obtain a "Total State Income" value. This value is total receipts less funds from the sale of bonds. Likewise our "total state spending" value is also net of bond fund expenditure. In our opinion the "Income less spending" value that results from subtracting total state spending from total state income gives the best single measure of the condition of the state budget that we know of.

VII. State Government Policy Instruments

Once a control forecast has been made with the Massachusetts Economic Policy Analysis (MEPA) Model, alternative forecasts can be made to "try out" alternative state government policies. Valuable insights about the economic consequences of alternative state policies can be gained by comparing the outcomes from these alternative simulations with the control forecast. The MEPA Model has 33 policy variables that can be directly manipulated by the state government, and 3 fuel cost variables that might be indirectly manipulated by the state government. The policy instruments fall into five categories: (1) Direct Consumer Taxes, (2) Personal Tax Parameters, (3) Government Spending Instruments, (4) Business Taxes and Credits and (5) Fuel Cost Variables. The Policy instruments in each category are listed and discussed in this section.

1. Direct Consumer Tax Rates

1. Sales	6. Cigarette	10. Liquor less than 10%
2. Property	7. Malt beverage	11. Liquor 15-50%
3. Meals	8. Sparkling wine	12. Liquor 50% +
4. Room Occupancy	9. Still wine	13. Deeds
5. Motor fuel		

All of these tax rates can be directly changed by the state government with the exception of the property tax. This tax can be changed by changing the amount of state aid. Given our predicted value for local government spending, changes in state aid would lead directly to changes in local property taxes.

All of the taxes in this category directly affect the value of the Boston consumer price index. Thus, the first impact of any tax increase will be to reduce real income and thus consumer purchases. The ramifications of these direct changes on employment wages, tax collections, etc., will reverberate throughout the model. The property tax will also affect business costs, as explained below.

2. Personal Tax Parameters

1. Earned income tax rate
2. Unearned income tax rate
3. Annuity income tax rate
4. Personal exemption for the blind
5. Personal exemption for dependents
6. Personal exemption for the elderly
7. Personal exemption for single returns
8. Personal exemption for joint returns (including working spouse credit)

Changes in these tax rates or exemptions will directly affect disposable income and, therefore, spending, employment, wages, exports from Massachusetts, etc. It should also be noted that by shifting the rates and exemptions in opposite directions, the progressivity of the tax system can be changed.

3. Government Spending Instruments

1. Total Government Spending less Welfare Expenditures
2. Debt Service
3. Pension Fund Contributions
4. Local Aid

Changes in total spending, of course, change government employment as well as the direct demands from the private economy that come from government spending.

Debt Service and Pension Fund contributions do not generate direct demand and thus have different impacts than other government spending. As mentioned, changes in local aid will indirectly change property tax rates.

4. Business Taxes

1. Corporate profit tax rate
2. Equipment and inventory tax rate
3. Investment tax credit
4. National banks tax rate
5. Savings bank tax rate
6. Insurance tax rate index
7. Public utility profits tax rate
8. Property tax (also listed above)
9. Unemployment insurance tax rate

Each of these tax rates affect business costs. One effect of changing business costs is to change business location decisions. Another is to influence relative factor intensities. Still another is to indirectly change the price of final products. As the effects from changing any one of these taxes radiates through the economy it influences every endogenous variable in the model.

5. Fuel Cost Variables

1. Industrial fuel costs
2. Commercial fuel costs
3. Residential fuel costs

While fuel costs cannot be directly controlled by state government, state regulation and other policies might be used to change these costs. Each of the three fuel cost categories will influence the economy differently.

Policy simulations that do not use the above instruments can often be performed by doing preliminary economic analyses to quantify all the direct effects of the policy alternative in question. Once the direct effects have been calculated, the model can be used to calculate all the 2nd, 3rd, and n^{th} round indirect effects of the policy alternative under consideration.

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CHAPTER 3

AN OVERVIEW OF THE CONTROL FORECAST

Our control forecast uses inputs from a U.S. economic forecast that is moderately optimistic.[1.] In the U.S. forecast national real per capita income is forecast to increase by fourteen percent from 1976 to 1980 and the U.S. unemployment rate is predicted to drop from its current rate of about eight percent to about five percent in 1980.

In our control forecast Massachusetts per capita real disposable income increases by thirteen percent from 1976 to 1980 and the Massachusetts unemployment rate drops, from our current predicted rate for the first quarter of 1977 of slightly less than nine percent, to about six percent at the end of 1980.

An important feature of our forecast is our predicted increase in Massachusetts manufacturing employment from 586 thousand in 1976 to 684 thousand in 1980. This change represents slightly under 17 percent growth over the five years compared to a predicted gain of over 12 percent in the nation. Our predicted growth for Massachusetts is slower than the national growth from 1976 to 1977 but faster thereafter. The three factors which lead to our projection of more rapid manufacturing growth in Massachusetts after 1977 than in the nation as a whole are:

1) The cost of manufacturing production in Massachusetts relative to the nation has been falling in the last few years in many industries. On the average the drop in the average cost per unit of output for Massachusetts

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1. "The Data Resources Review", February 1977 - We have adjusted the wage increase prediction in the DRI forecast to make it consistent with the rest of the DRI forecast. The forecast used was the control forecast made January 31, 1977.

manufacturing relative to the U.S. average has been two percent since 1973. This two percent can be compared with an average profit rate of from five to six percent on sales by U.S. firms. This drop in costs is forecast to lead firms to expand and locate in Massachusetts.

2) The drop in costs has come about from dropping relative labor costs in most industries. The drop in labor costs should encourage Massachusetts firms to undertake more labor using forms of production than they would have undertaken if our wages had moved exactly as national wages have.

3) Massachusetts has a more than proportional representation in the equipment manufacturing sector. This sector of U.S. manufacturing is forecast to grow at a more rapid rate than average manufacturing growth from 1978 through 1980 as a capital goods expansion takes place in the U.S.

Our prediction for growth in non-manufacturing employment shows a varied pattern. The export service sector grows somewhat less rapidly than services in the nation because our costs (especially wage costs) have been rising more rapidly than they have in the nation in this sector. This factor combined with a very slightly lower growth in final demand in Massachusetts than in the nation leads to growth in all of the non-manufacturing sectors except construction at slightly below the national average growth rate. Construction employment grows more rapidly in Massachusetts than in the nation because even a return to moderate economic growth in Massachusetts implies a substantial growth in Massachusetts construction.

We have computed three indexes to give an overview of the forecast. The values of the indexes in the forecast period are shown on the Summary Table (Tables 3-1 and 3-2) at the end of this chapter.

The first index is the employment rate index. It shows the percent of the population 16 and over employed in non-agricultural wage and salary employment in

Massachusetts relative to the percent of that group that was so employed in 1973. The predicted increases in the index is from 100.3 in 1976 to 105.1 in 1980. Over the forecast period this experience is in line with the national result. The ratio of Massachusetts total employment as measured by the household survey to the Massachusetts population is forecast to follow a simular pattern and it should have shown a simular time path historically but it has not. We find the discrepancy between the historical change in the Massachusetts Non-agricultural Wage and Salary employment series and the household survey series disturbing. Another disturbing development is a growing difference between the reported and the 202 employment series in 1976. (Our adjustments for this are explained in Chapter 5.)

The second index that we show is the real per capita disposable income index. It should be the best single measure of changes in the economic well-being of the citizens of Massachuaetts. In 1976 the index was at 97.7 percent of the 1973 level; by 1980 we predict that it will be at 110.2 percent of the 1973 level.

The third index type is the Massachusetts relative Business prodtction cost index set. The calculation of relative costs is described in detail on pages 30 through 35 above. Each index is the weighted average of the cost indexes for its component sector series. As described in Chapter 2 these sector relative cost indexes take into account all costs including relative wage rates, unemployment insurance costs, fuel costs, local property taxes, state business taxes, investment tax credits, costs of intermediate goods, etc.

February 1977

Table 3-1
CONTROL FORECAST

SUMMARY TABLE
MASSACHUSETTS ECONOMIC POLICY ANALYSIS MODEL
(Seasonally Adjusted Annual Rates)

	1975	1976	1977	1978	1979	1980
Employment--Nonag. W. & S.	2,273	2,310	2,349	2,422	2,495	2,558
% Change	-3.8	1.7	1.7	3.1	3.0	2.5
Manufacturing	577	586	597	629	657	684
% Change	-8.7	1.5	1.9	5.3	4.6	4.1
Non-Manufacturing	1,695	1,725	1,752	1,793	1,837	1,874
% Change	-2.0	1.7	1.6	2.3	2.5	2.0
Unemployment Rate	11.1	9.5	8.3	7.5	6.8	6.3
Employment Rate Index*	99.1	100.3	100.7	102.3	103.9	105.1
% Change	-2.3	1.2	0.3	1.6	1.6	1.2
Relative to U.S. Index*	97.5	96.6	96.0	96.1	96.4	96.4
Rate of Wage Change	8.6	7.3	9.3	9.2	8.2	8.7
Wage Index Rel. to U.S.*	98.3	98.3	98.9	98.6	98.7	98.9
Avg. Weekly Hours in Mfg.	39.3	39.9	40.3	40.5	40.5	40.5
Rate of Price Inflation	9.0	8.2	5.9	5.4	5.3	5.6
Relative to U.S. CPI*	99.2	101.5	101.1	101.1	101.2	101.[illegible]
Personal Income (mil$)	35,568	39,073	42,881	47,352	52,207	57,616
% Change	8.3	9.9	9.7	10.4	10.3	10.4
Disposable Income (mil$)	30,717	33,260	36,826	40,170	43,950	48,083
% Change	9.7	8.3	10.7	9.1	9.4	9.4
Real Per Cap. D.I. Index*	98.1	97.7	101.5	104.2	107.3	110.2
Relative to U.S.*	100.7	97.7	97.8	97.3	97.1	96.7
Rel. Business Cost Index*	99.7	99.3	99.5	99.3	99.4	99.5
Manufacturing*	98.9	98.1	98.1	98.0	98.1	98.1
Non-Manufacturing*	100.1	99.9	100.1	99.9	100.0	100.2

*Indexes equal 100 in calendar 1975.

