

## **Introduction**

The economic model in LEAM forecasts changes in output, employment and income over time based on changes in the market, technology, productivity and other exogenous factors. The resulting economic trend is used as an input to a dynamic housing market simulation that then feeds into LEAM as residential land-use change. The agent-based housing model predicts actual houses built in a given year based on trends in the economy and anticipated demand by specific population cohorts. The combined economic and housing model serves as a prime driver of land-use change. Through LEAM, this work connects knowledge in regional science, housing markets, and spatial land-use analysis.

LEAM modeling exercises simulate different scenarios involving alternative growth patterns based on regional and national changes (government policy, tax structure, new markets, changing demands etc). Scenarios are answers to 'what if' questions that together make clearer the decision choices available to a region. For example, alternative investment decisions can be modeled as different scenarios to see their impact on the regional economy and land-use. Scenarios are also a way to model shocks to the system. Shocks include local events such as closing a military base, as well as local responses to external policy changes, such as changes in the tax on gasoline. Shocks can be induced at a point in time or spread out over a period like investment in highway construction over 5 years.

Thus, with consistent demographic and economic forecasts under different scenarios, this model provides alternative demand on residential and commercial / industrial growth over time in the region. This strengthens LEAM's capacity to provide answers to a wide range of 'what-if' policy questions.

## **Method**

Coupled Input – Output Econometric models provide a wide array of impact analysis and forecasting abilities. When a model is run for a period of 30 years, many structural changes are expected to occur in the economy including changes in production

structure, consumption behavior, etc. To capture such dynamics, I-O models are integrated into wider dynamic modeling frameworks. In a computable general equilibrium framework, the coupled model accounts for equating supply and demand sides of each commodity in the market. This is true for matching labor demand and supply through migration patterns, changes in unemployment levels, labor force participation rate, etc.

The core model consists of nine economic sectors and nine components of final demand (see appendix). The output from each sector is consumed by other sectors (inter industry flows) and by components of final demand (which characterizes value added in the economy). The model consists of five modules of equations for each industrial sector and an additional module for demographics variables. The first module is the input output module that captures flow of goods and services inside the region, their destination to final demand and exports outside the region. To overcome the static nature of Input Output model, it is coupled with an econometric framework, where output, employment and income corrections due to changes in technology, productivity, etc are made in three different modules. The fifth module endogenizes the dynamics of final demand and provides feedback into the production cycle. The final or sixth module is the demographic model that balancing labor force demand and supply mechanisms. All the modules are solved simultaneously to completely forecast regional economic indicators that are used as input to other sub-models in LEAM.

## **Results**

The model described above provides consistent economic and demographic variables for the region. Various shocks like investments to specific sector, increase in public spending or consumption from households, etc can be applied to the regional economic system. The employment block models changes and productivity over time to determine regional employment levels. The percentage of workers living outside the region and commuting to work on daily basis is used as a policy variable to model effects of income leakages from the region. The income module models regional average wages in response to interaction between labor demand and labor supply. The average wages are converted into industry specific wage and total regional income is computed. Personal income is derived from wages and salary income after accounting for other components such as contribution to social security, transfer

payments, etc. The income leakage due to daily commuting is modeled in this block. Finally, differences in labor demand and supply affects net migration. If the employment demand increases relative to labor supply from households, the regional unemployment rate decreases until people migrate into the region and equilibrium is reached. These dynamics occurs with different time lags in different parts of the model. Population change is modeled on births, deaths and net migration. The total population is sub divided into different age-cohorts, each of which has a specific role to play in regional land use change, evolution and impact assessment in the region. Some of the base run results and demonstrative scenarios are attached in the appendix.

## **Conclusion**

The economic driver model used in LEAM captures causal mechanisms and not just patterns of changes and impacts. The forecasts generated are consistent with local conditions and all coefficients are region specific. It also provides an opportunity to model economy related shocks to the region and evaluate alternative 'what-if' possibilities. In addition to predicting consistent interdependent economic and demographic variables, its transparent structure helps to trace the propagation of shock through the system and present a clear picture of the regional dynamics providing useful information to Land-use Evolution and Impact Assessment Model.

