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The Iowa economic/fiscal impact modeling system

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1. Introduction

Elected officials, planners, and decision-makers at the local level have a vital interest in identifying the overall costs and benefits of economic and political changes. These changes can include local economic events such as plant or business closings or openings as well as changing federal and state policies and regulations. Local officials in charge of administering programs or making decisions on local development incentives need to understand the regional consequences of these changes. Local government and school administrators and other community groups need to be aware of these local implications to properly plan service delivery or to develop strategic responses.

In addition to dealing with these traditional local government and community decision making roles, changing intergovernmental relationships are creating new needs and opportunities for rural communities. Changes such as block grants, deregulation, welfare reform, health care financing reform, and agricultural policy reform are ending many of the traditional safety nets that protected many local governments and school districts from economic and social hardships. At the same time, these changes create opportunities for local leadership and for returns to aggressive and innovative public decision-making. In this evolving environment, the value of economic and social information, accurate projections, and local policy analysis are greatly enhanced.

The Iowa economic/fiscal impact model (IE/FIM) was developed at Iowa State University to provide local decision-makers with detailed economic, demographic, and fiscal information to assist in orderly planning and public service delivery. IE/FIM identifies city and county income, employment, population, school enrollment, and fiscal impacts in response to changes in their local or regional economies. The model was constructed at Iowa State University with support from the Experiment Station, the Department of Economics, and the U.S.D.A. National Research Initiative. The model is fashioned explicitly from the Virginia impact projection model and the COMPAS framework developed by Tom Johnson (Johnson and Scott). The Iowa version of this model has been modified appropriately to incorporate the unique spatial and political factors existing in Iowa.

In this paper, we provide a documentation of the labor market-based fiscal impact model used in Iowa to study labor, housing, and fiscal issues. We also present a discussion of the critical steps typically encountered in assembling and organizing the data and constructing this type of model. The model represents a decision alliance of communities, development groups, and local governments with university-based analysts and technical assistance providers. The modeling efforts allow local governments to help to isolate the causal factors to local change and to understand the implications of change.

2. Structure of the model

The conceptual design of the IE/FIM is straightforwardly structured according to the operation of local government and a basic assumption about the functioning of small rural economies. States have different mixes in how local governments are organized and the type of services that different units of local government are authorized to deliver. At the most basic level, however, citizens demand public services and local governments provide these services to the extent that they are politically or economically capable. In Iowa, counties are responsible for a limited set of public services and are more important to residents living outside cities. Residents of cities look to city government to provide most public services such as law enforcement, fire protection, and general community services. The choice of modeling city or county government or a composite of local government depends on the issue to be analyzed and the scope of services offered by local governments in a particular state.

The economic and demographic components of the model consider internal as well as external stimulus. Area populations are linked to area economic activity; therefore, either local employment levels and or employment levels of relatively nearby localities determine population levels.

2.1 Labor market

Understanding the local and regional labor market plays a central role in our model, as is also the case with the COMPAS-based models that have been promoted through RUPRI (the Rural Policy Research Institute).[1] These models are built with the assumption that economic growth is caused largely by exoge-

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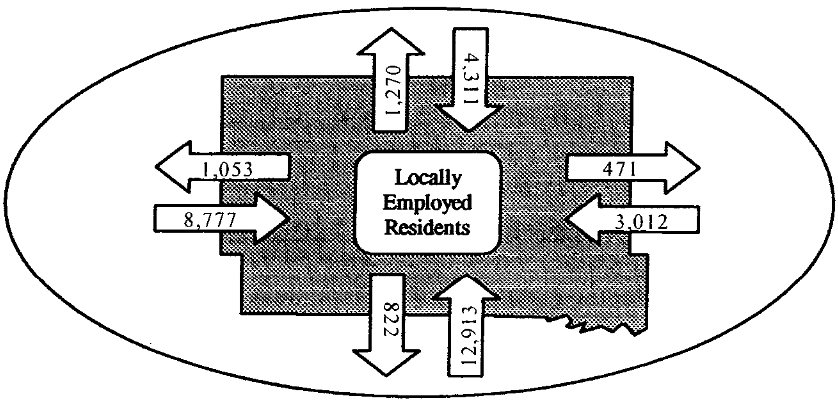
[1] Our discussion of the modeling process is based heavily on previous work by Johnson and Scott (1997) as well as earlier documentation materials and technical reports for Iowa (Swenson and Otto 1995, 1996).

nous increases in employment. In this simple model, demand can be viewed as perfectly inelastic at an exogenous level of employment. Total labor supply is perfectly elastic at the prevailing regional or national wage level (adjusted for local cost of living, amenities, etc.). Local labor supply has two components: locally employed residents and locally employed nonresidents or in-commuters. Locally employed residents equal the residential labor force less the unemployed and the out-commuters. These relationships are described below in Figure 1 for a county-based model.