Table 3-2

CONTROL FORECAST

SUMMARY TABLE
MASSACHUSETTS ECONOMIC POLICY ANALYSIS MODEL
(Seasonally Adjusted Annual Rates)

	77:1	77:2	77:3	77:4	78:1	78:2
Employment--Nonag. W. & S.	2,320	2,341	2,359	2,375	2,393	2,415
% Change	-0.7	3.7	3.1	2.8	3.0	3.7
Manufacturing	584	593	602	609	616	627
% Change	-4.6	6.3	6.4	4.7	4.9	7.2
Non-Manufacturing	1,736	1,748	1,757	1,766	1,777	1,788
% Change	0.6	2.8	2.0	2.1	2.4	2.5
Unemployment Rate	8.9	8.4	8.1	8.0	7.9	7.5
Employment Rate Index*	99.9	100.5	100.9	101.2	101.6	102.2
% Change	-0.3	2.3	1.7	1.3	1.6	2.1
Relative to U.S. Index*	95.9	96.0	96.0	96.0	96.1	96.1
Rate of Wage Change	9.1	13.0	9.2	9.5	9.8	7.1
Wage Index Rel. to U.S.*	98.8	98.9	99.1	98.8	98.6	98.6
Avg. Weekly Hours in Mfg.	40.1	40.3	40.4	40.4	40.5	40.6
Rate of Price Inflation	9.6	6.5	5.8	5.6	5.2	4.9
Relative to U.S. CPI*	101.0	101.1	101.2	101.2	101.2	101.1
Personal Income (mil$)	40,913	42,472	43,520	44,619	45,639	46,711
% Change	6.0	16.1	10.2	10.5	9.5	9.7
Disposable Income (mil$)	34,987	37,291	37,092	37,935	38,814	39,693
% Change	9.8	29.1	-2.1	9.4	9.6	9.4
Real Per Cap. D.I. Index*	98.9	103.5	101.4	102.1	102.9	103.8
Relative to U.S.*	98.2	98.0	97.6	97.3	97.3	97.3
Rel. Business Cost Index*	99.4	99.5	99.6	99.5	99.4	99.3
Manufacturing*	98.0	98.1	98.2	98.2	98.0	98.0
Non-Manufacturing*	100.0	100.1	100.2	100.1	100.0	99.9

*Indexes equal 100 in calendar 1973.

CHAPTER 4

SOME ADDITIONAL INFORMATION ABOUT THE CONTROL FORECAST

The forecast values for many of the MEPA model variables are presented in the Tables at the end of this chapter. Since most of the tables are self explanatory and since only a few minor departures were made from a straightforward use of the MEPA model in making the forecast, the text of this chapter will be brief. It will be confined to notes explaining the parts of Tables that require explanation and to pointing out the few judgmental interventions that were made in making the forecast.

Table 4-1 summarizes the employment forecast. This forecast starts with the projection of Massachusetts export production as shown in Table 4-2. In this Table the values shown for "Construction" and "Transportation and Utilities" are the exogenous components of the forecast for these industries. The multiplicative factor used for predicting Massachusetts exports (found by dividing the quantity of exports from Massachusetts by U.S. production) was set at the average of this value in the last two quarters of 1976 in all but four cases. They are shown in Table 4-3. For the furniture exports equation it was set at the average of all 1976 quarters, for rubber it was set at the value of the last quarter of 1976, for electrical equipment it was reduced by 5.5% from the last 2 quarters of the 1976 average and for printing it was reduced by 4 percent from the last two quarters of 1976 average. These four adjustments were made after a careful examination of the forecast with Richard Ring of the Division of Employment Security and with Benjamin Stevens of The Regional Science Research Institute. They were made to take into account factors that were not included in the mechanical use of the last two quarters of 1976 as an average value for the multiplicative factor. The multiplicative factor is really the proportion of national output in each industry that would be accounted for by exports from Massachusetts if there were no changes in the moving average of Massachusetts relative costs in the forecast period.

The current relative costs of Massachusetts production are shown in Table 4-4. The five-year moving averages of the relative costs that are used in the forecast are shown in Table 4-5. The labor intensities used to convert from quantity predictions to employment values are shown in Table 4-6. The Employment that depends on local demand is shown in Table 4-7.

Returning to the second page of Table 4-1, we find that the adjustment between "Total Massachusetts Jobs" and "Total Employment" as reported in the CPS survey is 22.3 thousand in 1975 and negative in the forecast period. In 1973 this adjustment was 137.2 thousand;in 1974 it was 94.6 thousand. Since the adjustment is made to account for people holding two jobs and for the residence adjustment it should not change by very much from year to year. This change in the difference between the 202 series and the CPS series over a period of four years is disturbing. The change would have been even greater if we had not made the adjustments to the 1976 values of the 790 series which are explained in Chapter 5.

We have reduced the Massachusetts population equation forecast by 18 thousand and the Massachusetts labor force equation forecast by 42 thousand over the forecast period. These adjustments were made to compensate for apparent shortcomings in the equations when used as forecasting equations.

Tables 4-8 and 4-9 show Massachusetts export employment and total employment expressed as a percent of the forecast employments for the U.S.

Table 4-10 shows the Wages and Salaries forecasts for the Massachusetts sectors.

The Personal income forecasts are shown in Table 4-11. All of these forecasts were made as explained on pages 60-62 above with one exception. The state unemployment benefits payments were adjusted on the basis of fourth quarter 1976 values. The latest data available for all other personal income values was the third quarter of 1976. The fourth quarter 1976 values were found using adjusted 790 series employment data.

Quarterly values for the first six quarters of the forecast are given in

Tables 4-12 and 4-13.

All state tax rates were held constant over the forecast period. State government demand was projected to increase by 35 percent in nominal dollars from 1976 to 1980.

Three important endogenous variables not shown in the tables are the investment variables. Residential investment is projected to increase from $.86 billion in 1976 to $1.09 billion in 1977, $1.30 billion in 1978, $1.51 billion in 1979 and $1.81 billion in 1980. Non residential construction is $.71, $.84, $1.05, $1.31 and $1.64 billion in the respective years. Investment in Massachusetts plant and equipment starts at a rate of $.9 billion in 1976 and grow to $1.69 billion in 1980.

CONTROL FORECAST

EMPLOYMENT IN MASSACHUSETTS
(Thousands of People, Seasonally Adjusted)

	1975	1976	1977	1978	1979	1980
Manufacturing	577.2	585.6	596.7	628.5	657.4	684.4
As % of U.S.	3.15	3.09	3.07	3.13	3.18	3.21
Durables	319.4	321.4	329.6	350.9	369.8	388.4
Ordnance (19)	20.5	19.2	19.6	21.4	23.0	24.3
Lumber (24)	3.6	3.8	4.2	4.6	4.9	5.3
Furniture (25)	8.5	8.5	8.6	9.1	9.5	10.0
Stone, Clay, etc. (32)	11.8	11.8	12.0	12.6	12.9	13.3
Primary Metals (33)	17.9	18.2	19.2	20.5	21.7	22.7
Fabricated Metals (34)	39.9	40.8	42.6	44.8	46.8	49.0
Non-elec. Machin. (35)	74.7	75.8	79.8	85.6	91.3	97.3
Elec. Equipment (36)	84.3	83.6	82.4	87.8	92.9	97.8
Transport. Equip. (37)	18.8	19.1	20.1	21.7	22.7	23.4
Instruments (38)	39.3	40.6	41.1	42.8	44.0	45.5
Nondurables	257.8	264.2	267.0	277.6	287.6	296.0
Food (20)	29.3	29.4	29.2	29.7	30.1	30.4
Textiles (22)	25.7	27.5	27.7	28.5	29.4	30.0
Apparel (23)	40.8	41.8	41.3	42.3	43.6	44.8
Paper (26)	27.7	28.5	29.6	30.9	32.0	33.1
Printing (27)	41.5	41.3	40.7	42.1	43.5	44.4
Chemicals (28)	18.7	19.4	19.9	21.1	22.3	23.2
Rubber (30)	29.1	29.5	31.3	32.7	33.7	34.7
Leather (31)	20.5	21.2	20.7	21.9	23.0	23.8
Other Nondurables (39)	24.5	25.7	26.7	28.5	30.1	31.6
Nonmanufacturing	1695.4	1724.6	1752.1	1793.0	1837.2	1873.6
✓ Contract Construction	77.3	70.8	72.5	76.0	78.0	80.2
✓ Transport & Utilities	114.0	112.8	113.1	114.9	116.9	118.4
Wholesale & Retail Trade	510.6	523.5	532.1	548.4	564.1	575.6
✓ Finance, Insurance, etc.	134.8	133.9	137.2	141.8	148.0	153.4
✓ Services & Miscellaneous	494.5	518.0	530.3	540.5	552.0	559.9
Government	364.3	365.7	366.9	371.4	378.3	386.1
✓ Federal	57.7	57.0	56.4	57.8	59.0	60.6
✓ State	85.0	83.3	83.9	83.5	85.3	87.3
Local	221.7	225.4	226.6	230.1	234.0	238.2
Nonag. Wage & Sal. Employ.*	2272.6	2310.2	2348.8	2421.6	2494.6	2558.0
As % of U.S.	2.95	2.92	2.90	2.90	2.90	2.90

*EMPLOYMENT REVIEW concept.

