POLICY ANALYSIS APPLICATIONS OF REMI ECONOMIC FORECASTING AND SIMULATION MODELS

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ABSTRACT

This article surveys the ways that regional economic forecasting and policy analysis models have been used to provide information as an input for policy decision making in the public and private sectors. The major areas are as follows: forecasting and planning; economic development; transportation; energy and natural resources; taxation, budget, and welfare; United States policies; and environmental policies. The survey indicates that, while analysis and research may be required to prepare for a model simulation, the predicted economic effects of a policy can be very important information as an input for a wide range of policy decisions.

INTRODUCTION

Regional forecasting and policy analysis models are used to forecast the economic effects of a wide range of policy initiatives.
The usefulness and accuracy of the predictions by these models depends as much on the inputs to the models and the interpretation of the results as it does on the models themselves. In this article we present a sample of studies that have been done with these models.

The major uses of the regional models can be divided into the following categories: forecasting and planning; economic development; transportation; energy and natural resources; taxation, budget, and welfare; United States policies; and environmental policies. We will consider each category in turn.

**DISCUSSION**

**Forecasting and Planning**

Economic forecasting is difficult for several reasons. The variables determined outside of the model (i.e., exogenous variables) must be forecast, the dynamic structure of the real economy must be captured in the model, and the effects of processes such as speculative episodes that are not included in the model must be foreseen. In addition to these difficulties, the forecaster must ascertain the current values of the variables in the model.

Given the difficulties of economic forecasting, it may be useful to think of a model as an instrument that can correctly capture many of the complex interactions in an economy, but may not include some of the aspects of the economy that might be foreseen by expert observers. In this instance, the model serves as an organizing instrument. It provides a structure within which various experts can bring their knowledge together to generate a coherent and consistent picture of the most likely future, as well as alternative possible futures. In this section, we discuss the various steps in making a forecast. We also cite articles that discuss forecasting and planning uses of the Regional Economic Models, Inc. (REMI) Economic-Demographic Forecasting and Simulation model. (1)

In order to make a forecast for a sub-national area, we need forecasts for the exogenous variables. The largest category of such variables for regional economic models are the national variables. Of particular importance are forecasts of national and international demand by industry.

In order to provide the industry detail needed for these exogenous variables, as well as other key national variables, a United States model based on the REMI model structure has been developed. (2) The model was constructed using current and projected input-output tables for the United States from the Bureau of Labor Statistics (BLS). (3) This forecast is based on a smooth trend of technological change, productivity change, and final demand change between the two input-output tables. Once this forecast is in place, a new final demand vector can be obtained from any vendor of United States forecasts and input into the model to replace the original final demand vector year by year. This generates a national forecast by industry that embodies current forecasts of cyclical behavior of the United States economy. The results of this forecast can then be used as the exogenous variable set for a regional model forecast.

Giarratani and Houston (4) show the effect of alternative national forecasts on the forecasts for the Pittsburgh region of a particular BLS trend forecast and a particular cyclical forecast by Wharton Econometric Forecasting Associates (WEFA). In Table 1, which is based on their article, the differences between the alternatives for the Pittsburgh forecast are greater than the differences between the alternative United States forecasts. This is apparently due to the fact that the Pittsburgh economy has a greater cyclical sensitivity than the national economy. For both forecasts, Pittsburgh showed somewhat slower growth than the nation. Giarratani and Houston
TABLE 1

Comparison of Two Alternative United States Forecasts and the Resulting REMI Forecasts for the Pittsburgh Region

<table>
<thead>
<tr>
<th>Percentage Differences between Alternative Forecasts in the Eighth Year of Forecast</th>
<th>REMI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>United States</strong></td>
<td><strong>Pittsburgh Region</strong></td>
</tr>
<tr>
<td>Employment</td>
<td>4.7</td>
</tr>
<tr>
<td>GNP (GRP) 1977 $</td>
<td>5.0</td>
</tr>
<tr>
<td>Pers. Income</td>
<td>14.8</td>
</tr>
<tr>
<td>Disp. Income</td>
<td>12.1</td>
</tr>
<tr>
<td>Price Index-77</td>
<td>12.2</td>
</tr>
<tr>
<td>Real Disp Income</td>
<td>0.2</td>
</tr>
<tr>
<td>Population</td>
<td>0.7</td>
</tr>
</tbody>
</table>

also point out that, for both the national and local forecasts, individual industries have even greater disparities from one forecast to another.