## **References**

- Brodjonegoro, B. 1997. The Econometric Input - Output model of Jakarta, Indonesia, and its Applications for Economic Impact Analysis. PhD Dissertation, Unpublished, University of Illinois at Urbana Champaign
- Conway, Richard S. Jr. 1990. The Washington projection and simulation model: A regional Interindustry Econometric Model. International Regional Science Review, Vol. 13, nos. 1 & 2, 141-165
- Israilevich, P.R., Hewings, G. J. D., Sonis, M. , Schindler, G. R. 1997. Forecasting Structural Change with Regional Econometric Input-Output Model. Journal of Regional Science, vol. 37, no 4, 565-590
- Rey, S.J. 2000. Integrated Regional Econometric + Input-Output Modeling: Issues and Opportunities. Papers in Regional Science 79: 271-292

## **Appendices**

**Table 1. Variables forecasted**

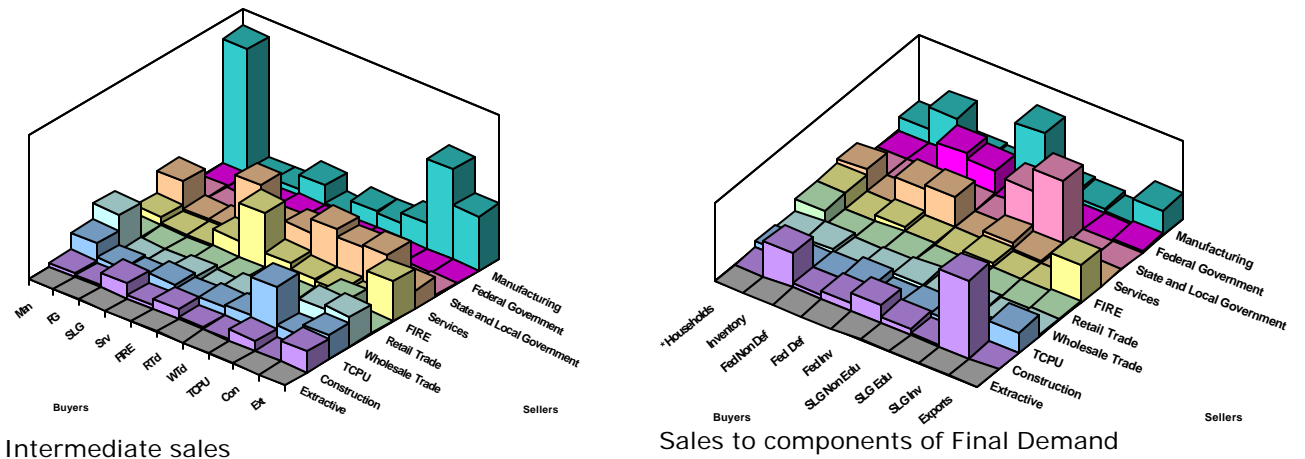
Economic Variables	Demographic Variables
Gross Regional Product	Population by age cohorts
	- 0-4
Consumption by households	- 5-14      School going age
Private Investment	- 15-14
Federal government	- 15-24      Active labor force and
- Non defense purchases	- 25-44      population in driving age
- Defense purchases	- 45-64
- Investment	- 65+      Retired population
State and local government	Components of population change
- Education	- Births
- Non education	- Deaths
- Investment	- Net migration
Personal Income	Labor Force
- Residential adjustment of income	Percent of resident workers
- Contribution to social security	Percent of non resident workers
- Income from dividends, rent, etc	Unemployment rate
- Transfer Payments	Average wage and by industry
- Per capita personal income	
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Output, employment and earnings: Total and disaggregated by industry	
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**Table 2. List of Economic Sectors**

