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MISSOURI PUBLIC SERVICE COMMISSION

GRAIN BELT EXPRESS CLEAN LINE LLC

CASE NO. EA-2016-0358

REBUTTAL TESTIMONY

OF

ALAN E. SPELL

ON

BEHALF OF

MISSOURI DEPARTMENT OF ECONOMIC DEVELOPMENT

Jefferson City, Missouri
January 24, 2017

Mo Dept. of Econ. Dev. Exhibit No. 526
Date 3-23-17 Reporter TS
File No. EA-2016-0358

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Grain Belt Express Clean Line LLC for a Certificate of Convenience and Necessity Authorizing it to Construct, Own, Operate, Control, Manage and Maintain a High Voltage, Direct Current Transmission Line and an Associated Converter Station Providing an Interconnection on the Maywood - Montgomery 345kV Transmission Line	)	Case No. EA-2016-0358

AFFIDAVIT OF ALAN E. SPELL

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

Alan E. Spell, of lawful age, being duly sworn on his oath, deposes and states:

1. My name is Alan E. Spell. I work in the City of Jefferson, Missouri, and I am employed by the Missouri Department of Economic Development as an Economic and Workforce Research Manager at the Missouri Economic Research and Information Center.
2. Attached hereto and made a part hereof for all purposes is my Rebuttal Testimony on behalf of the Missouri Department of Economic Development.
3. I hereby swear and affirm that my answers contained in the attached testimony to the questions therein propounded are true and correct to the best of my knowledge.

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI
DAWN ELLEN OVERBEY
My Commission Expires
December 13, 2019
Moniteau County
Commission #15456865

A E Spell
Alan E. Spell

Subscribed and sworn to before me this 24th day of January, 2017

Dawn Ellen Overbey
Notary Public

My commission expires: December 13, 2019

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I. INTRODUCTION

Q. Please state your name and business address.

A. My name is Alan E. Spell. My business address is 301 West High Street, Suite 580, PO Box 3150, Jefferson City, Missouri 65102.

Q. By whom and in what capacity are you employed?

A. I am employed as the Economic and Workforce Research Manager at the Missouri Economic Research and Information Center (MERIC), the research arm of the Missouri Department of Economic Development (DED).

Q. Please describe your educational background and employment experience.

A. I received a Bachelor of Science degree in economics from the University of South Carolina and a Masters degree in landscape architecture from the University of Georgia. I am a Certified Community Researcher, a designation received from the national Council for Community and Economic Research, for my work in economic analysis.

I currently manage a research team focused on providing economic and workforce analysis to policymakers, educators, planners, and the public. I have worked in economic development for over 20 years, in various roles to include site selection, land planning, spatial analysis, economic impact modeling, and industry/labor research.

Since 2005 I have managed the economic impact modeling activities for the DED and our team has conducted hundreds of impact studies since that time. The DED uses impact modeling to better understand the economic consequences of planned business activities, primarily in relation to state tax incentives anticipated in a project proposal. I have received formal training in two commonly used economic impact modeling systems, IMPLAN and Regional Economic Models, Inc. Policy Insight (REMI).

II. PURPOSE AND SUMMARY OF TESTIMONY

Q. What is the purpose of your Rebuttal Testimony in this proceeding?

A. The purpose of my testimony is to provide additional details on the economic impact analysis conducted by the Missouri Department of Economic Development regarding the Grain Belt Express Clean Line transmission project ("Grain Belt Express Project" or "Project"), which is discussed in the direct testimony of Mark Lawlor. The construction and operation of the Project is expected to have positive economic impacts to the state of Missouri with regard to jobs, income, gross domestic product, and tax revenues. Those impacts are summarized in Mr. Lawlor's **Schedule MOL-7** and further detailed in this testimony.

III. SUMMARY OF ECONOMIC IMPACT RESULTS

Q. What economic impacts of the Grain Belt Express Project did your study assess?

A. The study analyzed the potential economic impact the Project would have to the state of Missouri for the construction of the electrical transmission line and on-going operations. The impacts include the anticipated number of jobs, personal income, gross domestic product (GDP), state tax revenue, and county property taxes the Project will support. The analysis included the total statewide effect of construction which is anticipated to occur in years 2018 through 2020, the first year of impact (2021) when the transmission line is in operation and up-front landowner payments are made, and the annual impact anticipated in operational years that begin in 2022.

Q. What does the study estimate will be the economic impact of construction of the Grain Belt Express Project?

A. The construction phase of the Project is expected to support 1,527 total jobs over the three years, create $246 million in personal income, $476 million in GDP, and $9.6 million in state general revenue for the state of Missouri. These figures are presented in 2016 constant dollars using REMI's personal consumer expenditure deflator. Inputs for the construction phase includes $354 million in spending to build the transmission line in Missouri and $249 million in Missouri-specific manufacturing and professional service contract spending for the completion of the total project which spans four states (Kansas, Missouri, Illinois, and Indiana). Since impact models estimate supply-chain purchases based on construction spending, this analysis removed the portion of related manufacturing and services from the impact of the transmission line construction in Missouri to avoid double counting those inputs.

Q. What does the study estimate will be the economic impact of operations of the Grain Belt Express Project?

A. The operations phase analysis is divided into two time periods due to up-front landowner payments that would only impact the first year of operations, or year 2021. The economic impact in year 2021 of Project operations is expected to support 91 total jobs, create $17.9 million in personal income, $9.1 million in GDP, and $720,000 in state general revenue for the state of Missouri. Total county property taxes of $7.2 million are expected to be paid to the eight Missouri counties the transmission line crosses in 2021. Beginning in year 2022, when landowner payments are smaller, the impact is expected to support 28 total jobs, create $2.6 million in personal income, $4.2 million in GDP, and $111,000 in state general revenue on an annual basis. Annual county property taxes of $7.2 million are expected to continue.

Inputs for the operations phase of the Project include a one-time, up-front payment of $14.97 million to landowners in year 2021. The new transmission line is also expected to increase annual operations and maintenance spending by $5 million beginning in 2021. In year 2022 the annual payments to landowners are reduced to $1.23 million, based on the assumption that landowners choose annual payments over a one-time payment option.

IV. DESCRIPTION OF STUDY METHODOLOGY

Q. Please describe how the economic impact study was conducted.

A. The economic impacts of the construction and operations phases of the Project were estimated using the REMI economic model. The model takes direct spending inputs and predicts the jobs, income, GDP, and state fiscal revenue that will occur in Missouri based on new supply-chain purchases and worker spending. The county property tax estimates were provided by the Missouri State Tax Commission.

Q. What is the REMI model and how does it work?

A. The REMI models the flow of income that moves around an economy through the primary relationships between businesses and consumers. Those relationships are informed by input-output, commuter flows, and income data from the U.S. Bureau of Economic Analysis; employment, wage, and occupational data from the U.S. Bureau of Labor Statistics; and county business patterns, population, and migration data from the U.S. Census Bureau, among other sources. The model follows spending patterns to estimate the larger impacts to a region that include jobs, income, GDP, and government revenue. The REMI model also takes into account state expenditures when new workers move to Missouri in response to job opportunities simulated in the model. New workers bring families and the need for additional governmental services so those costs are deducted from state tax revenues.

REMI provides annual updates of the model to DED to continually incorporate newer information from the Bureau of Economic Analysis, Bureau of Labor Statistics, Census Bureau, and other agencies. The DED staff also take the extra step to annually calibrate the fiscal component with Missouri Office of Administration budget figures to produce better state tax estimates.

The REMI model has been used by DED for over fifteen years to estimate the impacts of business activities. REMI is a popular model with over 250 organizations, universities, and consulting firms using the system, including governmental agencies in 40 states. Many organizations use models like REMI as a tool in analyzing the potential economic benefits and costs associated with a business activity while recognizing that it is one part of a decision-making process. Future changes in the project inputs or general economy, for example, will impact the conclusions of any analysis and therefore these studies should be viewed as reasonable estimates given currently available information.

Articles about the REMI model have been published in professional and peer-reviewed journals, such as the *American Economic Review*, *Economic Systems Research*, *Journal of Regional Science*, *Applied Economics*, and the *International Regional Science Review*. A more complete description, to include model concepts, sources, and equations, can be found on REMI's website [1]in PDF format, which I have attached to my testimony as Schedule-AES 1.

[1] REMI documentation can be found at: http://www.remi.com/resources/documentation

Q. Does the REMI model take into account costs borne by property owners along the right-of-way such as lost property value or use of agricultural land?

A. The analysis does not include estimates of lost property value or use of agricultural land. At the time of conducting this analysis I did not have information on these potential effects. It is always the case that some consequences of a business activity, both positive and negative, will be either unknown, difficult to quantify, or both during an analysis. If reasonable estimates of the costs borne to property owners are available then those factors could be incorporated into a revised analysis.

Q. Where did you obtain your data inputs?

A. The estimates of construction and operations spending on the Project were provided by Clean Line, the company building the roughly 700-mile high voltage line across four states. Clean Line provided information on the timing of activities, the construction spending specific to Missouri, contracts with Missouri companies for project management and transmission line components, operation and maintenance spending, and details of landowner payments. Clean Line also provided Dr. Loomis's analysis, shown in **Schedule AES-2**, which was used to determine direct construction spending by detailed categories and by state. Construction spending by states was used with information on specific Missouri contract agreements to discount those sales if already accounted for in the construction impact estimate. This was done to avoid double-counting the impact to Missouri.