Continued

TABLE 4-1 (concluded)

	1975	1976	1977	1978	1979	1980
Nonag. Wage & Sal. Employ.*	2272.6	2310.2	2348.8	2421.6	2494.6	2558.0
Plus: All Other Nonag.	153.6	151.1	153.7	157.7	161.6	164.6
Plus: Agriculture	26.0	25.7	26.6	26.6	26.6	26.6
Total Mass. Jobs	2452.2	2486.9	2529.0	2605.8	2682.8	2749.2
Less: Adjustments**	22.3	-10.9	-11.0	-11.4	-11.7	-12.0
Total Employment***	2429.9	2497.8	2540.1	2617.2	2694.5	2761.2
As % of U.S.	2.87	2.86	2.83	2.83	2.84	2.85
Mass. Population	5831.7	5862.3	5898.0	5943.9	5997.8	6050.1
As % of U.S.	2.73	2.72	2.72	2.72	2.71	2.71
Mass. Populn. 16 and Over	4228.8	4293.8	4353.2	4413.7	4473.2	4529.8
Mass. Employment Rate****	57.5	58.2	58.3	59.3	60.2	61.0
Indexed to 1973	99.1	100.3	100.7	102.3	103.9	105.1
U.S. Employment Rate	55.3	56.1	56.6	57.4	58.0	58.5
Mass. Index Rel. To U.S.	97.5	96.6	96.0	96.1	96.4	96.4
Labor Force	2734.8	2761.0	2771.0	2829.9	2890.8	2946.6
Participation Rate	64.7	65.4	63.7	64.1	64.6	65.0
U.S. Participation Rate	60.4	60.7	61.1	61.4	61.8	62.0
Number of Unemployed	305.0	252.5	230.9	212.7	196.2	185.4
Unemployment Rate	11.1	9.5	8.3	7.5	6.8	6.3
U.S. Unemployment Rate	8.5	7.7	7.4	6.4	6.0	5.6

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*EMPLOYMENT REVIEW concept.
**Adjustments for double counting and place of residence.
***MASSACHUSETTS TRENDS concept.
****Total employment divided by the population sixteen and over.

February 1977 TABLE 4-2

EXPORT EMPLOYMENT IN MASSACHUSETTS

	1976	1977	1978	1979	1980
Manufacturing					
Durables					
Ordnance (19)	16.8	17.2	18.9	20.3	21.5
Lumber (24)	2.4	2.7	3.1	3.4	3.7
Furniture (25)	5.5	5.6	5.9	6.1	6.4
Stone, Clay, etc. (32)	6.0	6.3	6.7	7.0	7.3
Primary Metals (33)	11.2	11.9	12.9	13.7	14.3
Fabricated Metals (34)	30.6	32.4	34.2	35.8	37.6
Non-elec. Machin. (35)	60.9	64.3	69.2	73.8	78.6
Elec. Equipment (36)	76.5	75.0	80.0	84.7	89.1
Transport. Equip. (37)					
Motor Vehicles (371)	3.9	4.3	4.6	4.8	4.9
Exc. Mot. Veh. (370)	14.3	14.9	16.1	16.9	17.4
Instruments (38)	36.8	37.3	38.7	39.7	41.0
Nondurables					
Food (20)	11.9	11.7	12.0	12.2	12.4
Textiles (22)	17.3	17.5	18.1	18.8	19.2
Apparel (23)	29.4	29.2	30.0	31.1	32.0
Paper (26)	13.7	14.5	15.4	16.1	16.8
Printing (27)	22.5	21.6	22.6	23.5	24.1
Chemicals (28)	12.8	13.3	14.2	15.1	15.8
Rubber (30)	18.9	19.8	20.6	21.2	21.8
Leather (31)	16.0	15.7	16.7	17.6	18.3
Other Nondurables (39)	18.7	19.6	21.1	22.3	23.5
Nonmanufacturing					
Contract Construction	6.1	5.2	5.4	5.3	5.4
Transport & Utilities	17.8	16.8	17.1	17.4	17.6
Wholesale & Retail Trade	44.1	41.4	43.2	44.4	45.0
Finance, Insurance, etc.	11.5	10.9	11.6	12.1	12.6
Services & Miscellaneous	118.7	122.4	124.7	125.9	126.0

TABLE 4-3

MULTIPLICATIVE ADJUSTMENT FACTORS
USED TO PREDICT EXPORT EMPLOYMENT

	76:1	76:2	76:3	76:4	77:1	77:2
Manufacturing						
Durables						
Ordnance (19)	0.09231	0.09179	0.08821	0.08857	0.08839	0.08839
Lumber (24)	0.00369	0.00382	0.00380	0.00373	0.00377	0.00377
Furniture (25)	0.01351	0.01295	0.01207	0.01278	0.01283	0.01283
Stone, Clay, etc. (32)	0.01385	0.01333	0.01359	0.01386	0.01373	0.01373
Primary Metals (33)	0.00680	0.00661	0.00647	0.00653	0.00650	0.00650
Fabricated Metals (34)	0.02001	0.02017	0.02024	0.02021	0.02023	0.02023
Non-elec. Machin. (35)	0.02883	0.02862	0.02815	0.02853	0.02834	0.02834
Elec. Equipment (36)	0.04273	0.04228	0.04177	0.04012	0.03871	0.03871
Transport. Equip. (37)						
Motor Vehicles (371)	0.00474	0.00449	0.00453	0.00448	0.00450	0.00450
Exc. Mot. Veh. (370)	0.01499	0.01557	0.01604	0.01651	0.01628	0.01628
Instruments (38)	0.08967	0.08972	0.09001	0.09102	0.09051	0.09051
Nondurables						
Food (20)	0.00775	0.00754	0.00715	0.00736	0.00726	0.00726
Textiles (22)	0.02501	0.02434	0.02389	0.02366	0.02378	0.02378
Apparel (23)	0.02870	0.02861	0.02821	0.02852	0.02837	0.02837
Paper (26)	0.01865	0.01860	0.01814	0.01780	0.01797	0.01797
Printing (27)	0.02265	0.02207	0.02126	0.02026	0.01993	0.01993
Chemicals (28)	0.01417	0.01412	0.01369	0.01385	0.01377	0.01377
Rubber (30)	0.03230	0.03257	0.03354	0.03098	0.03098	0.03098
Leather (31)	0.08002	0.08157	0.07920	0.07956	0.07938	0.07938
Other Nondurables (39)	0.04891	0.04928	0.04914	0.04986	0.04950	0.04950
Nonmanufacturing						
Contract Construction	0.00188	0.00260	0.00160	0.00147	0.00154	0.00154
Transport & Utilities	0.00376	0.00415	0.00345	0.00347	0.00346	0.00346
Wholesale & Retail Trade	0.00292	0.00269	0.00234	0.00227	0.00230	0.00230
Finance, Insurance, etc.	0.00374	0.00397	0.00312	0.00298	0.00305	0.00305
Services & Miscellaneous	0.00924	0.00970	0.00971	0.00980	0.00975	0.00975

February 1977 TABLE 4-4

CURRENT COSTS IN MASSACHUSETTS RELATIVE TO THE U.S.