Next we consider the problem of calibrating the model to account for current preliminary data. Since final revised data may only appear with a one to three year lag, this means that adjustment to the model "forecast" must be accomplished with a mix of preliminary data and the model forecast. This is somewhat complicated by the large revisions that are sometimes made to preliminary data. Thus, in some instances, the possibility that the model forecast might be as good a predictor of the final revised data as the preliminary data should not be ruled out.

Nevertheless, adjusting the "forecast" over the period that is already "history" to take into account preliminary data is a necessary step toward making a forecast. This is usually accomplished through either additive or multiplicative adjustments to the model. For example, if preliminary data indicates that employment in the lumber industry has increased by 2% over the last year while the model has "predicted" that it would increase by 1%, then the output equation for lumber may be multiplied by 1.01 for the year in question and for subsequent years. In addition to changing the value in this transition period, a change in a multiplicative adjustment will influence the model’s response to policy change. Another approach would be to use additive adjustments. Since the model is quite linear within a range, these additive adjustments will have very little influence on the policy responses of the model.

After preparing a forecast of national variables to use as exogenous inputs and calibrating the model to partial preliminary data, the next step is to incorporate outside-of-model information. An example of this type of information would be an exogenous reduction in output for a defense-related industry next year to reflect an anticipated plant closing based on the termination of a defense contract. Another example would be adjustments to projected housing construction based on high rental vacancy rates and an overhang of single family homes for sale.

Finally, a forecast is made. Even at this point, more adjustments might be made based on expert opinion regarding certain industries, labor market factors not captured in the model, or business climate changes based on political factors.

The underlying purpose for which a forecast is made may also be relevant to the construction of the forecast. This is because the purpose for which a forecast is made may be associated with a loss function. A loss function indicates what the loss is from forecast inaccuracies. For example, a forecast of the amount of fuel needed
to fly a plane from Boston to the Azores that will determine how much fuel will be put in the tank of the plane will have a loss function which will show much more loss if the plane runs short of fuel then if it ends the flight with a little extra fuel. Thus, a forecast that is biased upward may be the optimal forecast in this case. Sometimes forecasts of tax revenues are biased downward, because the cost to a state government of coming up short is greater than the cost of coming out ahead. Ideally, however, instead of biasing the forecast, it is preferable to make an unbiased forecast that includes confidence intervals. One way to create these confidence intervals is to make an optimistic and a pessimistic forecast in addition to the unbiased forecast.

Point forecasts or range forecasts can be used for many purposes. Short-term quarterly forecasts are often used by state governments and business firms. A track record of a quarterly precursor to the REMI model for Massachusetts showed that any error that might have been inherent in the state model was more than offset by fine tuning of the forecast for Massachusetts in the presence of errors in the United States forecast. This observation was based on the fact that, for four out of six major variables, the Massachusetts forecasts were more accurate than the predictions for the same variables in the United States forecast on which it was based.

Economic and demographic forecasts can also be extended by the use of satellite models. For example, a tax revenue model may be added. In this case, economic variables that are useful in predicting the tax base are extracted from the economic and demographic model and input into the satellite model. Income components can be used to predict the economic base for income taxes, consumption variables can be used for sales taxes, and industry output variables can be used for corporate taxes.

Another type of satellite model that can be developed is a household income distribution model. For such a model, variables that determine the parameters of an income distribution function, such as a displaced log-normal distribution, can be based on the economic and demographic forecast. When the annual distribution of income is predicted, it can be input into a model to predict tax collections. If family income is converted from annual to working period rates, then a family income distribution model can be used as an input to a welfare case load model that will predict the number of households that will be eligible for welfare assistance.

As an alternative to models of categories of income, it is possible to use economic and demographic forecasts to update micro-data bases that contain thousands of individual family records. With such a micro-data base, it is possible to calculate income and sales taxes due by family and then to determine the incidence of taxes as well as total projected collections. Still another type of satellite model for forecasting is an electric load forecasting model. Other satellite models could include models to predict air and water pollution and sales for various types of private firms.