The county property tax estimates were provided by the State Tax Commission after they determined which taxing jurisdictions the transmission line would cross.

Q. Based off your experience are the inputs that Clean Line provided you reasonable estimates?

A. I believe the construction and operation spending inputs provided by Clean Line were reasonable.

V. CONCLUSIONS

Q. Please summarize the main conclusions of your testimony.

A. The construction and operation of the Project is expected to have positive economic impacts to Missouri with regard to jobs, income, gross domestic product, and state tax revenues beginning in year 2018. The construction phase (2018-2020) is expected to support 1,527 total jobs over the three years, create $246 million in personal income, $476 million in GDP, and $9.6 million in state general revenue for the state of Missouri. The first year of operations (2021), which includes spending to maintain the transmission line and nearly $15 million in initial landowner payments, is expected to support 91 total jobs, create $17.9 million in personal income, $9.1 million in GDP, $720,000 in state general revenue, and $7.2 million in county property taxes. Beginning in year 2022 the annual operations and landowner payments of the Project are expected to support 28 total jobs, create $2.6 million in personal income, $4.2 million in GDP, $111,000 in state general revenue, and $7.2 million in county property taxes.

Q. Does this conclude your prepared rebuttal testimony?

A. Yes.

REMI PI+ v1.7

REMI TranSight v3.7

REMI Tax-PI v1.7

Metro-PI v1.7

Model Equations

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I. Introduction

Since "all politics are local," the effects of policies on sub-national areas have always been of great interest in the policy-making process. If anything, the concern about regional economies is becoming greater. The reasons for this heightened concern have to do with a combination of economic realities, changing political structures, and the influence of economic research that has emerged over the last decade.

First, after decades of steadily expanding economic prosperity, evidence began to suggest that lagging economies may not inevitably catch up to more advanced areas. Coastal China has continued to develop more rapidly than the interior; much of the income growth in the U.S. in the past decade has been focused in leading metropolitan areas of the Northeast, Texas, and California; and regional disparities persist in almost every European country.

Second, national economies have become more open, through both globalization and regional blocks such as NAFTA and the EU. This changing political organization forces local economic regions to compete with each other, without the national protection of industries. Thus, regions within a country may have an economy that is much stronger or weaker than the national economy as a whole. For example, the states of eastern Germany still lag far behind those of western Germany, despite the overall strength of the German economy.

Finally, the "new economic geography" (see Fujita, et al.) has focused attention on the spatial dimension of the economy. In this emerging area of research, the geographic location of an economy may be even more significant than a national boundary. In fact, the new economic geography shows how economic disparities can surface even with equal resource endowments and in the absence of trade barriers. Since history plays an important role in the development of regional economies, these new research findings also suggest that economic policies may have a significant effect on local economic growth.

In light of this interest, regional policy analysis models can play an important role in evaluating the economic effects of alternative courses of action. Model users can answer "what if" questions about the economic effects of policies in areas such as economic development, energy, transportation, the environment, and taxation. Thus, simulation models for state, provincial, and local economies can help guide decision makers in formulating strategies for these geographical areas.

PI$^+$ (and its predecessor Policy Insight) is probably the most widely applied regional economic policy analysis model. Uses of the model to predict the regional economic and demographic effects of policies cover a range of issues; some examples include electric utility restructuring in Wyoming, the construction of a new baseball park for Boston, air pollution regulations in California, and the provision of tax incentives for business expansion in Michigan. The model is used by government agencies on the national, state, and local level, as well as by private consulting firms, utilities, and universities.

The original version of the model was developed as the Massachusetts Economic Policy Analysis (MEPA, Treyz, Friedlander, and Stevens) model in 1977. It was then extended into a model that could be generalized for all states and counties in the U.S. under a grant from the National Cooperative Highway

Research Program. In 1980, Regional Economic Models, Inc. (REMI) was founded to build, maintain, and advise on the use of the REMI model for individual regions. REMI was also established to further the theoretical framework, methodology, and estimation of the model through ongoing economic research and development.

Major extensions of the initial model include the incorporation of a dynamic capital stock adjustment process (Rickman, Shao, and Treyz, 1993), migration equations with detailed demographic structure (Greenwood, Hunt, Rickman, and Treyz, 1991; Treyz, Rickman, Hunt, and Greenwood, 1993), consumption equations (Treyz and Petraglia, 2001), and endogenous labor force participation rates (Treyz, Christopher, and Lou, 1996). A multi-regional national model has also been developed that has a central bank monetary response to economic changes that occur at the regional level (Treyz and Treyz, 1997).

Most recently, the model structure has been developed to include "new economic geography" assumptions. Economic geography theory explains regional and urban economies in terms of competing factors of dispersion and agglomeration. Producers and consumers are assumed to benefit from access to variety, which tends to concentrate production and the location of households. However, land is a finite resource, and high land prices and congestion tend to disperse economic activity.

Economic geography is incorporated in the model in two basic indexes. The first is the commodity access index, which predicts how productivity will be enhanced and costs reduced when firms increase access to intermediate inputs. This index is also used in the migration equation to incorporate the beneficial effect for consumers of having more access to consumer goods, which is factored into their migration decisions. The second index is the labor access index, which captures the favorable effect on labor productivity and thus labor costs when local firms have access to a wide variety of potential employees and are able to select employees whose skills best suit their needs.

II. Overview of the Model

PI^+ is a structural economic forecasting and policy analysis model. It integrates input-output, computable general equilibrium, econometric, and economic geography methodologies. The model is dynamic, with forecasts and simulations generated on an annual basis and behavioral responses to compensation, price, and other economic factors.

The model consists of thousands of simultaneous equations with a structure that is relatively straightforward. The exact number of equations used varies depending on the extent of industry, demographic, demand, and other detail in the specific model being used. The overall structure of the model can be summarized in five major blocks: (1) Output and Demand, (2) Labor and Capital Demand, (3) Population and Labor Supply, (4) Compensation, Prices, and Costs, and (5) Market Shares. The blocks and their key interactions are shown in Figures 1 and 2.

Figure 1: REMI Model Linkages

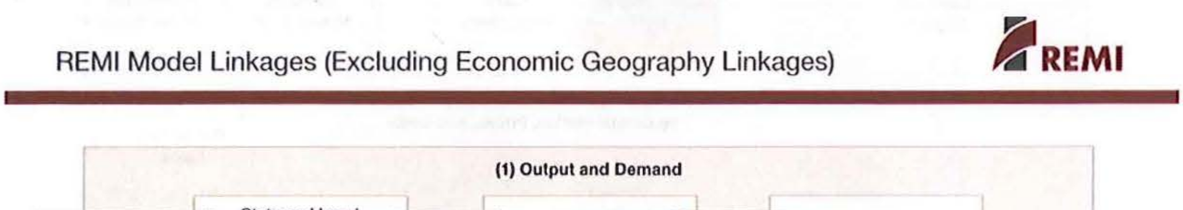
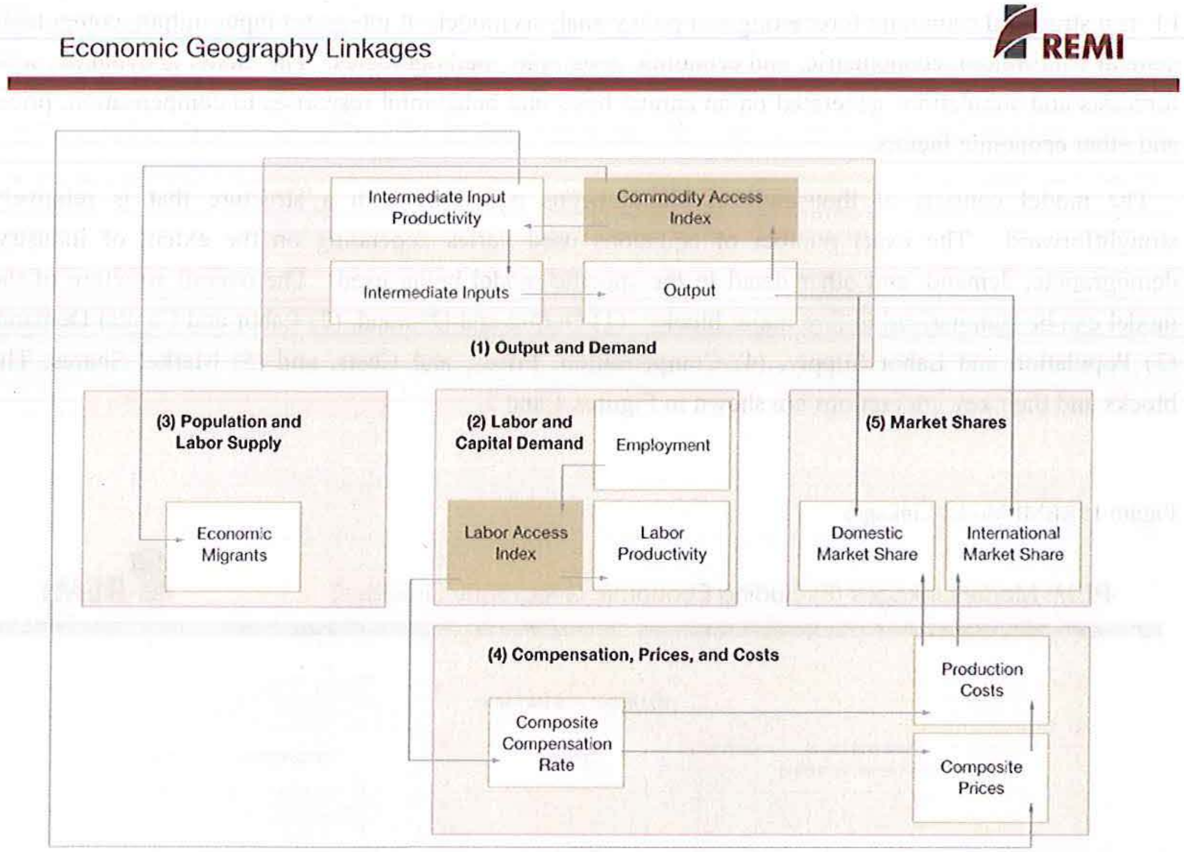