	1975	1976	1977	1978	1979	1980
Manufacturing						
Durables						
Ordnance (19)	0.966	0.961	0.963	0.961	0.962	0.963
Lumber (24)	0.965	0.929	0.924	0.922	0.923	0.924
Furniture (25)	1.039	1.025	1.031	1.029	1.029	1.030
Stone, Clay, etc. (32)	1.067	1.052	1.050	1.048	1.049	1.050
Primary Metals (33)	0.931	0.913	0.911	0.909	0.910	0.911
Fabricated Metals (34)	0.990	0.978	0.977	0.976	0.976	0.977
Non-elec. Machin. (35)	0.993	0.978	0.980	0.978	0.979	0.980
Elec. Equipment (36)	1.003	0.994	0.998	0.996	0.997	0.998
Transport. Equip. (37)						
Motor Vehicles (371)	0.991	0.985	0.992	0.991	0.991	0.992
Exc. Mot. Veh. (370)	0.988	0.982	0.989	0.988	0.989	0.989
Instruments (38)	1.060	1.064	1.062	1.061	1.062	1.062
Nondurables						
Food (20)	1.017	1.014	1.015	1.014	1.015	1.016
Textiles (22)	1.055	1.042	1.036	1.034	1.035	1.036
Apparel (23)	1.044	1.040	1.039	1.037	1.038	1.039
Paper (26)	0.976	0.966	0.963	0.961	0.962	0.963
Printing (27)	0.999	1.005	1.005	1.004	1.005	1.006
Chemicals (28)	1.018	1.009	1.009	1.008	1.009	1.010
Rubber (30)	1.018	1.020	1.021	1.019	1.020	1.021
Leather (31)	1.074	1.043	1.044	1.041	1.042	1.044
Other Nondurables (39)	1.012	1.010	1.011	1.009	1.010	1.011
Nonmanufacturing						
Contract Construction	1.066	1.000	1.007	1.005	1.006	1.007
Transport & Utilities	1.038	1.016	1.013	1.011	1.013	1.014
Wholesale & Retail Trade	1.004	1.005	1.008	1.005	1.007	1.008
Finance, Insurance, etc.	1.060	1.048	1.049	1.048	1.050	1.051
Services & Miscellaneous	1.042	1.059	1.061	1.059	1.060	1.061

TABLE 4-5

FIVE-YEAR MOVING AVERAGE COSTS IN MASSACHUSETTS, RELATIVE TO THE U.S.

	1975	1976	1977	1978	1979	1980
Manufacturing						
Durables						
Ordnance (19)	0.983	0.983	0.975	0.969	0.965	0.963
Lumber (24)	1.009	0.994	0.974	0.955	0.940	0.929
Furniture (25)	1.026	1.029	1.030	1.030	1.030	1.030
Stone, Clay, etc. (32)	1.083	1.078	1.070	1.063	1.057	1.051
Primary Metals (33)	0.956	0.944	0.932	0.924	0.917	0.914
Fabricated Metals (34)	0.997	0.994	0.988	0.984	0.981	0.979
Non-elec. Machin. (35)	1.010	1.004	0.996	0.989	0.984	0.980
Elec. Equipment (36)	1.012	1.011	1.006	1.002	0.999	0.997
Transport. Equip. (37)						
Motor Vehicles (371)	1.010	1.004	0.999	0.994	0.991	0.990
Exc. Mot. Veh. (370)	1.008	1.002	0.997	0.992	0.988	0.987
Instruments (38)	1.050	1.056	1.060	1.062	1.062	1.062
Nondurables						
Food (20)	1.021	1.020	1.018	1.016	1.015	1.015
Textiles (22)	1.064	1.062	1.055	1.048	1.042	1.039
Apparel (23)	1.052	1.051	1.048	1.044	1.041	1.039
Paper (26)	0.996	0.991	0.983	0.975	0.969	0.965
Printing (27)	1.021	1.018	1.012	1.007	1.004	1.004
Chemicals (28)	1.040	1.034	1.026	1.019	1.013	1.010
Rubber (30)	1.017	1.019	1.019	1.019	1.019	1.020
Leather (31)	1.073	1.070	1.064	1.057	1.052	1.047
Other Nondurables (39)	1.031	1.027	1.021	1.016	1.012	1.010
Nonmanufacturing						
Contract Construction	1.055	1.051	1.038	1.028	1.021	1.012
Transport & Utilities	1.040	1.038	1.030	1.024	1.020	1.016
Wholesale & Retail Trade	1.010	1.008	1.006	1.004	1.004	1.006
Finance, Insurance, etc.	1.067	1.065	1.058	1.053	1.051	1.051
Services & Miscellaneous	1.040	1.045	1.047	1.049	1.053	1.058

February 1977

TABLE 4-6

LABOR INTENSITIES IN MASSACHUSETTS, RELATIVE TO THE U.S.

	1975	1976	1977	1978	1979	1980
Manufacturing						
Durables						
Ordnance (19)	1097	1094	1091	1087	1084	1081
Lumber (24)	1016	1023	1032	1041	1051	1061
Furniture (25)	1003	1002	1000	999	997	995
Stone, Clay, etc. (32)	958	959	961	963	965	967
Primary Metals (33)	1109	1115	1121	1128	1134	1141
Fabricated Metals (34)	1067	1065	1065	1065	1064	1064
Non-elec. Machin. (35)	1038	1040	1043	1045	1048	1051
Elec. Equipment (36)	1040	1039	1037	1036	1035	1034
Transport. Equip. (37)						
Motor Vehicles (371)	1025	1030	1033	1036	1038	1041
Exc. Mot. Veh. (370)	1024	1028	1031	1034	1037	1039
Instruments (38)	1021	1012	1003	995	987	979
Nondurables						
Food (20)	1017	1014	1011	1008	1006	1003
Textiles (22)	959	958	958	958	959	959
Apparel (23)	982	980	978	976	974	972
Paper (26)	1068	1070	1072	1074	1077	1079
Printing (27)	1033	1032	1031	1029	1028	1027
Chemicals (28)	1023	1026	1029	1031	1034	1037
Rubber (30)	1036	1034	1030	1027	1023	1020
Leather (31)	979	980	982	983	985	986
Other Nondurables (39)	1006	1007	1007	1007	1007	1008
Nonmanufacturing						
Contract Construction	979	980	982	984	986	988
Transport & Utilities	1059	1062	1063	1065	1066	1068
Wholesale & Retail Trade	1030	1031	1031	1031	1031	1032
Finance, Insurance, etc.	1024	1023	1022	1021	1020	1019
Services & Miscellaneous	1022	1017	1010	1004	998	992

 TABLE 4-7

LOCAL EMPLOYMENT IN MASSACHUSETTS

	1976	1977	1978	1979	1980
Manufacturing					
Durables					
Ordnance (19)	2.4	2.3	2.5	2.6	2.8
Lumber (24)	1.4	1.5	1.5	1.5	1.6
Furniture (25)	2.9	3.0	3.2	3.4	3.6
Stone, Clay, etc. (32)	5.8	5.7	5.8	5.9	6.0
Primary Metals (33)	7.0	7.2	7.6	8.0	8.4
Fabricated Metals (34)	10.2	10.3	10.7	11.0	11.4
Non-elec. Machin. (35)	14.9	15.4	16.5	17.6	18.7
Elec. Equipment (36)	7.1	7.4	7.8	8.2	8.6
Transport. Equip. (37)					
Motor Vehicles (371)	0.2	0.2	0.2	0.2	0.2
Exc. Mot. Veh. (370)	0.7	0.7	0.8	0.8	0.8
Instruments (38)	3.8	3.9	4.1	4.3	4.5
Nondurables					
Food (20)	17.4	17.5	17.7	17.9	18.0
Textiles (22)	10.2	10.2	10.4	10.6	10.8
Apparel (23)	12.3	12.1	12.2	12.5	12.7
Paper (26)	14.7	15.1	15.5	15.9	16.3
Printing (27)	18.8	19.1	19.5	20.0	20.4
Chemicals (28)	6.6	6.6	6.9	7.2	7.4
Rubber (30)	10.6	11.5	12.1	12.5	12.9
Leather (31)	5.2	5.1	5.2	5.4	5.5
Other Nondurables (39)	6.9	7.1	7.5	7.8	8.1
Nonmanufacturing					
Contract Construction	64.6	67.3	70.6	72.6	74.9
Transport & Utilities	95.0	96.3	97.8	99.5	100.8
Wholesale & Retail Trade	479.4	490.7	505.2	519.7	530.6
Finance, Insurance, etc.	122.4	126.3	130.3	135.9	140.8
Services & Miscellaneous	399.3	407.9	415.8	426.1	433.9