We conclude this forecasting and planning section by citing the lessons that the Maine State Planning Office drew from their experience using a REMI model to develop a comprehensive long-range economic forecast to support policy making by the Governor and the Legislature. A paraphrased list of the lessons they learned are as follows:

1. Do not contract out the entire forecasting process. Concentrate on those aspects of interest to manipulate the model in user defined ways and to focus model development to suit user needs.

2. Set priorities. Add only necessary sub-models.

3. Write reports for interested nontechnical readers; illustrate them well.
4. Avoid making specific policy recommendations, but clearly spell out the implications of the analysis.

5. Carefully state the bad news, but do not be afraid to state it accurately. Presented properly and constructively, the bad news may be the most important finding.

6. Involve a team of outside private sector people who can provide a different perspective and can ask tough questions.

**Economic Development**

As indicated in the last section, a baseline forecast for a region may reveal certain problems that are likely to emerge. It is common to think of these problem areas as stemming from predictions of employment decline in some industries. While this is the typical case, it is also possible that an economy may be headed into a period of unsustainable growth which will be a precursor of an unpleasant roller coaster ride, such as that experienced by the Northeast and California in the late 1980's and early 1990's. In this case, the appropriate policy in the mid eighties would have been one that deferred demand in the immediate future to a later date.

Many economic development studies involve the prediction of the effects of a new plant opening in the region. For a simple simulation, these questions can be answered by using Industry Output policy variables or special Translator policy variables that represent the characteristics of narrowly defined industries. Two exemplary studies of plant location that went beyond the mechanical use of these policy variables were carried out by the University of Michigan and the Michigan Department of Commerce. One study was of the possibility of a Mazda assembly facility locating in Michigan. For this study, the authors undertook an extremely detailed analysis to answer two questions:

1. What are the state's relative locational advantages and disadvantages for the potential industry?

2. Given a decision to locate in Michigan, what is the impact on the state economy of the new activities generated?

To answer the first question, they looked at the historical series generated as a part of the REMI model construction for each state. They concentrated on constructing two measures, the local availability of inputs and relative production costs. To analyze the availability of local inputs, they looked at the column of purchases of inputs by the automobile industry in the input-output table. Next, they examined the proportion of local use supplied locally, the regional purchase coefficients (RPC's), for those input industries to find a weighted average of input RPC's. Using this process, they found that the percentage of required inputs for Motor Vehicle Assembly supplied locally were 33.3 percent in Michigan, but were only 19.0, 13.8, and 23.1 percent for their three competitor states, which were South Carolina, Nebraska, and Indiana respectively. They also noted that Michigan had a larger under-utilized labor pool of surplus labor with the requisite skills and that many of the suppliers were targeted to the automobile industry.

To examine relative production costs, they focused on the costs and the components of costs in the supplying industries. They found that Michigan was at a relative disadvantage in this area, with intermediate costs between 2 and 4 percent higher than in the rest of the country. They found that Michigan’s disadvantage in wage cost in the automobile industry was even greater, showing that, based on an index of 100 for Michigan, the wage costs indexes for South Carolina, Nebraska, and Indiana were 49.7, 62.5, and 85.1 respectively. However, when the authors adjusted for relative productivity in the auto industry to develop a measure of unit labor costs, the resulting indexes were 72.4, 73.5, and 97.2, showing a reduced advantage for the competing states.
some of the supplying industries, Michigan even had a cost advantage when measured by the unit labor costs indexes.

The second major question above, asking about the effect of this plant locating in Michigan on the state's economy, was answered using a 466 sector Input-Output model conjoined with a 53 sector model. This was done in such a way that the results from the processing sector of the input-output model for automobile assembly could be used as the initial disturbance in the 53 sector model. To accomplish this, the employment and wage effects of a processing sector only (Type 1 multiplier) simulation were aggregated from the detailed I-O model to 53 sectors. Then, calculations were made to find the set of inputs that would generate these same employment and wage effects in a processing sector only special case of the 53 sector model. This set of inputs was then used as the initial disturbance input for the full 53 sector REMI policy analysis model.