Figure 2: Economic Geography Linkages



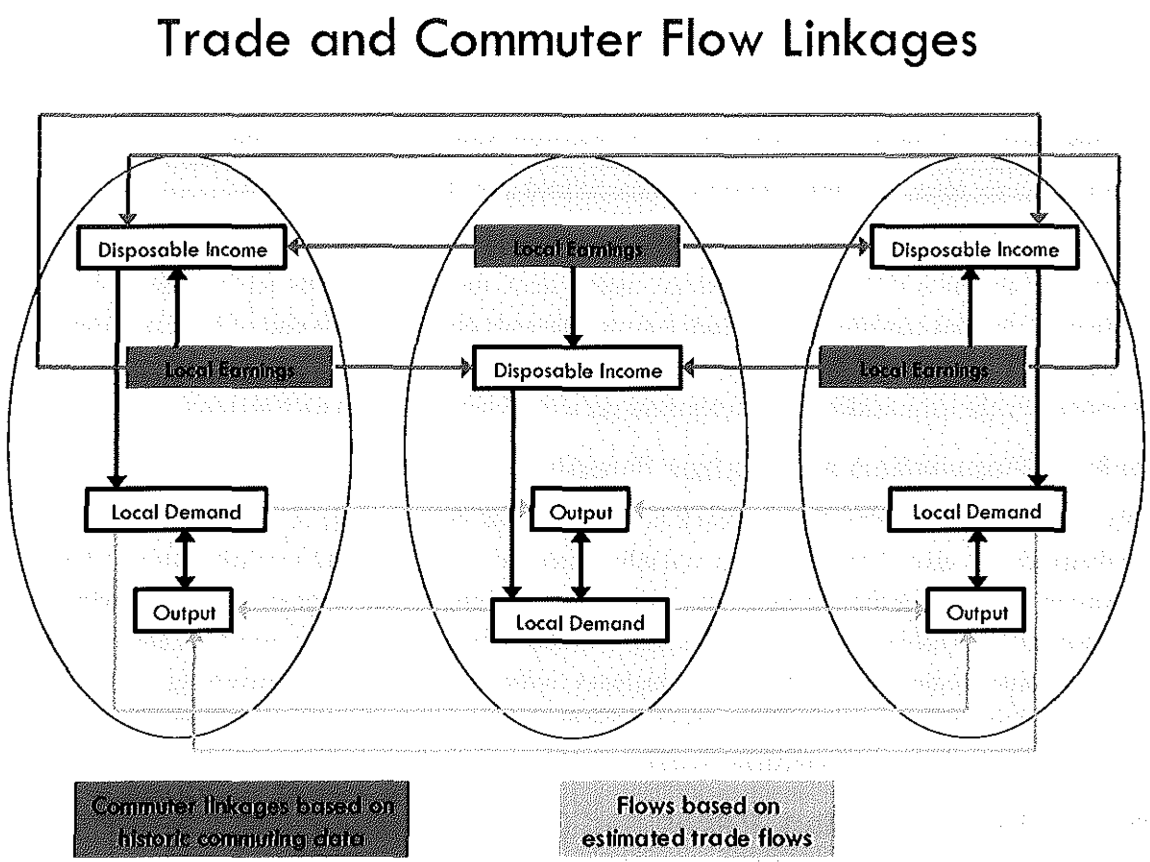
The Output and Demand block consists of output, demand, consumption, investment, government spending, exports, and imports, as well as feedback from output change due to the change in the productivity of intermediate inputs. The Labor and Capital Demand block includes labor intensity and productivity as well as demand for labor and capital. Labor force participation rate and migration equations are in the Population and Labor Supply block. The Compensation, Prices, and Costs block includes composite prices, determinants of production costs, the consumption price deflator, housing prices, and the compensation equations. The proportion of local, inter-regional, and export markets captured by each region is included in the Market Shares block.

Models can be built as single region, multi-region, or multi-region national models. A region is defined broadly as a sub-national area, and could consist of a state, province, county, or city, or any combination of sub-national areas.

Single-region models consist of an individual region, called the home region. The rest of the nation is also represented in the model. However, since the home region is only a small part of the total nation, the changes in the region do not have an endogenous effect on the variables in the rest of the nation.

Multi-regional models have interactions among regions, such as trade and commuting flows. These interactions include trade flows from each region to each of the other regions. These flows are illustrated for a three-region model in Figure 3. There are also multi-regional price and wage cost linkages as shown in the Figure at the end of Section III.

Figure 3: Trade and Commuter Flow Linkages



Multiregional national models also include a central bank monetary response that constrains labor markets. Models that only encompass a relatively small portion of a nation are not endogenously constrained by changes in exchange rates or monetary responses.

Block 1. Output and Demand

This block includes output, demand, consumption, investment, government spending, import, commodity access, and export concepts. Output for each industry in the home region is determined by industry demand in all regions in the nation, the home region's share of each market, and international exports from the region.

For each industry, demand is determined by the amount of output, consumption, investment, and capital demand on that industry. Consumption depends on real disposable income per capita, relative prices, differential income elasticities, and population. Input productivity depends on access to inputs because a larger choice set of inputs means it is more likely that the input with the specific characteristics required for the job will be found. In the capital stock adjustment process, investment occurs to fill the difference between optimal and actual capital stock for residential, non-residential, and equipment investment. Government spending changes are determined by changes in the population.

Block 2. Labor and Capital Demand

The Labor and Capital Demand block includes the determination of labor productivity, labor intensity, and the optimal capital stocks. Industry-specific labor productivity depends on the availability of workers with differentiated skills for the occupations used in each industry. The occupational labor supply and commuting costs determine firms' access to a specialized labor force.

Labor intensity is determined by the cost of labor relative to the other factor inputs, capital and fuel. Demand for capital is driven by the optimal capital stock equation for both non-residential capital and equipment. Optimal capital stock for each industry depends on the relative cost of labor and capital, and the employment weighted by capital use for each industry. Employment in private industries is determined by the value added and employment per unit of value added in each industry.

Block 3. Population and Labor Supply

The Population and Labor Supply block includes detailed demographic information about the region. Population data is given for age, gender, and ethnic category, with birth and survival rates for each group. The size and labor force participation rate of each group determines the labor supply. These participation rates respond to changes in employment relative to the potential labor force and to changes in the real after-tax compensation rate. Migration includes retirement, military, international, and economic migration. Economic migration is determined by the relative real after-tax compensation rate, relative employment opportunity, and consumer access to variety.

Block 4. Compensation, Prices and Costs

This block includes delivered prices, production costs, equipment cost, the consumption deflator, consumer prices, the price of housing, and the compensation equation. Economic geography concepts account for the productivity and price effects of access to specialized labor, goods, and services.

These prices measure the price of the industry output, taking into account the access to production locations. This access is important due to the specialization of production that takes place within each industry, and because transportation and transaction costs of distance are significant. Composite prices for each industry are then calculated based on the production costs of supplying regions, the effective distance to these regions, and the index of access to the variety of outputs in the industry relative to the access by other uses of the product.

The cost of production for each industry is determined by the cost of labor, capital, fuel, and intermediate inputs. Labor costs reflect a productivity adjustment to account for access to specialized labor, as well as underlying compensation rates. Capital costs include costs of non-residential structures and equipment, while fuel costs incorporate electricity, natural gas, and residual fuels.

The consumption deflator converts industry prices to prices for consumption commodities. For potential migrants, the consumer price is additionally calculated to include housing prices. Housing prices change from their initial level depending on changes in income and population density.

Compensation changes are due to changes in labor demand and supply conditions and changes in the national compensation rate. Changes in employment opportunities relative to the labor force and occupational demand change determine compensation rates by industry.