MASS. EXPORT EMPLOYMENT, AS A SHARE IN PER CENT

	1976	1977	1978	1979	1980
Manufacturing					
Durables					
Ordnance (19)	10.62	10.75	11.00	11.18	11.26
Lumber (24)	0.39	0.44	0.48	0.52	0.55
Furniture (25)	1.13	1.13	1.13	1.13	1.12
Stone, Clay, etc. (32)	0.96	0.99	1.02	1.05	1.07
Primary Metals (33)	0.94	0.98	1.03	1.07	1.09
Fabricated Metals (34)	2.20	2.26	2.30	2.34	2.36
Non-elec. Machin. (35)	2.93	3.01	3.11	3.18	3.24
Elec. Equipment (36)	4.18	3.92	3.98	4.03	4.05
Transport. Equip. (37)					
Motor Vehicles (371)	0.46	0.47	0.48	0.49	0.49
Exc. Mot. Veh. (370)	1.62	1.70	1.74	1.78	1.79
Instruments (38)	7.23	7.09	6.96	6.91	6.84
Nondurables					
Food (20)	0.70	0.68	0.68	0.68	0.68
Textiles (22)	1.79	1.81	1.86	1.91	1.94
Apparel (23)	2.27	2.27	2.30	2.33	2.34
Paper (26)	2.03	2.07	2.15	2.21	2.26
Printing (27)	2.08	1.95	1.99	2.02	2.01
Chemicals (28)	1.24	1.27	1.31	1.35	1.37
Rubber (30)	3.09	2.95	2.93	2.92	2.90
Leather (31)	5.89	5.97	6.14	6.30	6.42
Other Nondurables (39)	4.45	4.56	4.65	4.73	4.77
Nonmanufacturing					
Contract Construction	0.18	0.15	0.15	0.15	0.15
Transport & Utilities	0.39	0.37	0.37	0.37	0.37
Wholesale & Retail Trade	0.25	0.23	0.23	0.23	0.23
Finance, Insurance, etc.	0.27	0.24	0.25	0.25	0.25
Services & Miscellaneous	0.81	0.81	0.80	0.78	0.76

TABLE 4-9

MASSACHUSETTS' SHARE OF EMPLOYMENT, IN PER CENT

	1975	1976	1977	1978	1979	1980
Manufacturing	3.15	3.09	3.07	3.13	3.18	3.21
Durables	2.99	2.91	2.90	2.96	3.01	3.05
Ordnance (19)	11.99	12.12	12.21	12.46	12.64	12.71
Lumber (24)	0.65	0.63	0.67	0.71	0.75	0.78
Furniture (25)	1.89	1.73	1.73	1.74	1.75	1.75
Stone, Clay, etc. (32)	1.92	1.88	1.88	1.91	1.93	1.94
Primary Metals (33)	1.52	1.53	1.58	1.64	1.69	1.73
Fabricated Metals (34)	2.99	2.94	2.98	3.02	3.05	3.08
Non-elec. Machin. (35)	3.61	3.65	3.73	3.84	3.94	4.01
Elec. Equipment (36)	4.79	4.56	4.31	4.37	4.42	4.45
Transport. Equip. (37)	1.14	1.10	1.12	1.15	1.18	1.18
Instruments (38)	8.03	7.97	7.82	7.70	7.66	7.58
Nondurables	3.36	3.33	3.32	3.38	3.42	3.45
Food (20)	1.75	1.72	1.69	1.69	1.68	1.68
Textiles (22)	2.85	2.85	2.87	2.93	2.99	3.02
Apparel (23)	3.30	3.22	3.22	3.24	3.26	3.27
Paper (26)	4.30	4.21	4.23	4.32	4.40	4.46
Printing (27)	3.84	3.82	3.68	3.71	3.73	3.72
Chemicals (28)	1.85	1.88	1.90	1.95	1.99	2.01
Rubber (30)	4.96	4.82	4.66	4.65	4.64	4.62
Leather (31)	8.00	7.81	7.90	8.06	8.22	8.34
Other Nondurables (39)	6.06	6.10	6.21	6.30	6.38	6.42
Nonmanufacturing	2.89	2.87	2.84	2.82	2.82	2.80
Contract Construction	2.23	2.10	2.09	2.14	2.21	2.28
Transport & Utilities	2.53	2.50	2.47	2.47	2.48	2.49
Wholesale & Retail Trade	3.01	2.99	2.97	2.96	2.97	2.96
Finance, Insurance, etc.	3.19	3.10	3.07	3.06	3.06	3.05
Services & Miscellaneous	3.53	3.55	3.50	3.46	3.42	3.37
Government	2.47	2.42	2.40	2.36	2.34	2.32
Federal	2.10	2.08	2.03	2.03	2.03	2.03
State & Local	2.55	2.50	2.48	2.44	2.41	2.39
Nonag. Wage & Sal. Employ.*	2.95	2.92	2.90	2.90	2.90	2.90

*EMPLOYMENT REVIEW concept.

TABLE 4-10

WAGES AND SALARIES IN MASSACHUSETTS

	1975	1976	1977	1978	1979	1980
Manufacturing--Avg. Hourly Earnings						
Durables						
Ordnance (19)	4.64	5.05	5.55	6.06	6.55	7.13
Lumber (24)	3.76	3.91	4.28	4.67	5.05	5.49
Furniture (25)	3.94	4.12	4.53	4.95	5.36	5.83
Stone, Clay, etc. (32)	5.29	5.67	6.20	6.77	7.32	7.96
Primary Metals (33)	4.91	5.24	5.70	6.22	6.73	7.32
Fabricated Metals (34)	4.71	4.94	5.36	5.86	6.34	6.89
Non-elec. Machin. (35)	5.01	5.19	5.68	6.21	6.71	7.30
Elec. Equipment (36)	4.44	4.68	5.16	5.64	6.09	6.63
Transport. Equip. (37)	5.58	6.00	6.67	7.28	7.87	8.56
Instruments (38)	5.01	5.48	5.93	6.48	7.01	7.62
Nondurables						
Food (20)	4.64	5.01	5.48	5.99	6.47	7.04
Textiles (22)	3.74	3.96	4.30	4.69	5.08	5.52
Apparel (23)	3.42	3.66	3.97	4.34	4.69	5.10
Paper (26)	4.44	4.78	5.21	5.69	6.15	6.69
Printing (27)	5.19	5.57	6.06	6.62	7.16	7.78
Chemicals (28)	5.13	5.55	6.08	6.65	7.19	7.82
Rubber (30)	4.28	4.60	5.01	5.47	5.92	6.43
Leather (31)	3.46	3.61	3.90	4.26	4.61	5.01
Other Nondurables (39)	3.75	4.00	4.32	4.72	5.11	5.55
Nonmanufacturing--Annual Wage & Sal. Disbursement Per Employee						
Contract Construction	13.208	13.314	14.753	16.116	17.430	18.951
Transport & Utilities	12.664	14.002	15.151	16.551	17.900	19.462
Wholesale & Retail Trade	7.716	8.255	9.001	9.833	10.634	11.562
Finance, Insurance, etc.	10.680	11.542	12.503	13.659	14.772	16.061
Services & Miscellaneous	9.115	9.953	10.937	11.947	12.921	14.049
Government						
Federal	17.464	19.620	20.538	21.565	22.643	23.775
State & Local	9.893	10.622	11.618	12.691	13.726	14.924
Agriculture	1.099	1.178	1.301	1.421	1.537	1.671

TABLE 4-11

CONTROL FORECAST

PERSONAL INCOME IN MASSACHUSETTS
(Millions of Dollars at Seasonally Adjusted Annual Rates)

	1975	1976	1977	1978	1979	1980
INCOME BY PLACE OF WORK						
Wage & Sal. Disbursements	22,893	25,224	28,120	31,714	35,327	39,391
Other Labor Income	1,580	1,702	1,745	1,998	2,265	2,558
Proprietors' Income	1,619	1,820	1,882	1,989	2,084	2,174
Total Labor & Propr. Inc.	26,092	28,745	31,748	35,701	39,676	44,123
Breakdown by Industry:						
Farm	66	66	73	79	84	91
Manufacturing	7,252	8,134	9,220	10,675	12,098	13,711
Durables	4,712	5,262	5,985	6,981	7,957	9,078
Nondurables	2,540	2,872	3,235	3,694	4,141	4,633
Construction	1,280	1,226	1,378	1,565	1,735	1,933
Trade	4,448	4,895	5,395	6,047	6,701	7,406
Finance, Ins., & R.E.	1,668	1,801	1,993	2,244	2,523	2,833
Transportation & Util.	1,663	1,771	1,763	1,953	2,146	2,361
Services & Misc.	5,575	6,348	7,044	7,780	8,523	9,324
Government	4,140	4,504	4,881	5,358	5,866	6,463
Federal	1,100	1,219	1,266	1,370	1,473	1,595
State & Local	3,040	3,286	3,615	3,989	4,393	4,868
DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE						
Total L&P, Place of Work	26,092	28,745	31,748	35,701	39,676	44,123
Less: Soc. Insr. Contr.	1,298	1,418	1,572	1,837	2,047	2,286
Plus: Residence Adjmt.	-187	-198	-208	-220	-232	-244
Plus: Div., Int., & Rent	5,201	5,759	6,237	6,559	7,060	7,662
Plus: Transfer Payments	5,760	6,184	6,675	7,149	7,750	8,360
State Unempl. Benefits	799	645	540	544	543	560
All Other Transfers	4,962	5,539	6,136	6,604	7,207	7,800
Personal Inc., Pl of Res.	35,568	39,073	42,881	47,352	52,207	57,616
Less: Fed. Income Tax	3,648	4,209	4,480	5,374	6,226	7,253
Less: Mass. Income Tax	1,003	1,381	1,331	1,542	1,727	1,941
Less: Other Mass. Taxes	200	223	243	266	303	338
Dispos. P.I., Pl of Res.	30,717	33,260	36,826	40,170	43,950	48,083
Boston CPI, 1967 = 100	160.8	174.0	184.3	194.2	204.5	215.9
Real D.P.I., '67 Dollars	19,099	19,118	19,982	20,686	21,486	22,264
Real D.P.I., Per Capita	3.275	3.261	3.388	3.480	3.582	3.680
% Change	-0.0	-0.4	3.9	2.7	2.9	2.7