To supplement the intermediate input calculations made by the model, the Michigan Employment Security Commission conducted a survey of manufacturers to determine the percentage of their employment devoted to supplying the automobile assembly industry. Comparing the implicit survey predictions to the I-O model's predictions, the authors of the study decided to adjust the intermediate jobs created from the direct effect of 1000 jobs upward by 400 jobs distributed among the six industries that showed higher deliveries in the survey than assumed by the model.

The predicted economic effects from a Mazda automobile assembly plant started with predictions for total effects in the initial construction period in 1985 of 1,250 employees and $35 million in personal income and increased to 12,201 employees and $682 million in personal income in 1990 after the construction had been completed, and the plant was in full operation employing 2,500 people. The employment multiplier for construction in different years ranged from 2.10 to 2.64 during the construction period.

while the automobile assembly employment multiplier ranged in different years from 4.40 to 4.89. As an appendix to their study, the authors did a number of sensitivity tests. They found that if the direct and indirect wage effects had been suppressed, then the 1990 employment multiplier would have been 5.12 instead of the 4.67 in the standard model. They also found that if the 400 extra supplier jobs that had not been added for every 1,000 assembly jobs, then their employment multiplier would have dropped from their reported 4.4 to 3.6. Shortly after the study was presented, Mazda announced that it would locate in Michigan.

In another subsequent study of a Mitsubishi-Chrysler plant, the same authors presented information that indicated that the potential benefits to the Michigan economy from this facility would be less than the costs that would have been incurred by the state in providing location incentives for the plant. The state of Michigan subsequently withdrew from this competition. These two examples show that economic analysis, when carefully and accurately done, can make an important input into the decision making process.

In addition to providing useful information for potential firms that may locate in the local area and in providing an assessment of the implications of those decisions for the economy, models are often used to evaluate projects that require direct or indirect state funding. In assessing such proposals, it is essential to include all parts of the proposal. If funding from the local government is required, then either taxes must be increased or other government spending must be reduced. Because a great deal of discretion is involved in deciding which tax to increase or what government program to cut, the need to balance the budget is not automatically programmed in the model. This has led Edwin Mills to conclude:

By ignoring the need of state and local governments to raise money to finance proposed projects, the models make it appear that there are particular benefits to government projects that would not flow from similar private projects. (14)
Therefore, it should be emphasized that it is incumbent on every user of a model to include the whole project in the model analysis. Since only one number (usually the number of jobs created) is typically reported to the public, it is not sufficient to simply include a caveat explaining that the economic effects of the financing costs have been excluded!

A study by Carlson et al.\(^{15}\) shows how alternative assumptions that include all aspects of a project can turn a predicted net gain in jobs of 8,000 for an expanded convention center into a net job loss of over 300 jobs. Even studies that do not involve public financing, such as permitting horse racing\(^{16}\), must take into account the negative effects, such as decreased consumer spending on other consumption, as well as the job creating aspects.

An adjustment for reduced other spending was also made in a study of the effects of the Kansas City Chiefs and Royals on the state of Missouri.\(^{17}\) In this case accounting for alternative expenditures that consumers might have made reduced the net job effect of these franchises by 635 jobs. Tourist expenditures were also a part of this study, as they are for many economic development applications. These can be input via tourism translators that incorporate spending disturbances for a typical tourist day by different types of tourist, or they can be input by increasing consumption vectors for particular types of spending based on surveys of local tourist expenditures. Overall, the study showed a net job gain of 4,418 jobs and additional tax revenues of $9.2 million. It is important to note that when the economy is stimulated, it usually raises the probability of employment and the real wage. In both cases, this leads to migration into the area that then requires more government services. In this particular study, 118 new government employees were required. The expense of increased government employment and purchases must be deducted from any predicted revenue increases before any net gain to the state and local government budgets is inferred.

REMI MODELS

The range of economic development issues that can benefit from use of model analysis is wide. In addition to those mentioned above, some of the economic development issues for which studies have been done include: a proposed building moratorium in a county; installation of a super conducting super collider; industrial targeting; reducing activity at a nuclear test site; the effect of a nuclear waste site; the effect of a university; spinoffs from a port project; alternative allocations of government start-up loans; offshore drilling; a shopping and entertainment complex; and casino gambling. Economic development issues are also included under other topics that we present in this paper.