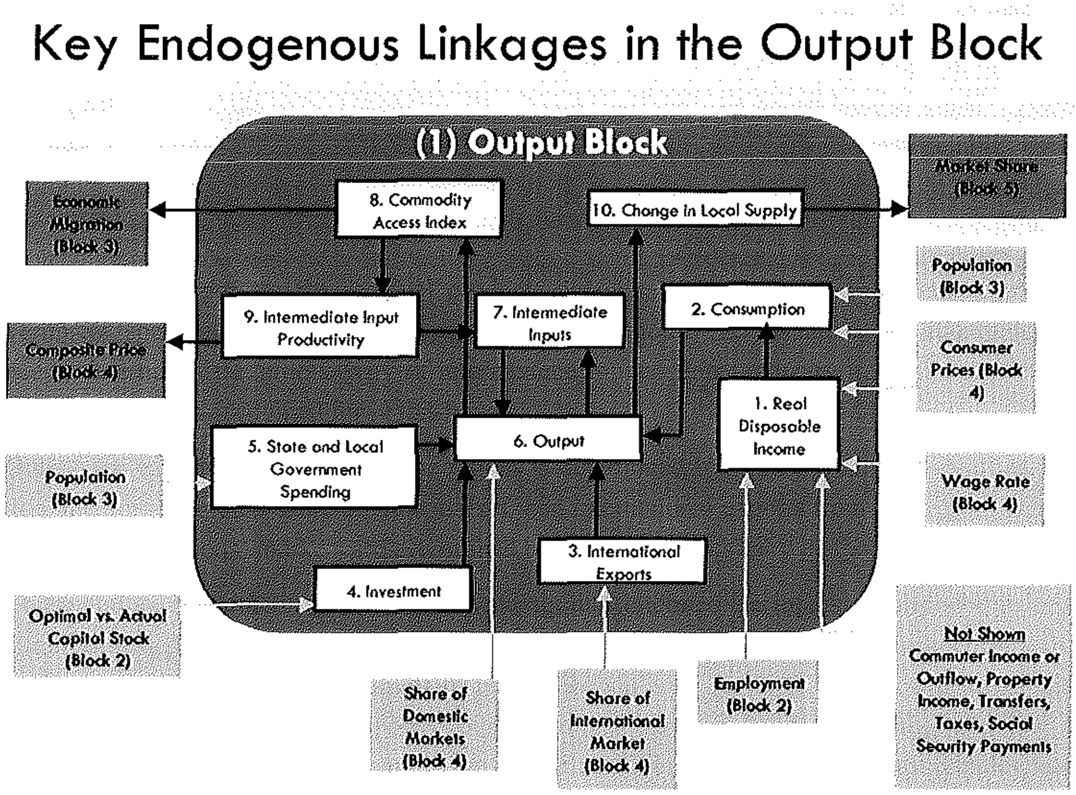
Block 5. Market Shares

The market shares equations measure the proportion of local and export markets that are captured by each industry. These depend on relative production costs, the estimated price elasticity of demand, and the effective distance between the home region and each of the other regions. The change in share of a specific area in any region depends on changes in its delivered price and the quantity it produces compared with the same factors for competitors in that market. The share of local and external markets then drives the exports from and imports to the home economy.

III. Detailed Diagrammatic and Verbal Description

The first task in this section is to examine the internal interactions within each of the blocks. The second task is to examine the linkages between the blocks. Finally, the last task is to tie it all together by looking at the key inter-block and intra-block linkages.

Block 1. Output and Demand



This block incorporates the regional product accounts. It includes output, demand, consumption, government spending, imports, and exports. The commodity access index, an economic geography concept, determines the productivity of intermediate inputs. Inter-industry transactions from the input-output table are also accounted for in this block.

Output for each industry in the home region is determined by industry demand in all regions in the nation, the home region's share of each market, and international exports from the region. The shares of home and other regions' markets are determined by economic geography methods, explained in block 5.

Consumption, investment, government spending, and intermediate inputs are the sources of demand. Consumption depends on real disposable income per capita, relative prices, the income elasticity of demand, and population. Consumption for all goods and services increases proportionally with population. The consumption response to per capita income is divided into high and low elasticity consumption components. For example, the demand for consumer goods such as vehicles, computers, and furniture is highly responsive to income changes, while health services and tobacco have low income elasticities. Demand for individual consumption commodities are also affected by relative prices. Changes in demand by consumption components are converted into industry demand changes by taking the proportion of each commodity for each industry in a bridge matrix.

Real disposable income, which drives consumption, is determined by compensation, employment, non-compensation income, and the personal consumption expenditure price index. Labor income depends on employment and the compensation rate, described in blocks 2 and 4, respectively. Non-compensation income includes commuter income, property income, transfers, taxes, and social security payments. Disposable income is stated in real terms by dividing by the consumer price index.

Investment occurs through the capital stock adjustment process. The stock adjustment process assumes that investment occurs in order to fill the gap between the optimal and actual level of capital. The investment in new housing, commercial and industrial buildings, and equipment is an important engine of economic development. New investment provides a strong feedback mechanism for further growth, since investment represents immediate demand for buildings and equipment that are to be used over a long period of time. The need for new construction begets further economic expansion as inputs into construction, especially additional employment in this industry, create new demand in the economy.

Investment is separated into residential, nonresidential, and equipment investment categories. In each case, the level of existing capital is calculated by starting with a base year estimate of capital stock, to which investment is added and depreciation is subtracted for each year. The desired level of capital is calculated in the capital demand equations, in block 2. Investment occurs when the optimal level of capital is higher than the actual level of capital; the rate at which this investment occurs is determined by the speed of adjustment.

Government spending at the regional and local level is primarily for the purpose of providing people with services such as schooling and police protection. However, government spending is usually linked to revenue sources. Thus, changes in government spending are driven by changes in population as well as the overall size of the economy (GRP). The government spending equation takes into account regional differences in per capita and per GDP government spending, as well as differential government spending levels across localities within a larger region.

The demand for intermediate inputs depends on the requirements of industries that use inputs from other sectors. These inter-industry relationships are based on the input-output table for the economy. For example, a region with a large automobile assembly plant would have a correspondingly large demand for primary metals, since this industry is a major supplier to the motor vehicles industry.

Thousands of specialized parts are needed to assemble an automobile, and the close proximity of the parts suppliers to the assembly plant is particularly significant under just-in-time inventory management procedures. More generally, the location of intermediate suppliers is important to at least some extent for every industry. Thus, the economic geography of the producer and input suppliers is a key aspect of regional productivity.

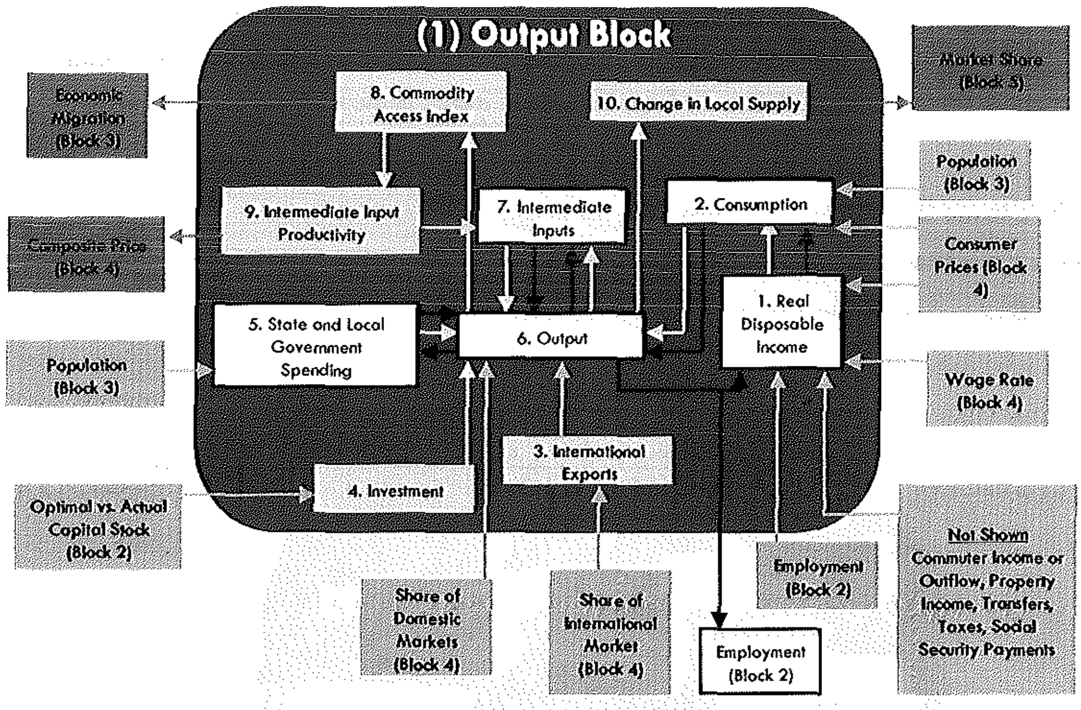
The agglomeration economies provided by the proximity of producers and suppliers is measured in the commodity access index. This index determines intermediate input productivity. The commodity access index for each industry is determined by the use of intermediate inputs, the effective distance to the input suppliers, and a measure of the productivity advantage of specialization in intermediate inputs. This productivity advantage is the elasticity of substitution between varieties in the production function. Although producers may be able to find a substitute for the precise component or service that they desire, access to the most favorable input provides a productivity advantage. When substitution between varieties is inelastic, then the productivity benefit of access to inputs is high. Thus, agglomeration economies are strong for the production of electrical equipment, computers, and machinery, and other industries that require specialized types of inputs for which substitution is difficult.

An increase in the output of an industry provides a larger pool of goods and/or services from which to choose. Since firms incur some fixed cost to produce a new variety, this increased pool of goods and services represents an increased availability of varieties. Therefore, an increase in industry output leads to a greater supply of differentiated goods and services, which can in turn lead to higher productivity and increase output. This positive feedback between tightly related clusters of industries is one source of regional agglomeration.