Figure 1. The conceptual labor market



The concentric circles represent the primary and secondary labor markets and the arrows depict in- and out-commuting flows. In- and out-commuters are separated in our specification, rather than combined into net commuters because they exhibit differences in preferences for public services, spatial amenities, and occupational characteristics of households and because submarkets for different labor skills exist. Labor force and in-commuters are positive components of supply, and out-commuting is a negative component. Unemployment is a residual component of supply.

Formally, we can express these conditions in an initial labor market equilibrium

$$X_D = X_S, \tag{1}$$

which equates demand and supply (local employment and employed labor force from all locations). The demand curve is a function of wages:

$$X_D = f(w), \tag{2}$$

(where w is the wage rate) which when inverted becomes

$$w = g(X_D). \tag{3}$$

Decomposing labor supply available for local employment into its components gives

$$X_S = X_{LF} - X_U - X_O + X_I. \quad (4)$$

Each component of supply is a function of employment and a vector of supply shifters,

$$X_{LF} = f_L(w,Z_{LF}) = f_L(g(X_D),Z_{LF}), \quad (5)$$

$$X_O = f_O(w,Z_O) = f_O(g(X_D),Z_O), \quad (6)$$

and

$$X_I = f_I(w,Z_I) = f_I(g(X_D),Z_I), \quad (7)$$

where:

X_D = Labor demand (local employment);
X_S = Labor supply, made up of its components;
X_{LF} = Resident labor force;
X_O = Out-commuters;
X_I = In-commuters;
X_U = Unemployed;
w = Wage rate; and
Zs = Supply shifters (for the various components of supply).

Given the discussion and the conceptual model above, equations (4) through (7) can be re-expressed as the core relationships of the local labor market module [equations (8) through (11)]. In this formulation, the number of unemployed acts as the residual after the in-commuters, out-commuters, and employed resident labor force have been determined.

Unemployed ≡ Labor Force + In-commuters - Employment - Out-commuters(8)

All three components of labor supply will be primarily determined by employment in the local economy. In addition, they will depend on relative housing conditions, costs of living, quality of public services, tax levels, the mix of jobs, and similar variables in the location of employment versus alternative locations. This set of explanatory variables is motivated by the Tiebout hypothesis that argues that persons choose residences that offer their preferred mix of amenities and public services. Political units for which data are routinely collected (usually the county level) offer a logical building block as a labor market unit. In addition, commuting will depend on the distance between place of residence and place of work. Spatial characteristics such as area in the county and distance to other cities also affect the ability and willingness of residents to commute to employment.

Conceptually:

Labor force = f(employment, housing conditions, cost of living, public services, taxes, industry mix, area) (9)

Out-commuting = f(employment, external employment, external labor force, housing conditions, cost of living,

public services, taxes, industry mix, area,
distance to jobs) (10)

In-commuting = f(employment, external employment, external labor force, housing conditions, cost of living, public services, taxes, industry mix, area, distance to residence) (11)

Population is hypothesized to be a function of labor force and variables that affect the labor force participation rate and the dependency ratio.

Population = f(labor force, participation rate, dependency rate) (12)

Where the dependency rate is the ratio of the nonworking population to the working population.

These equations form the basic building blocks of the Iowa fiscal impact model and the COMPAS model. Subsequently we have added components that estimate school enrollment and housing market responses to changes in the local economy.

Enrollment = f(labor force, male participation rate, female participation rate) (13)

Housing supply = occupied housing + vacant housing (14)

Occupied housing =f(labor force, average earnings, housing costs, persons per unit, contiguous labor force, contiguous employment, family index) (15)

where:

Family index = Rate of married couple households with children ages 18 or less.