Transportation

The direct effects of transportation infrastructure investments fall into various categories. The key categories are as follows: (1) construction and construction financing effects; (2) operating effects; (3) environmental effects; (4) tourism effects; (5) cost savings for businesses; and (6) cost savings (including safety improvements) for consumers and commuters.

The construction effects (1) are handled in a straightforward manner by using construction translator policy variables for the types of construction involved. The construction financing effects are addressed by changing appropriate tax rates or reducing alternative government expenditures by the appropriate amounts. The operating effects (2) are of significance for public transportation facilities. These are input into the model by increasing employment in the appropriate sector (e.g., interurban transport), reducing consumer expenditures on other types of transportation, and increasing taxes to pay subsidies. The environmental effects (3) apply mainly to substituting public transportation for private automobile transportation and are considered in the environmental section below. Tourism effects (4) are discussed in the proceeding section.
The use of a REMI model to evaluate economic development benefits for highway decision making are discussed in an article by Weisbrod and Beckwith. They propose changes in real disposable income gains, plus auto user benefits, as the appropriate measure for the development benefits gained from a highway project. They then compare these benefits to the costs to derive a cost/benefit ratio. In their article, they describe how the cost reductions to business and auto users are calculated. They also present findings that show how reductions in the cost of doing business affect the regional economy.

In the remainder of this section we focus on the way that costs savings to business (5) and benefits to automobile users (6) can be incorporated in the model analysis. The savings to automobile users is a reduction in cost (less commuting time) or increase in benefits (safer travel) that will not be reflected by price indexes. Therefore, it should be treated as an amenity gain, and the amenity term in the migration equation should be adjusted by an amount that reflects the dollar value of non-monetary gains. This will increase the net number of migrants into the area, and have ramifications in the labor market and the rest of the model.

The effect of the improved roads is to reduce trucking costs. This reduction is accomplished by increasing the policy variable for productivity in the trucking industry. In addition, productivity gains should also be introduced for industries that supply their own trucking.

Transportation improvements that lead to reduced costs will reduce sales prices for regional industries. These reductions will be appropriately transmitted through the model. However, transportation cost reductions that directly reduce sales prices are different than other price reductions. They apply equally to competing imports to the extent that they reduce costs for imports. Therefore, the competitive response in the model for regional industries that increases local market shares when there are reductions in sales prices must be offset by appropriate reductions in the market share when these decreases stem directly from reduced transportation costs. This reduction can be calculated by using the proportion of total cost due to trucking in the industry in question, the percentage cost change in trucking, and the market share elasticity response for local markets. If a primary goal is to use transportation infrastructure improvements to foster economic development, then the increase in the variable of interest (e.g., employment, real disposable income, or real per capita income for current residents) per dollar of cost would be the appropriate measure for evaluating competing projects.

Energy and Natural Resources

Fuel costs are an important cost to the economy of any region even though they are often a small percentage of the total cost for most industries, because energy use is pervasive and regional fuel prices are volatile. In addition, fuel price changes often depend on the policy changes.

The REMI model has been used to look at the effect of energy price changes that have related to electric rates and to natural gas rates. In most cases, the motivation has been to present evidence for or against the proposed policy on the basis of its implications for the regional economy. In one case, it was used to argue for a restraining order to prevent a price increase. It was argued that some of the people suffering a loss would be those who would indirectly lose their jobs. However, since it would be impossible to identify which specific job losses were due to the higher prices, it would not be possible to compensate these people.

A fuel price increase simulation is accomplished by increasing the appropriate fuel price variable for industrial and commercial users and by decreasing consumer purchasing power through the consumer expenditure price index, to reflect the extra amount that
consumers will have to pay for electricity. To complete any simulation, the effects on the production side must also be considered. Since fuels are often imported, the effect of changing energy strategies may be to substitute local production for imports (e.g., a wood-gas process for electricity production to replace imported oil) or to replace local production (e.g., high sulfur coal in Illinois for imported western coal) with an external energy supply. Thus, even when the regional employment effects of fuel price changes are in one direction, the choice of energy source may have direct effects that will change the sign of the predicted employment effects.