Since standard input-output analysis is often used to predict the effect of a firm either moving into or out of an area, it is important to explain why the results of the input-output analysis is incomplete. The following diagrams and explanation give an overview of the differences and similarities between PI^+ and Standard Input-Output.

In the first diagram ("Factors Included in Standard Input-Output Models"), white boxes ▭ indicate the linkages that constitute most I-O models.

Factors Included in Standard Input-Output Models



Some input-output models differentiate consumption by average household spending rates based on average earnings by industry. REMI differentiates between changes in income per capita and income changes due to changes in population, and includes different income elasticities for purchases of different consumer products (e.g. the consumption type that includes cigarettes has a lower income elasticity than the type that includes motor vehicles). Also, most I-O models would not account for the inflow and outflow of commuter earnings.

Thus, the I-O model captures the inter-industry flows that occur as output changes (each extra dollar of steel used 3 cents of coke) and it has feedbacks to consumer spending that are generated by changes in workers' income. Since population migration changes are not modeled, feedbacks to state and local governments in terms of new demands for per capita services are not included. Investment spending to construct new residential housing and commercial buildings cannot be modeled in static input-output models, because it is a transitory process that will occur when the need for housing and new stores occurs due to higher incomes and population but will return towards the baseline construction activity once the number of new houses and stores has risen enough to meet the one-time permanent increase in demand.

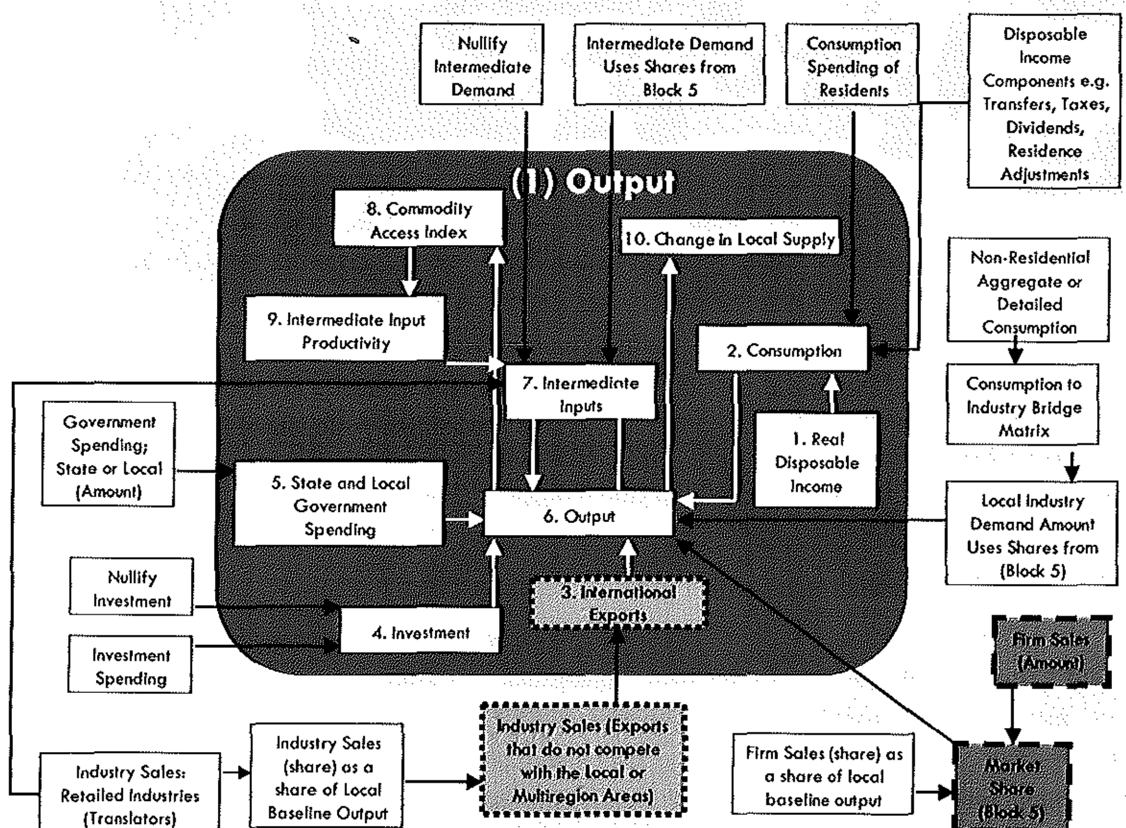
The change in the share of all markets as costs, the access to intermediate inputs, and the access to labor and feedback from other areas in a multi-region model are not included in standard I-O models. These all have effects in the short run, but the effects are even much larger in the long run. While an I-O analysis just gives a partial static picture, the REMI model catches all of the dynamic effects for each year in the future.

In addition to the difference in the extent of the important feedbacks in the REMI model compared to I-O, there is a major difference in the options for inputting policy variables in the two models. The following diagram shows the way standard input for the I-O model is Export Sales (going into International Exports) in comparison to the large number of inputs in the REMI model for Block 1.

REMI's Two Input Options vs. The Standard IO Single Option

Key Policy Variables for the Output and Demand Block

Block 1. Output and Demand



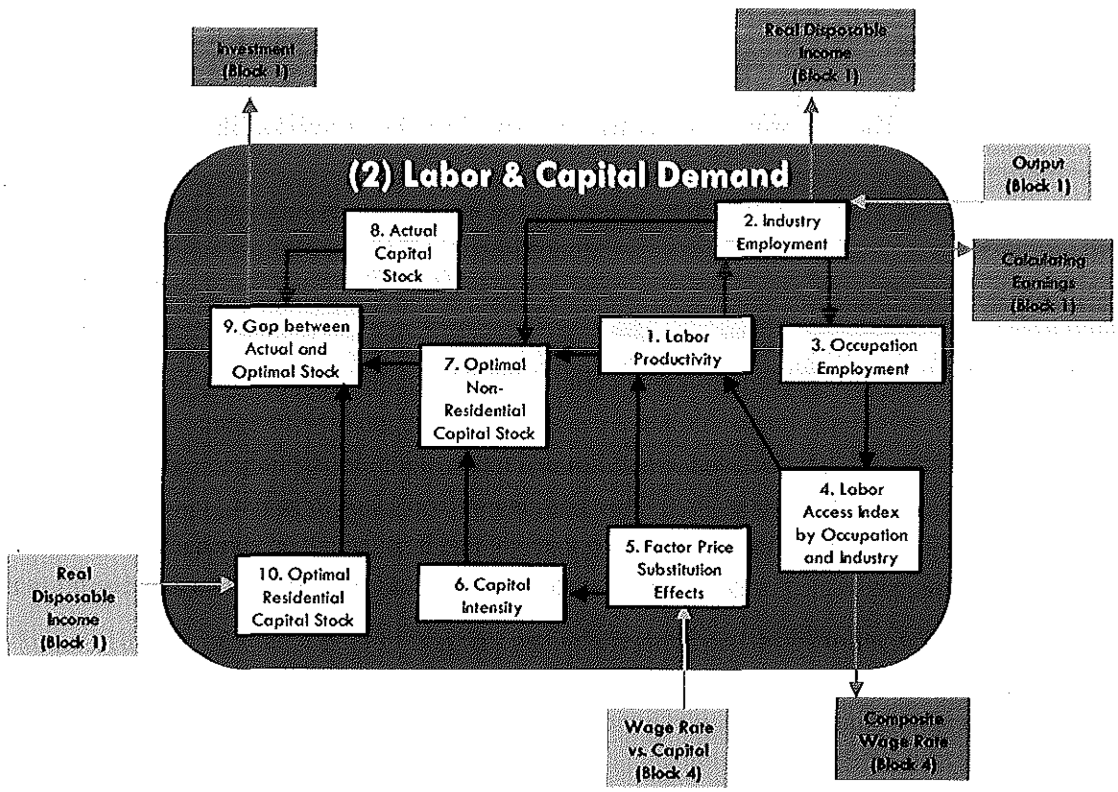
Standard input-output models only account for the direct output changes entered into the model, neglecting the displacement effects or augmenting effects on similar businesses in the region (or regions) modeled. The REMI model also provides this option.

Only the REMI model provides for inputting the output of the new firm in a way that accounts for displacement of competing employers in the home region and other regions in the multi-region model.

The alternative way that the REMI model provides for the effect of a firm entering or leaving a region due to a policy change can have substantial effects on the predicted outcome. For example, if a new grocery store is subsidized to move in, but 95% of all groceries are bought in the home region in the baseline case, then most of the sales of the new firm would displace sales in the grocery stores that are currently in the home region. This would mean that the net increase in jobs would only be a fraction of the firm's employment. The gain would mainly have to come from the increasing share in other regions, and this may be small if the initial shares indicate that the geographic area served by this industry is always very close to its source. In addition to considering the initial displacement, the REMI policy variable for a new firm will show how the future will be different if this new firm maintains its initial gain in share in the multi-region, the rest of the monetary union, and the rest of the world markets. Thus, the long-term effects will capture the differential effects of gaining share in an industry in which demand in the relevant markets is expanding rapidly versus those in which the demand is growing slowly. It will also capture the way that future projected changes in output per worker will mean that sales growth and employment growth may differ markedly.