Housing costs = f(labor force, average earnings, labor force/population, average rents, contiguous labor force index, contiguous employment index, persons per unit, family index) (16)

New housing = f(occupied housing, vacant housing, persons per unit, change in real income, change in real income squared, change in employment, change in employment squared, labor force/population, housing costs, contiguous labor force index, contiguous employment index) (17)

2.2 Fiscal impact equations

Changes in employment and population in the local labor market affect local tax bases and the expected level of local services required. The identification and estimation of local government fiscal changes are based on the assumption that local governments consider the demands of their residents and provide the level of services at the lowest possible cost. The theoretical foundation for models of public service provision is found in the public finance literature (Boadway 1989; Wildasin and Wilson 1991). Johnson and Scott (1997) also have presented a discussion of the foundation and construction of a model of public service provision that we follow in this portion of our paper.

The IE/FIM incorporates estimates of several categories of local government expenditures: administration, public safety and fire protection, health and welfare, highways, community development, and parks and recreation. Based on these theoretical relationships, local government service expenditures per capita are generally hypothesized as:

Expenditures = f(quality, quantity, input conditions, demand conditions).

Each type of public service expenditure is defined for a different set of independent variables relevant to that particular service. The public services for which equations are estimated and the variables that are used to determine them are summarized in Table 1.

The IEFIM also estimates several categories of local government revenues: property tax and other tax revenues, intergovernmental assistance from the federal government, the state government, and local governments, charges and fees, and other miscellaneous general revenues. The model does not attempt to estimate revenues or expenditures associated with local government enterprises such as water systems, gas and electric utilities, and transit services.

The summary of revenue sources and their determinants that are estimated in our model are also included in Table 1. To operationalize the labor market and fiscal components of the model, appropriate data need to be collected and relationships must be estimated. The following section discusses strategies employed in this phase of the model development process.

3. Issues in constructing community models

The preceding discussion presented the conceptual framework for the COMPAS-type community model used in Iowa. This section attempts to share some of the experiences gained in helping several states leap the procedural obstacle of amassing and processing the initial data necessary to construct these models.

The dynamic foundation of all of these models is a gravity-based, labor force change component that is responsive to changes in local employment, participation, or labor supply in light of a regional supply and demand for labor. There are several elements of fiscal/labor force model construction that warrant some description. Most of these involve some of the procedural problem-solving necessary for constructing the model.

Problem 1: Determine in-commuters, out-commuters, place of work employment from STF 5 or the journey to work data in the REIS CD-ROM.

Table 1A. The general construction of the IE/FIM revenue and expenditure variables. County expenditure equations

	Dependent variables									
Independent variables	All administration	Police-law enforcement	Courts	Highways	Community	Parks and Rec	Welfare	Public health	Regular expenditures	Taxable valuation
Population	O	O	O	O	O	O	O	O	O	O
Population2			O	O	O			O	O	O
Labor:population										
Wage index						O	O			
Female participation rate										O
Total participation rate										O
Married families w/children	O		O							O
Per capita income		O								O
Land area per capita		O		O						O
Change in population rate										O
Incommuters per capita	O		O							
Outcommuters per capita					O	O				
Retail firms per capita										O
Percent living in town	O								O	
Retail sales per capita									O	
Distance to MSA		O				O				
Cleared crimes per capita			O							
Nonbase emplymnt per capita							O	O		
% nonwhite per capita							O			
Unemployment rate		O							O	O

Table 1B. Construction of IE/FIM revenue and expenditure variables. Country revenue equations

	Dependent variables					
Independent variables	Property taxes	Other taxes	Federal aid	State aid	Local aid	Miscellaneous
Population	O	O	O	O	O	O
Population^2	O	O	O	O	O	O
Wage index					O	O
Married fam. w/child.		O				
Per capita income	O		O			
Per capital income^2	O		O			
Land area per capita	O		O	O		
Change in pop. rate	O	O	O	O	O	
Incommuters per cap.		O				
Outcommuters per cap.					O	
Percent living in town			O		O	
Retail sales per capita						O

The primary equations in the labor force component of the model are displayed in equations (8) through (11) above. Getting the in- and out-commuting numbers along with the place of work employment numbers requires data from the 1990 census–there are no newer numbers. The easiest way to get the needed numbers is to use the journey to work data that are contained in the REIS (Regional Economic Information System) CD-ROM that is issued annually. The Bureau of Economic Analysis (BEA) uses these same data (with estimates of employment change) to determine net earnings exports. The alternate source is Summary Tape File 5 from the 1990 census.