In non-energy related natural resources studies (e.g., Taconite mining in Minnesota or the fishing industry in New Bedford, Massachusetts) the way in which a natural resource is utilized will have important regional economic effects. An example of the type of choice that sometimes confronts policy makers is the debate over whether or not the value of commercial fishing, which has reduced certain fish stocks so that sport fishing is in a steep decline in Sarasota, Florida, has a larger economic benefit than the potential loss of recreational fishing and its related tourism expenditures.

Taxation, Budget, and Welfare

State governments face many fiscal decisions that have consequences for their states' economy. These decisions involve changes in tax rates, budgetary spending, and transfer payments. Here we consider each category in turn.

There are three major categories of state taxes: business, sales, and income. Business taxes influence the implicit rental cost of capital. However, the relationship between the changes in the cost of capital and the change in the size and timing of business tax receipts may be unique to that particular tax provision. For example, a change in the corporate tax rate that increases the cost of capital by one percent next year may yield enough revenue to change the investment tax credit by enough to cut the cost of capital by two percent. Thus, a tax change that is revenue neutral might reduce the cost of capital in the short term and stimulate investment in the state. The complicated interactions of state and federal business tax provisions are incorporated in a policy analysis model by assuming rational decision making and using mathematical derivations. To carry out tax simulations, the revenue consequences must also be estimated.

Sales taxes enter the model as an increase in consumer prices. If taxes are collected on all items sold in the state, than this does not affect the relative price of local and imported goods. It may, however, affect the price of one consumer good relative to another. To the extent that outside-of-model studies demonstrate elasticities of price response among consumer categories, the shifts among them must be input into the model as shifts among consumption final demand components. Of course, the decreased purchasing power caused by increased sales taxes reduces local purchases and, thus, local employment. Sales tax increases also deter inward migration by driving a bigger wedge between nominal personal and real disposable income. Changes in income taxes reduce purchasing power by directly reducing disposable income and, therefore, have many of the same impacts in an economy as a sales tax change.

A study of the effects of a revenue neutral shift in taxes, accomplished by increasing the manufacturing investment tax credit by 15 percentage points, which was financed by raising sales taxes with a refund for low income groups, was done for Massachusetts. This study showed that in the twelfth year of the simulation there would be a 13,000 job gain in manufacturing and a 4,000 job loss in non-manufacturing. Real per capita disposable income would be increased by one-quarter of one percent. A recent study of Michigan showed that a cut in personal taxes offset by a decrease in the manufacturing investment tax credit would lead to a net loss of jobs. The proposed change was not implemented.
Ancillary income distribution and micro-data based models, as mentioned in the forecasting and planning section above, may be linked with a REMI model to provide more detailed tax analyses and more accurate feedbacks. For example, if an income tax with exemptions or progressive rates is in place, this model could take these factors into account in feeding back tax collection estimates to the model.

Local governments may change property taxes. These changes affect the cost of capital and directly reduce consumer purchasing power. Of course, these tax changes will be combined with changes in local government spending.

Shifts in the state budget spending priorities, in addition to those directly aimed at economic development, can have important economic consequences. In each case, any secondary effects not captured directly in the model should be entered as additional policy variables. For example, a shift from state and local spending on safety to education may have consequences for labor productivity as well as for the amenity attractiveness of a local area relative to other areas. While amenity changes are hard to measure, studies are available that have examined the relationship of public spending per pupil on student performances\textsuperscript{(23)} and on the amenity attractiveness of reducing student-teacher ratios.\textsuperscript{(24)}

As an example of predicting the economic effects of changes in transfer payments, we consider a study of proposed changes in Massachusetts\textsuperscript{(25)} in Aid to Families with Dependant Children (AFDC). For this study, a proposed 17.5 percent increase in the welfare payment rate is eligible for a fifty percent federal reimbursement. The other funding is obtained from increases in state sales, income, and corporate taxes. By the twelfth year of the simulation it shows a decrease of six thousand jobs. However, real per capita disposable income is increased by one-hundredth of one percent. This apparent anomaly is explained by the increase in federal funds coming into Massachusetts that more than offset the lost income from the reduction in employment.