The range of other policy variables for the output and demand block can be seen in the diagrams. These other ways that policy can influence the economic and demographic future of an area are not available for standard I-O models, because the linkages to most of the key processes that influence the outcomes in the region are not included in the structure of I-O models.

Block 2. Labor and Capital Demand



The Labor and Capital Demand block includes employment, capital demand, labor productivity, and the substitution among labor, capital, and fuel. Total employment is made up of farm, government, and private non-farm employment. Employment in private non-farm industries depends on employment demand and the number of workers needed to produce a unit of output. Employment demand is built up from the separate components of employment due to intermediate demand, consumer demand, local and regional government demand, local investment, and exports outside of the area. The employment per dollar of output depends on the national employment per dollar of output, the cost of other factors, and the access to specialized workers.

The availability of a large pool of workers within a region contributes to the labor force productivity. Each worker brings a set of unique characteristics and skills, even within the same occupational category. For example, a surgeon may specialize in heart, brain, or knee surgery. Although a brain surgeon may be able to perform a heart operation, the brain surgeon is likely to be less effective than a surgeon who has specific experience with heart surgery. Hospitals in major medical centers such as Houston are in an excellent position to meet their staff requirements because the number of qualified job applicants in the region is so large.

More broadly, locations that can be easily reached by a large number of potential employees can better match jobs with workers. The equation for labor productivity due to labor access is calculated separately for each occupation. Occupational productivity in each location is based on the residential location of all potential workers and their actual or potential commuting costs to that location.

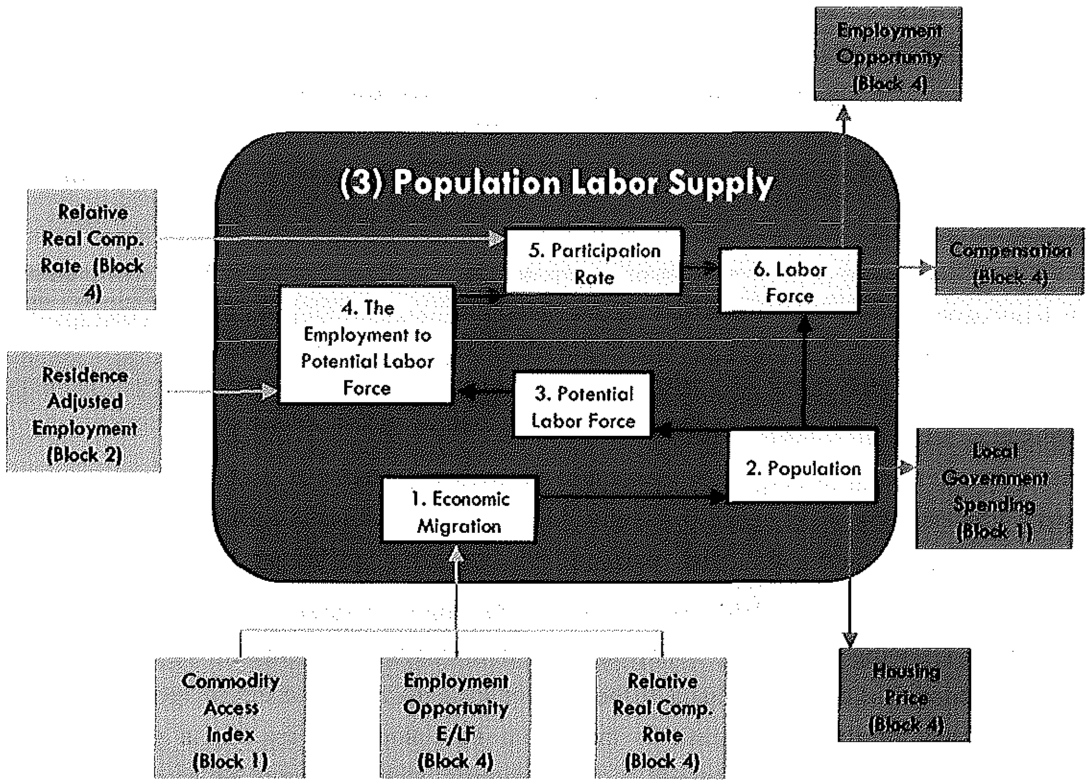
The contribution of labor variety to productivity is measured by an occupation-specific elasticity of substitution based on a study that considered wages and commuting patterns across a large metropolitan area. While the match of workers in specialized roles that are consistent with their training has a large impact on productivity for medical occupations, it is significantly less important for workers in the food service sector. Industry productivity due to specialization is built up from occupational productivity, using the proportionate number of workers in each occupation that are employed by a given industry.

The number of employees needed per unit of output depends on the use of other factors of production as well as labor access issues. Labor intensity, which measures the use of labor relative to other factors, is determined by the cost of labor relative to the cost of capital and fuel. The substitution between labor, capital, and fuel is based on a Cobb-Douglas production function, which implies constant factor shares. Labor intensity is calculated for each industry.

Demand for capital is driven by the optimal capital stock equation for industries and for housing. The optimal level of capital is determined for non-residential structures and equipment for each industry. The regional optimal capital stock is based on the industry size measured in capital-weighted employment terms, the cost of capital relative to labor, and a measure of the optimal capital stock on the national level. The variable for employment weighted by capital use is determined by the capital weight, employment, and labor productivity. The capital weight is the ratio of industry capital to employment in the region compared to the capital to employment ratio for the nation. The national optimal capital stock is based on the investment in the nation, the actual capital stock, the speed of adjustment, and the depreciation rate.

The optimal level of capital for residential housing is determined by the real disposable income in the region relative to the nation, the optimal residential capital stock for the nation, and the price of housing. To account for the cost of fuel, the fuel components of production (coal mining, petroleum refining, electric and natural gas utilities) are taken out of intermediate industry transactions and considered as a value-added factor of production. Then, firms substitute between labor, capital, and fuel (electric, natural gas, and residual fuel) as the relative costs of factor inputs change.

Block 3. Population and Labor Supply



The Population and Labor Supply block includes detailed demographic information about the region. The population is central to the regional economy, both as a source of demand for consumer and government spending and as the determinant of labor supply. As the composition of the population changes through births, deaths, and migration, so goes the region.

The demographic block is based on the cohort-component method. Population in any given year is determined by adding the net natural change and the migration change to the previous year's population. The natural change is caused by births and deaths, while migration occurs for economic and non-economic reasons. Population data is given for age, gender, and ethnic category.

Fertility rates are the ratio of births to the number of women in each age group. The survival rate is equal to one minus the death rate, which is the ratio of deaths to population in each cohort. Since fertility rates vary widely across age and ethnic groups, and survival rates vary widely for gender as well as age and ethnic category, the detailed demographic breakdown is needed to accurately capture the aggregate birth and survival rates.

Migration, economic or non-economic, also varies widely across population groups. Changes in retirement, international, and returning military migration are all assumed to occur for reasons that are not primarily due to with changing regional economic conditions. Retirement migration depends on the retirement-age population in the rest of the country for regions that have gained retirement population in the past, and on the retirement-age population within the regions for places that tend to have a net loss of retirees. The probability of losing or gaining a retiree is age and gender specific for each age group.

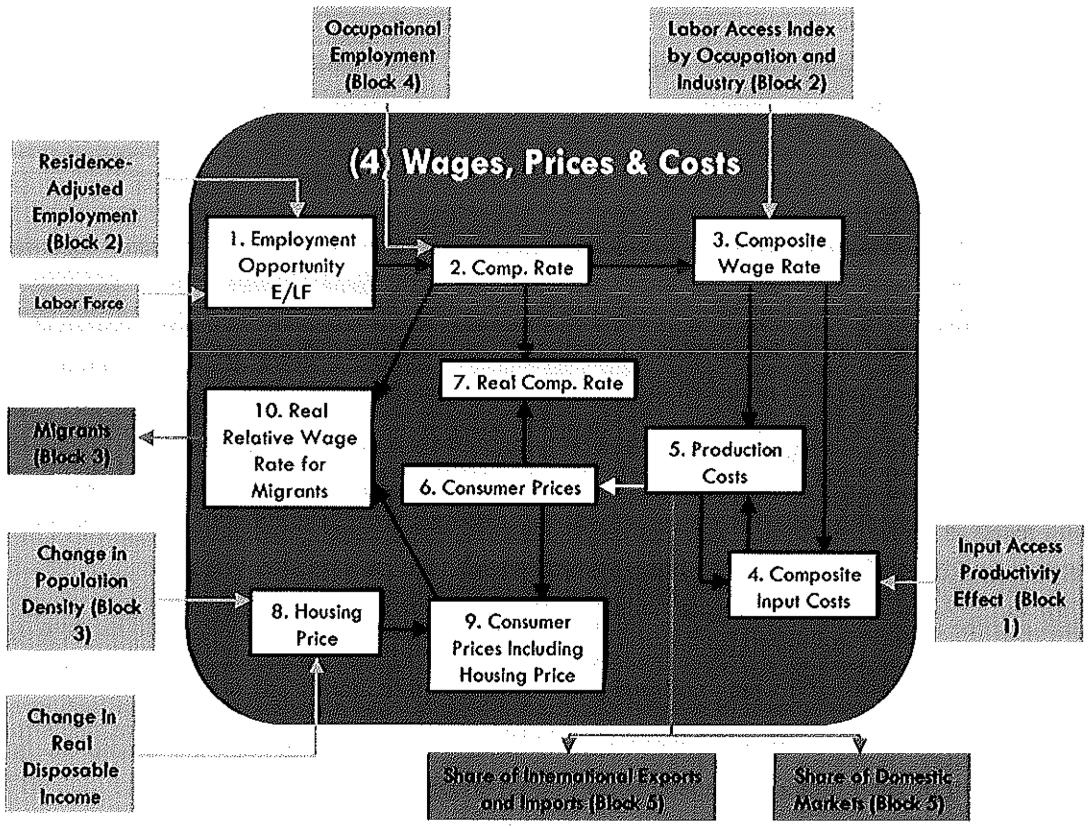
International migration is also based on previous patterns. Changes in political restrictions on immigration and the economy of the immigrants' country are more significant in determining international migration than are changes in the economy of the home region. Returning military migration patterns are also better explained by existing patterns than by regional economic conditions, so returning military is also an exogenous variable.