4. Data from the JTW data set in the REIS CD-ROM

This data set lists counts of workers by place of residence (POR) and place of work (POW). By using the JTW database engine included in the software, all relevant counts can be solved for:

- How many persons work in your counties,
- How many of those workers are in-commuters (and from where),
- How many are out-commuters (and where they go), and
- The number of employed persons in your county regardless of whether they commute or not.

From this data set it is possible to solve for all but the unemployed component of equation (8) above. Unemployed counts can be obtained from the 1990 census data to arrive at a new labor force count for each county. Equation (8), the identity, is now solved. In this system of equations, though, new estimates of in- and out-commuting [equations (9) and (10)] need to be incorporated.

External Employment (XEMP) = 3_iContinguous Employment$_i$/Distance^2_i

External Labor Force (XLF) = 3_iContinguous Labor Force$_i$/Distance^2_i

Problem 2. Determine external labor force, employment, and distance values.

Solving for in- and out-commuters in the system of equations involves overcoming a few hurdles. First, although the in- and out-commuters for the previous equation have been identified, we have not solved for the contiguous labor force and contiguous employment statistics. These indices are derived form the following gravity equations:

Contiguous employment or labor force counts are compiled from the journey to work database that has been gleaned for determining in- and out-commuters. In previous versions of this model, it was necessary to physically edit the counties that were meaningfully attached to another. Given that the value of this index is more strongly influenced by the distance squared denominator, however, such precision is probably not warranted, and the statistics can be compiled by using all of the county data.

Another problem is the distance calculation. A population-weighted midpoint first needs to be calculated for each of our counties. The population-weighted midpoints for the counties are calculated from a U.S. gazetteer file downloadable from the U.S. census. This method works well for midwestern states with relatively uniform county sizes, populations, and no meaningful physical barriers. This procedure may not be appropriate to mountain states.

Table 2. Data from the U.S. gazetteer data set

Placefips	City	State	Pop 1990	Houses	Land area (km)	Water area (km)	Lat	Log
00124	Abbeville city	AL	3173	1320	40308	121	31567949	-85253681
00460	Adamsville city	AL	4161	1554	7948	0	33595542	-86957993
00484	Addison town	AL	626	286	7688	0	34199940	-87177921
00676	Akron town	AL	468	220	1437	0	32876118	-87738779
00820	Alabaster city	AL	14732	5144	48812	106	33226547	-86824620
00988	Albertville city	AL	14507	6238	66073	260	34262453	-86209414

Nonetheless, distance is calculated as the right-angled distance between the two county population-weighted midpoints (see the following spreadsheet example). Once the reference distances are calculated, then the individual county index values are tallied into an overall xemp or xlf index value unique to each of our counties. Knowing these values, in- and out-commuters can be estimated [equations (10) and (11)], which feed back to become endogenous elements of the identity.

Table 3. Data from the distance calculation spreadsheet

POR-FIP	PORNAME	WORKERS	POW-VIP	POWNAME	LON_1	LAT_1	LON_2	LAT_2	XVALCALC	YVALCALC	GEODISTv
1029	Cleburne	2	19027	Carroll	-85.490231	33.667909	-94.8600204	42.032285	508.8123	577.14197	1086.0
1051	Elmore	5	19103	Johnson	-86.18839	32.595902	-91.566981	41.689339	295.0059	627.44715	922.5
1071	Jackson	9	19081	Hancock	-85.998098	34.779508	-93.723182	43.0777156	413.06655	572.53774	985.6
1095	Marshall	7	19123	Mahaska	-86.317393	34.336133	-92.62017	41.352878	342.2833	484.15545	826.4
1097	Mobile	8	19163	Scott	-88.13116	30.700677	-90.6177328	41.609152	138.2560	752.68481	890.9
1103	Morgan	14	19103	Johnson	-86.912356	34.515668	-91.566981	41.6899339	251.8511	494.98333	746.8
1115	St. Clair	2	19153	Polk	-86.349397	33.687872	-93.635906	41.619154	396.7801	547.25846	944.0

After constructing in- and out-commuters, only a calculation of unemployment (or labor force) is needed to estimate the system. (Place of work employment is exogenous.) This equation is determined from variables out of the system (e.g., unemp = powemp, state unemployment rate, poverty rate, etc **or** lf = powemp, percent elderly, participation rate). Either way, an additional equation is needed to complete the identity.