**REMI Models**

Overall, policy analysis models have been used to analyze many taxation, budget and welfare questions. For each policy, care must be taken to consider factors not included in the policy analysis model, as well as those that are embodied in its equations.

**National Policy Changes**

Changes in economic policy at the national level can influence a sub-national area through its effect on the national economy as a whole or through its relative and direct effects on the region or regions being analyzed. In the first case, it is always necessary to perform a national simulation as part of carrying out regional analyses. In the second case, it is only necessary to carry out the national simulation if the reverberation of the policy on the nation as a whole creates significant feedbacks for the sub-national area in question.

Studies with regional and multi-regional models and the United States model analyzing changes in United States defense spending illustrate the issues described above. In a study of the impact of increasing the size of Fort Drum in upper New York state on the area in which it is located, it is not necessary to include changes in the United States and other regional economies in the analysis. This is done, because the policy effect is strictly local and the feedbacks to the rest of the United States are small enough to be ignored.\textsuperscript{(26)} However, a study of the effect of the defense buildup from 1981-1985\textsuperscript{(27)} on all of the states in the United States, as well as the United States economy, requires a full multi-regional and national analysis.

The defense buildup in the early 1980's compared to equivalent increased spending across all final demand sectors had significant effects on the regional distribution and composition of economic activity, as well as on the total national economy. A study of these effects that included use of a multi-regional REMI model of all of
the states, as well as the United States, showed that thirty-five states had net employment losses due to the buildup compared to the alternative spending scenario.

In order to carry out any study of this kind, the conceptual framework for the national economy must be considered. The most straightforward assumption for short term analysis is that the economy will respond in a Keynesian way. In this framework, a United States model with fixed national regional purchase coefficients (RPC's) and export shares is appropriate. While this was the version of the model chosen for the defense buildup study, other model closures may be appropriate for other studies. For a long term study, it would be likely that the population of the United States and the national rate of labor force participation would be unaltered by most policies. This, in turn, would imply that the number of people employed is preset if we also note the economic long term tendency is to return to a natural unemployment rate. Thus, a model where wage rates and prices respond to restore the control forecasts employment would be appropriate. We consider such applications later in this section.

For the defense buildup study, an alternative had to be defined against which the buildup that actually occurred could be compared. For this alternative, it was assumed that in the absence of the buildup, monetary and fiscal policies would have increased demand by the same dollar amount as the military spending spread over all final demand components in the same proportion. In order to find this alternative, a model baseline that replicated the historical data set was generated. This was accomplished by using the historically observed multiplicative adjustments that were required to make each equation track the economy exactly. To the extent that the model is non-linear, this adjusted baseline will appropriately reflect the influences of the error terms in the historical period on the difference between the baseline and the alternative. In order to generate the alternative, the military procurement expenditures were removed from each state and within

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state final demand was increased according to the proportion determined for the United States as a whole. Two additional factors had to be considered. The first one was that the United States forecast was different, and the second was that effects on nearby states were more important in generating indirect demand for inputs than those in distant states. These problems were addressed by solving the United States model first to obtain changes in demand from the rest of the United States, then solving for major regions to obtain demands from the rest of the region, and finally solving for each state within the major region multi-regional models.

Another multi-regional simulation that requires attention to the assumptions made is in progress and concerns the effect of cutting automobile imports by twenty percent. In this case, two closures are being considered. In the first, the extra automobile sales from United States production would be treated as an exogenous increase in sales. In the second, non-automobile imports would be increased enough to offset the drop in auto imports. The rationale behind the second closure would be that exchange rates would adjust to maintain imports, because, at the macroeconomic level, negative net imports are due to a domestic savings rate that is not adequate to support domestic investment.

In looking at transportation, educational, or environmental policies at a national level, the national effects must be analyzed in addition to the regional effects. If this is done, the simple summation of the regional effects may be subject to a fallacy of composition, because some of the regional gains may be at the expense of other regions. Programs that raise overall national productivity may influence the total potential of the nation to produce. This may also be the result if production is moved from parts of the country with low productivity to those with high productivity. This result, along with the national implications of wage increases in one region as opposed to another when one region is a wage leader, is set forth in a multi-regional model of France.
An ultimate objective of regional and international modelers must be to provide better information so that national and international policies can take into account the mitigation of regional and national economic distress. As mentioned above, the United States has completed a decade when regional disparities in unemployment have shifted around the country and have been very significant. This history is likely to make the issue of regional policy at a national level an increasing priority for federal policy makers.