CONTROL FORECAST

EMPLOYMENT IN MASSACHUSETTS
(Thousands of People, Seasonally Adjusted)

	77:1	77:2	77:3	77:4	78:1	78:2
Manufacturing	583.6	592.5	601.9	608.7	616.1	626.9
As % of U.S.	3.05	3.07	3.08	3.10	3.11	3.12
Durables	321.0	326.7	332.4	338.4	343.3	349.8
Ordnance (19)	18.8	19.4	19.7	20.4	20.7	21.2
Lumber (24)	4.0	4.1	4.3	4.4	4.5	4.5
Furniture (25)	8.5	8.6	8.[illegible]	[illegible].8	8.9	9.1
Stone, Clay, etc. (32)	12.1	11.9	12.0	12.2	12.4	12.6
Primary Metals (33)	18.3	19.4	19.8	19.2	19.7	20.6
Fabricated Metals (34)	41.5	42.3	43.1	43.7	44.0	44.9
Non-elec. Machin. (35)	77.4	79.2	80.2	82.2	83.8	84.9
Elec. Equipment (36)	80.3	80.9	83.1	85.3	86.0	87.7
Transport. Equip. (37)	19.6	19.9	20.2	20.7	21.0	21.6
Instruments (38)	40.4	41.1	41.3	41.6	42.3	42.8
Nondurables	262.6	265.8	269.4	270.3	272.9	277.1
Food (20)	29.1	29.2	29.3	29.4	29.5	29.6
Textiles (22)	27.4	27.8	28.0	27.7	27.8	28.6
Apparel (23)	41.0	41.1	41.4	41.7	41.9	42.2
Paper (26)	28.8	29.4	29.9	30.0	30.4	30.7
Printing (27)	40.2	40.5	40.9	41.1	41.6	42.0
Chemicals (28)	19.6	19.8	19.9	20.2	20.5	20.9
Rubber (30)	30.4	30.8	31.7	32.1	32.2	32.8
Leather (31)	20.4	20.9	21.0	20.6	21.1	21.8
Other Nondurables (39)	25.7	26.3	27.3	27.5	27.9	28.4
Nonmanufacturing	1736.3	1748.4	1757.2	1766.4	1776.9	1787.7
Contract Construction	70.3	71.9	73.2	74.5	75.1	75.8
Transport & Utilities	112.3	113.1	113.4	113.7	114.2	114.7
Wholesale & Retail Trade	527.3	530.4	533.4	537.3	542.0	546.8
Finance, Insurance, etc.	136.1	136.8	137.6	138.4	139.6	141.1
Services & Miscellaneous	525.8	529.4	531.9	534.0	537.1	539.1
Government	364.5	366.9	367.6	368.5	369.0	370.3
Federal	55.9	56.1	56.6	56.9	57.1	57.8
State	84.0	84.1	83.8	83.5	83.3	83.0
Local	224.6	226.7	227.2	228.0	228.6	229.5
Nonag. Wage & Sal. Employ.*	2319.9	2341.0	2359.0	2375.1	2393.0	2414.6
As % of U.S.	2.89	2.90	2.90	2.90	2.90	2.90

[illegible]YMENT REVIEW concept.

Continued

TABLE 4-12 (concluded)

	77:1	77:2	77:3	77:4	78:1	78:2
Nonag. Wage & Sal. Employ.*	2319.9	2341.0	2359.0	2375.1	2393.0	2414.6
Plus: All Other Nonag.	152.1	153.3	154.2	155.2	156.3	157.2
Plus: Agriculture	26.6	26.6	26.6	26.6	26.6	26.6
Total Mass. Jobs	2498.5	2520.8	2539.9	2556.9	2575.9	2598.5
Less: Adjustments**	-10.9	-11.0	-11.1	-11.2	-11.3	-11.3
Total Employment***	2509.5	2531.9	2551.0	2568.1	2587.1	2609.8
As % of U.S.	2.83	2.83	2.83	2.83	2.83	2.83
Mass. Population	5882.4	5893.2	5902.0	5914.5	5926.0	5937.7
As % of U.S.	2.72	2.72	2.72	2.72	2.72	2.72
Mass. Populn. 16 and Over	4331.4	4345.6	4360.2	4375.6	4391.1	4406.2
Mass. Employment Rate****	57.9	58.3	58.5	58.7	58.9	59.2
Indexed to 1973	99.9	100.5	100.9	101.2	101.6	102.2
U.S. Employment Rate	56.3	56.5	56.7	57.0	57.2	57.3
Mass. Index Rel. To U.S.	95.9	96.0	96.0	96.0	96.1	96.1
Labor Force	2754.5	2762.7	2776.0	2790.9	2807.7	2822.4
Participation Rate	63.6	63.6	63.7	63.8	63.9	64.1
U.S. Participation Rate	61.0	61.1	61.2	61.2	61.3	61.4
Number of Unemployed	245.1	230.8	225.0	222.8	220.6	212.6
Unemployment Rate	8.9	8.4	8.1	8.0	7.9	7.5
U.S. Unemployment Rate	7.8	7.5	7.3	6.9	6.6	6.5

*EMPLOYMENT REVIEW concept.
**Adjustments for double counting and place of residence.
***MASSACHUSETTS TRENDS concept.
****Total employment divided by the population sixteen and over.

February 1977

TABLE 4-13

CONTROL FORECAST

PERSONAL INCOME IN MASSACHUSETTS
(Millions of Dollars at Seasonally Adjusted Annual Rates)

	77:1	77:2	77:3	77:4	78:1	78:2
INCOME BY PLACE OF WORK						
Wage & Sal. Disbursements	26,644	27,746	28,591	29,500	30,414	31,232
Other Labor Income	1,665	1,709	1,770	1,837	1,900	1,966
Proprietors' Income	1,838	1,872	1,898	1,921	1,953	1,977
Total Labor & Propr. Inc.	30,147	31,328	32,259	33,258	34,268	35,174
Breakdown by Industry:						
Farm	69	73	75	76	77	78
Manufacturing	8,623	9,059	9,427	9,772	10,142	10,518
Durables	5,580	5,871	6,116	6,374	6,624	6,875
Nondurables	3,043	3,188	3,312	3,398	3,518	3,642
Construction	1,292	1,354	1,406	1,459	1,503	1,542
Trade	5,149	5,329	5,472	5,631	5,808	5,957
Finance,Ins.,& R.E.	1,902	1,968	2,021	2,079	2,146	2,206
Transportation & Util.	1,682	1,745	1,789	1,834	1,885	1,925
Services & Misc.	6,740	6,971	7,144	7,321	7,524	7,672
Government	4,689	4,829	4,924	5,084	5,183	5,276
Federal	1,238	1,244	1,257	1,326	1,332	1,352
State & Local	3,451	3,584	3,667	3,758	3,851	3,924
DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE						
Total L&P, Place of Work	30,147	31,328	32,259	33,258	34,268	35,174
Less: Soc. Insr. Contr.	1,520	1,557	1,590	1,619	1,757	1,818
Plus: Residence Adjmt.	-203	-206	-209	-212	-215	-218
Plus: Div.,Int., & Rent	6,038	6,168	6,309	6,431	6,449	6,536
Plus: Transfer Payments	6,451	6,739	6,750	6,762	6,894	7,036
State Unempl. Benefits	553	534	532	540	549	536
All Other Transfers	5,898	6,205	6,218	6,221	6,345	6,500
Personal Inc., Pl of Res.	40,913	42,472	43,520	44,619	45,639	46,711
Less: Fed. Income Tax	4,468	3,656	4,796	5,001	5,089	5,238
Less: Mass. Income Tax	1,222	1,284	1,385	1,434	1,480	1,517
Less: Other Mass. Taxes	235	241	246	250	255	263
Dispos. P.I., Pl of Res.	34,987	37,291	37,092	37,935	38,814	39,693
Boston CPI, 1967 = 100	180.2	183.0	185.7	188.2	190.6	192.9
Real D.P.I., '67 Dollars	19,418	20,374	19,979	20,155	20,362	20,574
Real D.P.I., Per Capita	3.301	3.457	3.385	3.408	3.436	3.465
% Change	-0.2	20.3	-8.1	2.7	3.4	3.4

CHAPTER 5

THE FORECASTING RECORD OF THE JUNE 1975 MASSACHUSETTS ECONOMETRIC MODEL.

The forecasting record of the June 1975 Massachusetts Econometric Model is shown on the tables in this chapter. The compilation of a forecasting record at this time is difficult due to the absence of revised data. To circumvent this problem we use our current estimates of the revised data in the final column for comparison. In the last three quarters of 1976 our estimate of total non-agricultural wage and salary employment and the non-manufacturing employment is higher than the reported values (790 series) by 22, 25, and 27 thousand in the 2^{nd}, 3^{rd}, and 4^{th} quarters respectively. These increases were made in anticipation of revisions that we feel will be made in light of the newest data on the covered employment (202 series) and the household survey series (CPS).