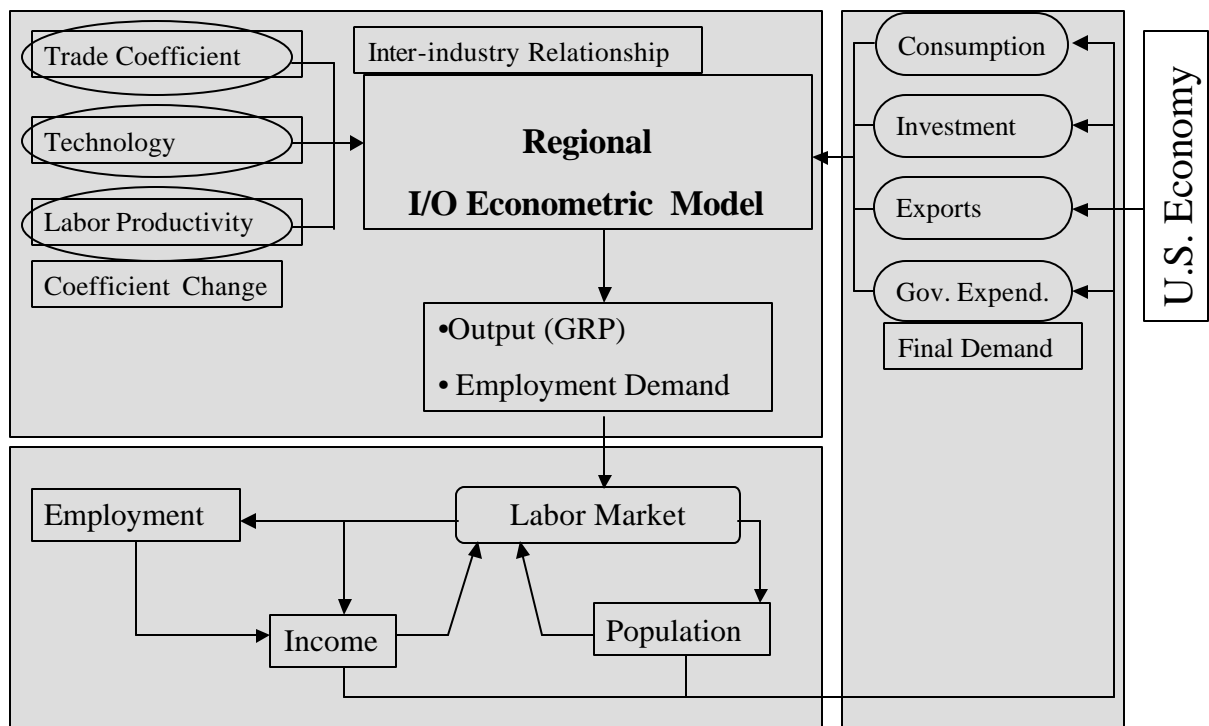
Extractive (agriculture and mining sector)	Retail Trade
Construction	Wholesale Trade
Manufacturing	Finance, Insurance and Real Estate
Transportation, Communications and Public Utilities	Federal Government Enterprise
State and Local Government Enterprise	

**Table 3. Components of Final Demand**

Household Consumption	Private Investment and Inventory
State and Local Government Education Purchase	State and Local Government Investment
State and Local Government Non Education Purchase	Federal Government Investment
Federal Government Non Defense Purchase	Net Exports
Federal Government Defense Purchase	



**Figure 1. Model Structure: Input Output relations in the economy**



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**Figure 2. Model Structure: Integrated Model**

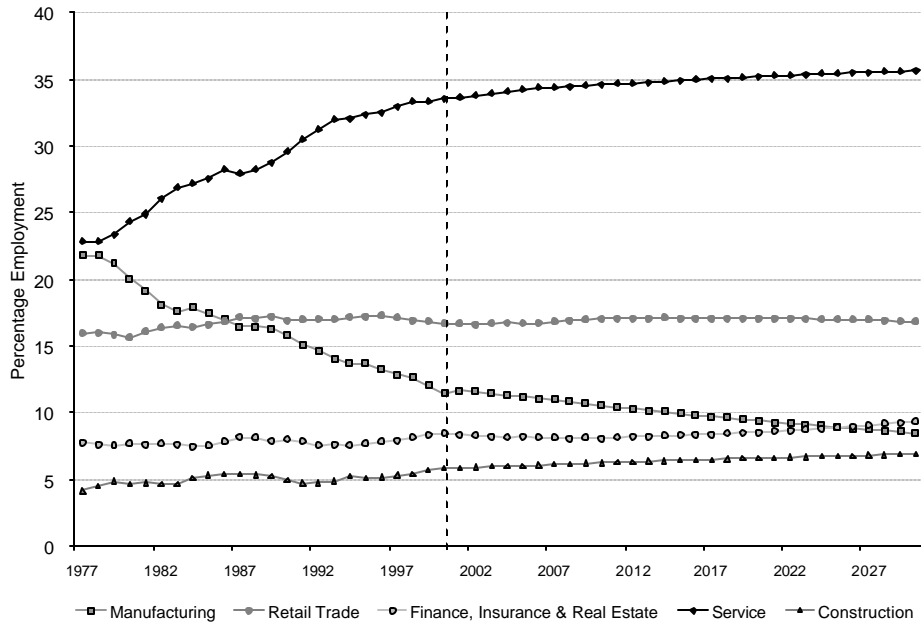
**Table 4. Employment Forecast (thousands)**