Environmental Policies

A growing concern about the environment has lead to national and local legislation that is directed toward the reduction of all types of pollution. New rules, regulations, and marketable permit plans designed to improve the environment have important regional socio-economic effects. REMI models are in use extensively to predict these effects.

In a paper summarizing a socio-economic assessment of the 1991 Air Quality Management Plan (AQMP) for the Los Angeles basin Lieu and Treyz divide the types of direct effects of the plan into the following three categories of policy variables: (1) costs - changes in the cost of doing business; (2) spending - changes in the composition of spending; and (3) amenities - benefits to individuals. Each of these aspects of the implementation of the AQMP are analyzed separately using a multi-area model of the basin and then a simulation including the net effect of all three aspects is shown.

Cost increases by industry were applied based on engineering and equipment cost estimates, net of savings from operating more efficient equipment, and using recycled materials. These cost increases reduced profitability for industries that sell mainly in the national markets and, therefore, can not change their prices. In this category of industries, the largest profit reductions were one-percentage point on sales in the leather and furniture industries. For the other industries that sell mainly in regional markets and can change their prices, the increase in selling prices for eating and drinking establishments was four percent. The average increase over all regional industries was six-tenths of one percent. The net effect of the cost increases was to reduce employment (see Figure 1) and real disposable income.

Changes in the composition of spending effected employment both positively and negatively. Construction of new public
transportation facilities, funded by borrowing, increased employment demand. The operation of the new transportation facilities also increased employment, because, even when considering the reduction in spending caused by raising the revenues for this transportation, the net effect was to substitute local employment for general consumption, such as a car purchase, which includes a high import component. However, reducing health care expenditures (a local industry) and increasing general consumption had a negative employment effect. In the end, the positive employment effects (see Figure 1) of construction and public transportation dominated in the period considered.

The employment gains in amenity attractiveness were estimated based on out-of-pocket individual savings on medical care, mortality reduction benefits based on 3.7 million dollars per life saved, and visibility benefits estimated using a hedonic approach and housing prices. The effect of the increased amenities was to increase population, which reduced wage rates and increased transfer payments. The net effect was to increase employment (Figure 1), but to decrease measured real per capita income. The net total effect of the policies was to increase employment, but to reduce measured real disposable income. This latter measure excludes the non-monetary amenity gains to individuals.

A current air pollution control strategy is being studied using the same model to evaluate a proposal to issue marketable permits to polluters. These permits would be traded and would be reduced each year. The lease value of the permits becomes an opportunity cost to the firms holding them as assets. The permit approach compared to command and control should reduce the net cost of pollution control as the market finds the least cost way to cut pollution. However, the regional effects on employment of this program have not yet been subject to an analysis that uses the model in an appropriate way.

Uses of REMI models are planned for all areas in the United States by the Environmental Protection Agency. In these applications the United States model will have to be run with average effects before each of the regional models is run. Models have been used to look at the effect of adopting the California gas standards in the Northeast on the economies of each of the Northeastern states. Other applications in the environmental area have included analysis of the economic effects of a nuclear waste dump in Nevada, the effect of industrial water rationing in Atlanta on downstream economies, and the options for solid waste disposal in Minnesota. In general, any environmental policy that will effect the economy can be simulated. In most cases, the categories of variables used in analyzing the Los Angeles basin air quality improvement initiatives will be those used in other environmental studies.

CONCLUSION

In this paper, some of the uses of regional policy analysis models have been reviewed. The uses of these models are expanding as the need to examine the regional economic effects of policy decisions is becoming more apparent. While the use of these models may require a good deal of analysis and research prior to using the model, any policy that will have an effect on a local economy can be input into a regional policy analysis model. The results of a simulation with the model may indicate that the effects are the same, larger, smaller, or in a different direction than those expected. Whatever the outcome, this information will make an important contribution to research based policy decision making.

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