Since many series are peridocally revised substantially we have adjusted all of our forecasts variables except for the rate of inflation and the unemployment rate for data revisions. We have done this by multiplying one plus the percentage change that we predicted times the revised value of the last data point (as it is now reported). In other words we have applied our predicted changes to the last observed revised data point.

All of the forecasts for total employment for the fourth quarter of 1976 are within one percent of our current estimate of that value. This achievement in forecast accuracy is diminished somewhat by the fact that the June 1975 value was achieved partially because of offsetting errors in the manufacturing and non-manufacturing predictions. The personal income predictions for the fourth quarter of 1976 are all within one and one half percent of the current estimate for that value. The real percapita prediction errors range between two and one half and one percent for the fourth quarter of 1976. The model forecasts of the unemployment rate have turned out to be a much better predictor of the revised rate than the preliminary estimates made using the federally mandated formulas and the current observed data. The inflation rate predictions are close to the actual on the basis of the annual average but have not captured the extremely erratic behavior in the reported series on a quarterly basis.

The Massachusetts model July 1975 tax forecast for Fiscal '76 state tax revenues was $2,339 million. Taxes were increased by enough to raise revenues by $423 million according to official estimates. This $423 plus the model forecast is $2,762 million. This compares with a realized value of $2,610 million. The January 1976 and the June 1976 forecasts of Fiscal 1976 revenues are given on a table below. The phenomenal accuracy of the total forecast is due to some extent to offsetting errors in some of the components.

TABLE 5-1

Comparison of Predicted
and Current
Estimates of Actual Values.

	Quarter	July '75 Forecast	Jan. '76 Forecast	June '76 Forecast	Feb. ' Estima
	74:4	----	----	----	2344
	75:1	2317	----	----	2297
	75:2	2344	----	----	2257
Total Non-Agricultural	75:3	2315	----	----	2260
Wage and Salary	75:4	2320	2279	----	2276
Employment[1.]	76:1	2325	2279	----	2301
	76:2	2340	2292	2318	2305
	76:3	2335	2318	2337	2310
	76:4	2344	2328	2345	2324
	74:4	----	----	----	617
	75:1	589	----	----	589
	75:2	577	----	----	574
Manufacturing	75:3	571	----	----	568
Employment[1.]	75:4	565	577	----	579
	76:1	564	575	----	583
	76:2	565	578	594	586
	76:3	565	580	591	583
	76:4	567	582	591	590

---

1. The values predicted by the model are adjusted for data revision of the values in the quarter prior to the forecast. The revised forecast values are calculated by multiplying 1 plus the forecast change times the revised historical value in the period prior to the forecast. The values reported for the rate of inflation and the unemployment rate are not adjusted.

Table 5-1

Comparison of Predicted

and Current

Estimates of Actual Values. (continued)

	Quarter	July '75 Forecast	Jan. '76 Forecast	June '76 Forecast	Feb. '77 Estimates
Non-Manufacturing Employment[1]	74:4	----	----	----	1727
	75:1	1728	----	----	1708
	75:2	1769	----	----	1683
	75:3	1745	----	----	1693
	75:4	1758	1709	----	1698
	76:1	1766	1712	----	1718
	76:2	1783	1724	1725	1719
	76:3	1778	1750	1748	1727
	76:4	1787	1760	1755	1734
Personal Income (Millions $'s)[1]	74:4	----	----	----	33840
	75:1	34607	----	----	34360
	75:2	35794	----	----	35030
	75:3	36193	----	----	35920
	75:4	36840	36793	----	36970
	76:1	37475	37473	----	37950
	76:2	38310	38414		38500
	76:3	38908	39708		39530
	76:4	39664	40626		40320
Per Capita Disposable Income (67$'s)[1]	74:4	----	----	----	3257
	75:1	3217	----	----	3203
	75:2	3365	----	----	3336
	75:3	3265	----	----	3262
	75:4	3278	3278	----	3299
	76:1	3297	3247	3317	3235
	76:2	3310	3268	3339	3219
	76:3	3305	3340	3377	3287
	76:4	3332	3357	3375	3303

1. The values predicted by the model are adjusted for data revision of the values in the quarter prior to the forecast. The revised forecast values are calculated by multiplying 1 plus the forecast change times the revised historical value in the period prior to the forecast. The values reported for the rate of inflation and the unemployment rate are not adjusted.

Table 5-1

Comparison of Predicted

and Current

Estimates of Actual Values. (conclusion)

	Quarter	July '75 Forecast	Jan. '76 Forecast	June '76 Forecast	Feb. '7 Estimat
	75:1	10.3	9.9	----	10.0
	75:2	10.3	11.3	----	11.5
	75:3	9.9	10.5	----	11.7
Unemployment	75:4	10.1	10.1	----	11.4
Rate %	76:1	9.3	10.3	9.9	10.7
	76:2	9.8	9.7	8.7	9.8
	76:3	9.4	9.1	8.5	9.1
	76:4	9.2	9.4	8.7	8.5
	75:1	10.1	----	----	9.2
	75:2	8.6	----	----	6.8
	75:3	7.9	----	----	10.4
Rate of Price	75:4	6.3	7.0	----	4.5
Inflation (Boston CPI)	76:1	6.2	5.7	4.3	18.4
	76:2	5.9	6.8	5.7	1.4
	76:3	5.8	6.7	5.8	6.2
	76:4	5.8	6.3	5.6	1.8

Table 5-2

Comparison Of Predicted And Actual Values

For January 1976 And June 1976 Forecast Of

Taxes By The Massachusetts Econometric Model

	Prediction Jan. 1976	% Error	Prediction June 1976	% Error	Actual Values
Alcoholic Bev.	79	2.5	77	–	77
Banks	45	18.4	43	13.1	38
Commercial	18	38.5	18	38.5	13
Saving	27	8.0	25	–	25
Cigarettes	142	2.9	140	1.4	138
Corporations	282	4.1	280	3.3	271
Deeds	8	14.3	7	–	7
Income	1,213	-.2	1.185	-2.5	1,216
Withholding	1,010	-.3	989	-2.3	1,013
Estimates	191	2.1	182	-2.7	187
Return	11	-26.0	14	-6.6	15
Inherit & Estate	59	–	59	–	59
Insurance	80	-16.2	93	–	93
Meals	118	-5.6	123	-1.6	125
Motor Fuel	207	-.5	220	6.8	206
Public Utilities	5	-70.6	15	-11.8	17
Room Occupancy	11	–	10	9.1	11
Sales	366	5.1	354	1.7	348
Miscellaneous	4	20.0	5	–	5
Total Taxes (Corp. & Taxes)	2,618	.3	2,610	.0	2,609

CHAPTER 6

A SAMPLE ALTERNATIVE POLICY SIMULATION

In order to illustrate how the Massachusetts Economic Policy Analysis (MEPA) model can be used to test proposed government policies we are presenting a sample policy simulation starting on the following page.

Once a control forecast has been made it is a relatively simple task to perform an alternative policy simulation. In the case illustrated below only three changes were made from the control to the alternative forecast. Two investment series were increased by adding a direct change to the respective investment equations and employment in the electrical industry was increased by making a direct addition to the employment equation for the electrical equipment industry. The on line computer time required to run an alternative simulation such as the one shown and to print out the comparison tables is less than one hour.

THE MASSACHUSETTS ECONOMIC POLICY ANALYSIS MODEL
Economics Department, University of Massachusetts
Amherst, MA 01003 (Tel. 413-545-0915)

POLICY SIMULATION SERIES: Number 1

DATE: February 18th, 1977

QUESTION: What effects would a program that directly increased investment in the Massachusetts electrical equipment industry by a net amount of fifteen million dollars per year have on the Massachusetts economy?

ANSWERED BY: George Treyz and Roy Williams

ASSUMPTIONS:

1) A program would be devised that would increase investment in the Massachusetts electrical equipment industry by $15 million per year. (Since any program would undoubtedly lead to financing some investment that would have taken place anyway and reducing investment by competing Massachusetts firms, the gross program would have to be larger than the net investment increases - e.g. if 25% of the program goes to investments that would have taken place in any case the program would have to be for $20 million; 50% leakage or competitive replacement would require a $30 million program; etc.)

2) The extra net investment of $15 million per year would start in the first quarter of 1977 and continue at that level through 1980. Of the $15 million investment each year $3.7 million would be used for the construction of non-residential structures and $11.3 million would be used to purchase equipment.

3) One year after the new investment had started one new job would be created in the electrical equipment industry for each $20,000 of new capital stock.

4) No state expenditures or state tax rates would be affected by the direct

and indirect effects of the program except for state transfer payments. (Thus, on the one hand we have left out the direct costs to the state of the program. On the other hand, we have also left out the changes in state spending and state tax rates that might result as new state revenues and new state needs develop in response to the indirect effects of the program.)

<u>RESULTS:</u> The attached tables show the net effects that would result from a program based on the above assumptions. These tables show the difference between a forecast based on this program and the control forecast for the Massachusetts economy.