Economic migration is the movement of people to regions with better economic conditions. Economic migrants are attracted to places with relatively high wages and employment opportunities. Migrants are also attracted to places with high amenities. Potential migrants value access to consumer commodities, which depend on economic conditions. Thus, as the output of consumer goods and services increases, the amenity attraction of the region increases. Other amenities are due to non-economic factors. These amenities or compensating differentials are measured indirectly by looking at migration patterns over the last 10 years. In this way, the compensating differential is calculated as the expected compensation rate that would result in no net in- or out-migration. For example, people may be willing to work in Florida even if paid only 85% of the average U.S. compensation rate.

The labor force consists of unemployed individuals who are seeking work as well as employed workers. The labor force participation rate is thus the proportion of each population group that is working or looking for work. To predict the labor force, the model sums up the participation rate and cohort size for each demographic category. Participation rates vary widely across age, gender, and ethnic category; thus, the labor force depends in large part on the population structure of the region.

The willingness of individuals to participate in the labor force is also responsive to economic conditions. Higher compensation rates and greater employment opportunities generally encourage higher labor force participation rates. The extent to which rates change in response to these economic factors, however, differs substantially for different population groups. For example, the willingness of men to enter the labor force is more influenced by compensation, while women are more sensitive to employment opportunities.

Block 4. Compensation, Prices, and Costs

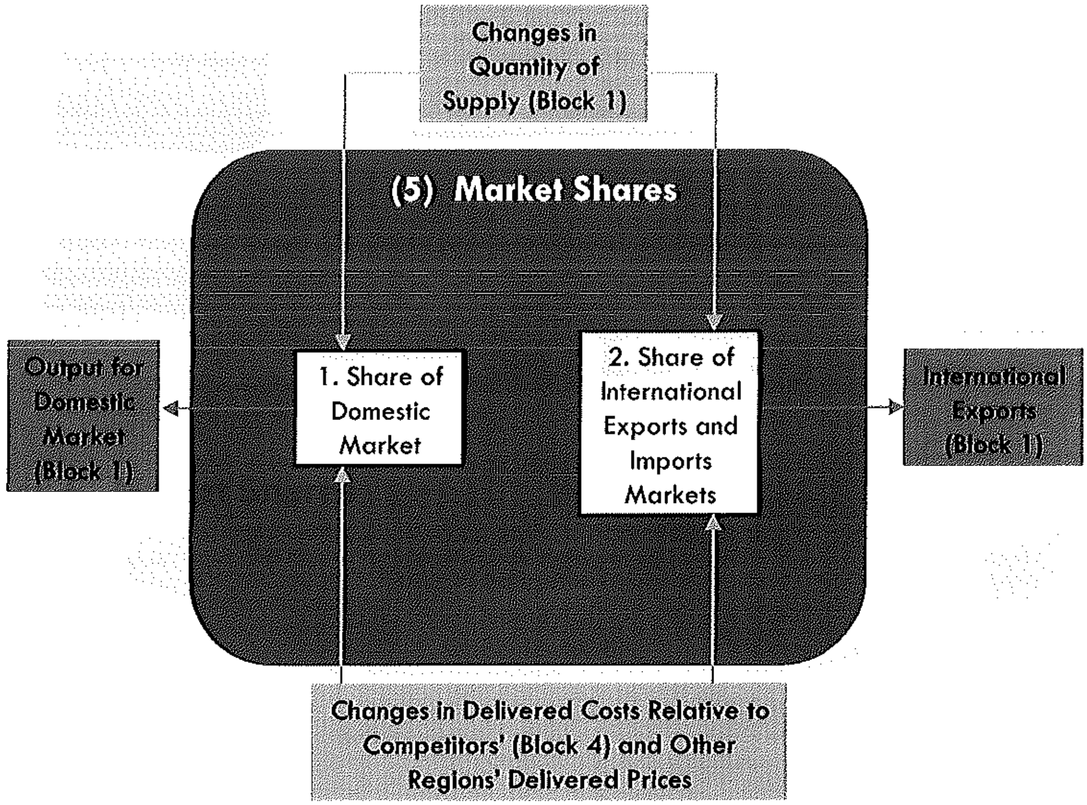


This block includes compensation, consumer prices, production costs, housing prices, and composite wages and input costs. Compensation, prices, and costs are determined by the labor and housing markets. The labor market is central to the regional economy, and compensation differences are the primary source of price and cost differentials between regions. Demand for labor, from block 2, and labor force supply, from block 3, interact to determine compensation rates. Housing prices depend on changes in population density and changes in real disposable income.

Economic geography concepts account for productivity and corresponding price effects due to access to specialized labor and inputs into production. The labor access index from block 2, as well as the nominal compensation rate, determines the composite compensation rate. The composite cost of production depends on the productivity-adjusted compensation rate of the region, costs of structures, equipment, and fuel, and the delivered price of intermediate inputs.

The delivered price of a good or service is based on the cost of the commodity at the place of origin, and the distance cost of providing the commodity to the place of destination. This price measure is calculated relative to delivered prices in all other regions, and weights the delivered price from all locations that ship to the home region.

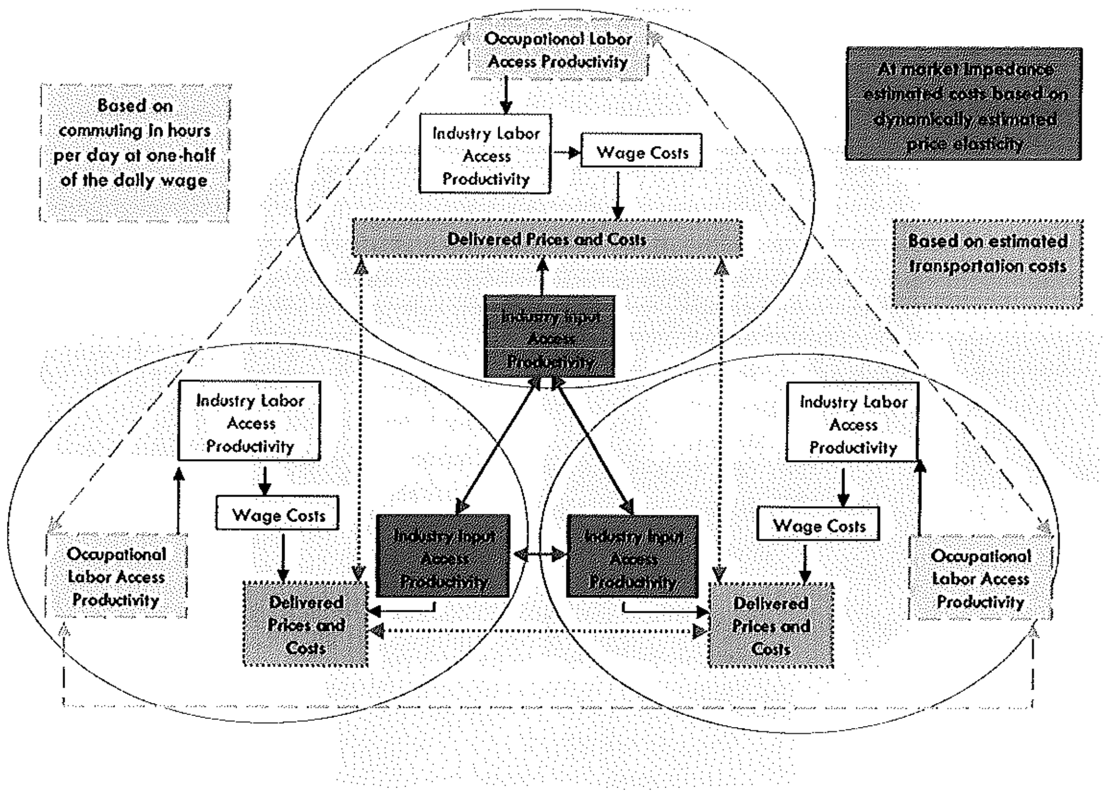
Block 5. Market Shares



The Market Shares block represents the ability of the region to sell its output within the local region, to other regions in the nation, and to other nations. Although the share of local markets is generally higher than any other market share, the equation for the market share of the home region is the same as for other regions within the nation. The share of international exports from the home region depends on national exports overall, and relative cost and output changes in the home region.