Industry	2000	2005	2010	2015	2020	2025	2030
Extractive	25.8	25.6	26.2	26.7	27.4	28.2	29.2
Construction	95.4	103.2	108.5	114.1	118.9	123.4	127.8
manufacturing	185.3	191.6	182.9	176.2	169	162.3	156.4
Trans. Com. and Util.	101.1	110	112	114.7	116.3	117.5	118.8
Wholesale Trade	78.7	83.3	84.7	86.2	87.5	88.7	90.1
Retail Trade	269.4	285.5	295.3	302.7	307.1	309.6	310.6
FIRE	136.9	140.3	140.4	147.5	154	162	172.4
Services	541.5	584.8	598.9	617.8	633.1	645.4	657
Federal Government	46.3	44.6	42.8	41.8	40.7	39.9	39.2
Sate and Local Gov.	132.2	137.9	138.8	141.6	142.9	141.9	141.3
Total, All Industries	1612.6	1706.8	1730.5	1769.3	1796.9	1818.9	1842.8

**Table 5. Comparison of forecasts from LEAM with MERIC**

Industry	MERIC*				LEAM			
	2000	2010	Gross	%	2000	2010	Gross	%
	Estimated	Projected	Change	Change	Actual	Projected	Change	Change
Extractive	9,800	12,060	2,260	23.06	25,771	26,164	393	1.52
Construction	75,130	90,660	15,530	20.67	95,383	108,476	13,093	13.73
Manufacturing	183,390	175,250	-8,140	-4.44	185,335	182,943	-2,392	-1.29
Trans. Com. and Util.	101,790	101,730	-60	-0.06	101,129	112,004	10,875	10.75
Wholesale Trade	72,760	75,500	2,740	3.77	78,713	84,663	5,950	7.56
Retail Trade	239,710	265,930	26,220	10.94	269,374	295,283	25,909	9.62
FIRE	83,640	89,260	5,620	6.72	136,866	140,410	3,544	2.59
Services	493,180	562,300	69,120	14.02	541,472	598,938	57,466	10.61
Federal Government	17,280	16,280	-1,000	-5.79	46,334	42,805	-3,529	-7.62
Sate and Local Gov.	53,280	58,050	4,770	8.95	132,238	138,767	6,529	4.94
Total, All Industries	1,389,670	1,507,080	117,410	8.45	1,612,615	1,730,452	117,837	7.31

\*Missouri Economic Research and Information Center, Missouri Department of Economic Research



**Figure 3. Changes in employment structure**  
(percentage of total employment for each sector) in the region.

**Table 6. Population Forecasts (persons)**

	LEAM	Census	% Difference	Modified LRTP*	% Difference
2005	2,575,643	2,608,142	-1.246	2,541,951	1.325
2010	2,604,951	2,666,368	-2.303	2,582,637	0.864
2015	2,628,963	2,719,701	-3.336	2,638,658	-0.367
2020	2,649,889	2,758,434	-3.935	2,697,986	-1.783
2025	2,666,039	2,786,367	-4.318	2,752,314	-3.135
2030	2,681,002			2,799,342	-4.227

\*Long Range Transportation Plan, East West Gateway Coordinating Council