The remaining equations for population and enrollment are functions of the labor force (or unemployment) identity. Once estimated, the equations yield the coefficients that will be included in the impact spreadsheet. Three-stage least squares are used to estimate the system.

Problem 3. Compile relevant social statistics to include in the model.

At the conceptual level, these local government expenditure and revenue models are based on rigorous theoretical foundations. It has been our experience, however, that only a handful of social or economic variables at the county level determine variance in the fiscal variables—the labor force change variables do most of the work. The social or economic variables have been organized into three categories:

1. Family characteristics: (percent of married families with children, average number of children per household, percent of families with children in poverty, percent of children in poverty)
2. Workforce characteristics: (male participation rate, female participation rate, total participation rate, teen participation rate)
3. Economic characteristics: (firms, nonmanufacturing firms, manufacturing firms, average earnings, characteristics of income, etc)

It also needs to be recognized that there are physical or spatial characteristics that may be pertinent to the determination of local government spending. In constructing IE/FIM, a population density variable (total area/population) is useful as also is the percentage of rural residents (or nonrural) in a county. For western states physical and political characteristics might matter, such as percentage federally owned land, an Indian reservation in a particular county, or a mountain range. While the list of social and economic variables should include important influences, given the small increments to variance explained, it is important to focus on a more limited and useful set of key indicators.

Problem 4. Whole system estimation of the fiscal variables.

At a theoretical level, the entire package of labor force and fiscal variables should be estimated as a system using three-stage least squares. In practice, this approach can be a real sticking point in finishing the models. Researchers trying to estimate a rich set of revenue and expenditure variables may find it difficult to stabilize the model. Stability usually can be achieved by limiting the revenue and expenditure items, but it comes at the expense of analytic detail.

Based on our experience, this estimation process does not need to be an impassable hurdle. Labor force change can be estimated as a system. If the model proves unstable, look first for outliers or for a local government whose characteristics are exercising undue influence on the system. Including variables to represent the characteristics of this observation point could improve the explanatory power of the entire system. Another possibility is to consider segregating the observations—building a nonmetro model, for example. If none of these efforts help stabilize the model, there are other alternatives. One option is to build a prototype model using OLS equations for the fiscal or other social variables (being mindful, of course, of the intrinsic biases) and eventually to re-estimate the model properly. The prototype model can be used as an educational tool to begin better understanding local economic and governmental functioning and ultimately improve the modeling effort.

This discussion has focused on developing community models based on county level data. In Iowa a separate city level model has been developed and is used in conjunction with the county-level model when working with individual cities on similar sets of policy issues. In choosing to develop city level models, the crucial issue is not data availability, but the nature of issues with which a particular unit of local government needs to deal. In states such as Virginia where city and county boundaries overlap, the issue is moot. In Iowa where cities provide most local public services, it is essential that they be included when doing local government impact assessments.

5. Conclusions

The Iowa type model has been used nearly exclusively as a labor and fiscal impact model, usually in conjunction with an input-output model such as IMPLAN. The VIP and the show-me models constructed in Virginia and Missouri are used also for scenario assessment and projection. There are only minor differences in all of these models, and each is tailored to meet the primary policy analysis needs of the states or communities in which the models are used or to capitalize on the skills of the analysts using them. The labor market cores of these models are all similar and are easily modified or adapted to meet evolving regional needs or to align them with other models in other states. Separate modules have been constructed for use in Iowa to emulate fiscal impacts, housing impacts, and capital valuation changes due to changes in employment in a particular location.

This community-level modeling system is amenable and valuable for analyzing policy issues that involves a labor market component. Issues such as welfare and health care reform in rural areas are possible applications of the model. Additional social and environmental indicators that are related to economic changes could also be readily added to the model. These efforts would expand the audience for the modeling and policy analysis information.

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