1) First Year (1977)

<u>Employment</u> - 452 new jobs would be created by the direct and indirect effects of the programs. About one-hundred jobs would be generated in the non-electrical equipment industry because 33 percent of the non-electrical equipment purchased in Massachusetts is produced in Massachusetts - About sixty contract construction workers would be required to build the $3.7 million in new plant.

<u>Unemployment</u> - The improvement in labor market conditions would lead to an increase of 247 people in the labor force. Some of this increase would come from discouraged workers who would now enter the labor force and some would come from the 132 people over 16 who would either migrate to Massachusetts for the new jobs or who would decide not to emigrate from Massachusetts. Due to the increase in the labor force the net reduction in the number of unemployed people would be only 238 people or about fifty percent of the increase in employment.

<u>Wages and Prices</u> - Wages would increase by two thousandths of one percent due to the slightly improved labor market conditions. The Boston Consumer Price Index would increase slightly due to the wage increase and because the demand for local government services would increase somewhat

faster than the capital stock and thus increase the rate of local property taxes.

Incomes and Taxes - Personal income would increase in response to more employment and higher wages. The net increase in Massachusetts income taxes would be $310 thousand dollars.

2) Fourth Year (1980)

Employment - To analyze the 4,454 jobs that would be created by 1980 by the program we might first subtract the 452 jobs associated with the direct $15 million of investment. This would leave about four thousand jobs generated by the direct and indirect effects of the new employment in the electrical equipment industry. About one half of these jobs would come from the direct effect of the 1,969 jobs that would be directly created in the electrical equipment industry and the rest would be the result of indirect economic effects. The slightly higher wage costs in Massachusetts that would be indirectly caused by the program would slightly reduce Massachusetts employment as they worked through the system. For example, three jobs would be lost by 1980 in ordnance as higher labor costs led to substituting less labor intensive equipment or locating production outside of Massachusetts.

Unemployment - The unemployment rate is reduced from 6.30 percent in the control forecast to 6.23 percent in the forecast that is conditional on the investment program.

Wages and Prices - Wages would be up by .066 percent. These higher wages would account for about thirty percent of the increase in personal income under this program. Prices would be up .027 percent due to the higher property taxes and higher wages.

Incomes and Taxes - Despite increases in population and prices real per capita income would be increased by the program by almost one tenth of one percent. Massachusetts income taxes would be increased by almost four and one half million dollars.

3) Later Years

A longer simulation would be required to fully evaluate the long range effects of the program. In such a simulation explicit assumptions would have to be made about new state spending in response to changes caused by the program and explicit assumptions would have to be made about the disposition of tax revenues (assuming that they are in excess of the new state spending and the costs of the program). In the absence of tax cuts in the longer simulation some of the initial employment advantages of the program would be lost as transitory induced investment was reduced and as business decision makers responded to the slightly higher labor costs when making business location decisions and when making decisions about the labor intensity of production.

SUMMARY: If a way could be found to increase investment in the electrical equipment industry by a net amount of $15 million per year without displacing current Massachusetts workers by creating competing production, this program would add about four and one half thousand jobs to the state economy by its fourth year of operation. By the fourth year this program would also increase real per capita incomes by about one-tenth of one percent and would decrease the unemployment rate by about seven one-hundredths of one percentage point. Furthermore it would increase state income tax revenue by about four and one half million dollars per year.

THE EFFECTS OF A PROGRAM THAT DIRECTLY INCREASES INVESTMENT IN THE ELEC. EQUIPMENT INDUSTRY BY A NET AMOUNT OF $15 MILLION PER YEAR

SUMMARY TABLE
MASSACHUSETTS ECONOMIC POLICY ANALYSIS MODEL
(Seasonally Adjusted Annual Rates)

	1977	1978	1979	1980
Employment--Nonag. W. & S.	0.452	1.415	3.005	4.454
% DIFF	0.019	0.058	0.120	0.174
Manufacturing	0.155	0.677	1.505	2.261
% DIFF	0.026	0.108	0.229	0.330
Non-Manufacturing	0.298	0.738	1.500	2.193
% DIFF	0.017	0.041	0.082	0.117
Unemployment Rate	-0.009	-0.028	-0.051	-0.070
% DIFF	-0.112	-0.372	-0.755	-1.115
Fixed Weight Wage Index	0.000	0.000	0.001	0.002
% DIFF	0.002	0.011	0.033	0.066
Boston C.P.I.	0.001	0.008	0.025	0.058
% DIFF	0.001	0.004	0.012	0.027
Personal Income (mil$)	5.895	20.428	49.863	87.503
% DIFF	0.014	0.043	0.096	0.152
Disposable Income (mil$)	4.936	16.935	41.070	71.543
% DIFF	0.013	0.042	0.093	0.149
Real Per Cap. Disp. Inc.	0.000	0.001	0.002	0.003
% DIFF	0.010	0.029	0.060	0.091
Rel. Business Cost Index	0.001	0.005	0.015	0.030
% DIFF	0.001	0.005	0.015	0.031
Mass. Income Tax	0.310	1.056	2.560	4.447
% DIFF	0.023	0.068	0.148	0.229
Non-Resid. Construction	0.004	0.006	0.010	0.014
% DIFF	0.513	0.557	0.727	0.833
Mfg. Plant & Equip. Invt.	0.015	0.016	0.018	0.021
% DIFF	1.476	1.326	1.295	1.265

February 18, 1977

Table 6-2

THE EFFECTS OF A PROGRAM THAT DIRECTLY INCREASES INVESTMENT IN THE ELEC. EQUIPMENT INDUSTRY BY A NET AMOUNT OF $15 MILLION PER YEAR

EMPLOYMENT IN MASSACHUSETTS
(Thousands of People, Seasonally Adjusted)

	1977	1978	1979	1980
Manufacturing--Total	0.155	0.677	1.505	2.261
Durables--Total	0.140	0.633	1.422	2.167
Ordnance (19)	0.000	0.000	-0.000	-0.003
Lumber (24)	0.001	0.001	0.002	0.002
Furniture (25)	0.003	0.005	0.009	0.012
Stone, Clay, etc. (32)	0.003	0.008	0.015	0.020
Primary Metals (33)	0.003	0.009	0.018	0.024
Fabricated Metals (34)	0.009	0.015	0.025	0.030
Non-elec. Machin. (35)	0.103	0.107	0.119	0.122
Elec. Equipment (36)	0.015	0.483	1.228	1.962
Transport. Equip. (37)	0.001	0.001	0.000	-0.003
Instruments (38)	0.003	0.005	0.007	0.003
Nondurables--Total	0.015	0.044	0.083	0.094
Food (20)	0.002	0.006	0.013	0.018
Textiles (22)	0.001	0.001	0.002	-0.001
Apparel (23)	0.001	0.004	0.007	0.006
Paper (26)	0.002	0.008	0.016	0.020
Printing (27)	0.003	0.007	0.013	0.014
Chemicals (28)	0.001	0.003	0.006	0.006
Rubber (30)	0.002	0.009	0.019	0.026
Leather (31)	0.001	0.001	0.002	-0.000
Other Nondurables (39)	0.002	0.004	0.007	0.006
Nonmanufacturing--Total	0.298	0.738	1.500	2.193
Contract Construction	0.062	0.088	0.146	0.199
Transport & Utilities	0.018	0.049	0.102	0.149
Wholesale & Retail Trade	0.111	0.280	0.575	0.847
Finance, Insurance, etc.	0.022	0.062	0.133	0.200
Services & Miscellaneous	0.068	0.205	0.429	0.619
Government--Total	0.017	0.053	0.116	0.179
Federal	NA	NA	NA	NA
State	-0.001	-0.002	-0.005	-0.007
Local	0.018	0.055	0.120	0.186
Nonag. Wage & Sal. Employ.*	0.452	1.415	3.005	4.454

*EMPLOYMENT REVIEW concept

(continued)

	1977	1978	1979	1980
Nonag. Wage & Sal. Employ.*	0.452	1.415	3.005	4.454
Plus: All Other Nonag.	0.032	0.078	0.157	0.227
Plus: Agriculture	NA	NA	NA	NA
Total Mass. Jobs	0.485	1.493	3.162	4.681
Less: Adjustments**	NA	NA	NA	NA
Total Employment***	0.485	1.493	3.162	4.681
Mass. Population	0.178	0.543	1.225	1.845
Mass. Population over 16	0.132	0.403	0.914	1.381
Mass. Employment Rate****	0.009	0.028	0.058	0.085
Indexed to Fiscal 1973	0.016	0.049	0.101	0.147
Mass. Index Rel. to U.S.	0.016	0.047	0.096	0.138
Labor Force	0.247	0.757	1.801	2.787
Participation Rate	0.004	0.011	0.027	0.042
Number of Unemployed	-0.238	-0.736	-1.361	-1.894
Unemployment Rate	-0.009	-0.028	-0.051	-0.070

*EMPLOYMENT REVIEW concept
**Adjustments for double counting and place of residence.
***MASSACHUSETTS TRENDS concept
****Total employment divided by the population over 16

Outline of Chapters 1-6