Changes in market shares within the nation depend on changes in industry production costs and output. Production cost increases lower market shares, but higher output raises market shares. Market shares rise with output increases, since higher output is better able to meet local and other regions' demand for goods and services by providing more choices.

Multi-Regional Price and Wage Linkages



IV. Block by Block Equations

Block 1 – Output and Demand

Output Equations

The output in area k for industry i is determined by the following equation:

$$Q_i^k = \sum_{l=1}^{m} s_i^{k,l} DD_i^l + sx_i^{k,row} * X_i^u \tag{1-1}$$

Where;

Q_i^k = The output for industry i in area k.

DD_i^l = The domestic demand for industry i in area l.

X_i^u = Exports of industry i from the nation (u).

$s_i^{k,l}$ = Area k's share for industry i of the market in area l.

$sx_i^{k,row}$ = Area k's share of the national exports of i to the rest of the world (row).

m = The number of areas in the model (minimum 2). Also the letter that denotes the exogenous region (i.e. rest of the nation) for any model that does not incorporate a monetary feedback.

The DD_i^l is the quantity demanded in l. The $s_i^{k,l}$ term will incorporate the changes in k's share of i in l that are due to the changes in k's delivered price of i to l compared to the weighted average price charged by all of the areas that deliver to l, the variety of i offered in k compared with the variety offered by competitors in l, and the mix of fast-growing relative to slow-growing detailed industries that make up industry i in area k compared to the mix in the nation (see Block 5 below).

$$DD_i^l = \left(\sum_{j=1}^{n} a_{ij,t}^l Q_j^l + \sum_{j=n+1}^{n+c} a_{ij}^u C_j^l + \sum_{j=n+c+1}^{n+c+inv} a_{ij}^u I_j^l + \sum_{j=n+c+inv+1}^{n+c+inv+g} a_{ij}^u * G_j^l \right) * sd_{i,t}^l \tag{1-2}$$

Where;

DD_i^l = Domestic demand for industry i in area l.

a_{ij}^u = The average i purchased per dollar spent on j in the nation (u) in the current time period[1].

[1] Where input-output accounts use a commodity-by-industry input-output framework in which commodities and industries are classified separately, the make and use tables can be used to convert to an industry-by-industry framework.

$$a^l_{ij,t} = {a^u_{ij}} \Big/ {MCPRODA^l_{i,t}} \qquad (1\text{-}3)$$

Where;

$a^l_{ij,t}$ = The average i purchased per dollar spent on producing j in region l in period t.

$MCPRODA^l_{i,t}$ = The moving average of $MCPROD^l_{it}$.

sd^l_{it} = The share of area l's demand for good i in time t that is supplied from within the nation.

n = The number of industries.

c = The number of final demand consumption categories.

inv = The number of investment sectors.

g = The number of government sectors.

Q^l_j = The output of industry j in area l.

C^l_j = The demand for consumption category j in area l.

I^l_j = The demand for investment category j in area l.

G^l_j = The spending by government type j[2] in area l.

$$MCPROD^l_{i,t} = \left[\frac{\left\{ \sum_{l=1}^{m} \left(\frac{Q^l_{i,t}}{\sum_{j=1}^{m} Q^j_{i,t}} \right) \left[\left(ED^{lk}_i \right)^{\eta_i} \right]^{1-\sigma_i)} \right\}^{\frac{1}{1-\sigma_i}}}{\left\{ \sum_{l=1}^{m} \left(\frac{Q^l_{i,T}}{\sum_{j=1}^{m} Q^j_{i,T}} \right) \left[\left(ED^{lk}_i \right)^{\eta_i} \right]^{1-\sigma_i)} \right\}^{\frac{1}{1-\sigma_i}}} \right]^{-1} \qquad (1\text{-}4)$$

$MCPROD^l_{i,t}$ = Intermediate Input Access Index. It predicts the change in the productivity of intermediate inputs due to changes in the access to these inputs in area l.

Where;

σ_i = The price elasticity of demand for industry i. (This parameter is estimated econometrically as the change in market share due to changes in area k's delivered price compared to other competitors in each market in which area k sells products of industry i.)

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[2] All local government demands in a local area translate into local government spending in that area.

However, demand for state government services in a county within a state results in government spending on services in the counties where state government services are supplied, which may only lead to a small amount of extra state government services or spending in the area where the demand arises. Likewise, national government demand may result in national spending or services in different areas of a country.

ED^{lk} = The "effective distance" between l and k. (This variable is obtained by aggregating from the small area trade flows in our database.)

Q_i^l = Output of i in l.

η_i = Distance deterrence elasticity. This is estimated using the exponent in the gravity equation (β_i) and the estimated price elasticity σ_i and then using the identity $\eta_i = \frac{\beta_i}{\sigma_i - 1}$.

$$MCPRODA_t = (1-\lambda)MCPROD_t + \lambda MCPRODA_{t-1}$$

$$CPROD_j^k = \prod_{i=1}^{n} \left(MCPRODA_i^k\right)^{PCE_{i,j}^u} \qquad (1\text{-}5)$$

$CPROD_j^k$ = The consumption commodity j access index in area k.

$PCE_{i,j}^u$ = The proportion of each industry's input to consumption commodity j.

n = The number of industries.

$\lambda = 0.8$ = speed of adjustment for moving average

$$MIGPROD_t^k = \prod_{j=1}^{c}\left(\frac{CPROD_{j,t}^k}{CPROD_{j,t-1}^k} \right)^{wc_{j,t-1}^u} * MIGPROD_{t-1}^k \qquad (1\text{-}6)$$

$MIGPROD^k$ = The consumer access index.

$MIGPROD_T = 1$

c = The number of consumption commodities.

$$wc_{j,t-1}^u = \frac{C_{j,t-1}^u}{\sum_{j=1}^{c} C_{j,t-1}^u}$$

Consumption Equations

The following consumption equation is used, which substitutes for the equation published in a 2001 article by George Treyz and Lisa Petraglia.[3]

$C_{j,t}^k$ = 1 [calibration effect] * 2 [age composition effect] * 3 [regional effect] * 4 [marginal income effect] * 5 [region-specific marginal price effect] * 6 [national consumption per capita effect] * 7 [local population]

[3] *Consumption Equations for a Multiregional Forecasting and Policy Analysis Model;* G.I. Treyz and L.M. Petraglia; *Regional Science Perspectives in Economic Analysis*, Elsevier Science B.V. 287-300; 2001.

(1). Calibration Effect | (2). Age Composition Effect | (3). Regional Effect | (4). Marginal Income Effect | (5). Region-Specific Marginal Price Effect | (6). U.S. Forecast Effect | (7). Local Population

$$C_{j,t}^{k} = \left[\frac{\frac{YD_T^k}{N_T^k}}{\frac{YD_T^u}{N_T^u}}\right] * \left[\frac{\sum_{l=1}^{7}(\%DG_{l,t}^{k} * PC_{l,j}^{u})}{\sum_{l=1}^{7}(\%DG_{l,t}^{u} * PC_{l,j}^{u})}\right] * \left[\frac{\frac{\overline{C}_{j,2012}^{R}}{\overline{C}_{j,2012}^{u}}}{\text{AgeCompEffect(2)}}\right] * \left[\frac{\left(\frac{\frac{RYD_t^k}{N_t^k}}{\frac{RYD_t^u}{N_t^u}}\right)}{\left(\frac{\frac{RYD_T^k}{N_T^k}}{\frac{RYD_T^u}{N_T^u}}\right)}\right]^{\beta_j} * \left[\frac{\left(\frac{\frac{CIFP_{j,t}^k}{\overline{P}_t^k}}{\frac{P_{j,t}^u}{\overline{P}_t^u}}\right)}{\left(\frac{\frac{P_{j,T}^k}{\overline{P}_T^k}}{\frac{P_{j,T}^u}{\overline{P}_T^u}}\right)}\right]^{\gamma_j} * \left(\frac{C_{j,t}^u}{N_t^u}\right) * N_t^k \qquad (1\text{-}7)$$

Variable Definitions

RYD = Real Disposable Income

YD = Nominal Disposable Income

N = Population

P = Price = $CIFP$

$\overline{P}^k$ = Average price in area for the weighted average of all the commodities that make up total consumption

$\overline{C}$ = Average consumption per household

C = Consumption

%DG = percentage of Demographic Age Group

PC = Propensity to consume

Subscripts

t = time period

T= last history year time period

j = consumption commodity

l = age group

Superscripts

k = local region

u = entire nation

β_j= marginal income elasticities (estimated separately for luxuries and necessities)

γ_j= marginal price elasticities (estimated separately for luxuries and necessities)

R = major region of the country (Northeast, Midwest, South, West)

Real Disposable Income Equations

Real disposable income (RYD) in the region equals personal income (YP) adjusted for taxes (TAX) and the PCE-Price Index, which represents the cost of living ($\overline{P}'$). Total personal income (YP) depends on compensation (*COMP*), and proprietors' income (YPI), property income ($YPROP$), employee and self-employed contributions for government social insurance ($TWPER$), employer contributions for government social insurance (*EGSI*), transfer payments (V), and an adjustment to account for the difference between place-of-work and place-of-residence earnings (RA).

Compensation, *COMP*, is an aggregation of individual industry wages and salaries and supplements to wages and salaries. Thus,

$$COMP = \sum_{i=1}^{n} E_i * CR_i \tag{1-8}$$

Where;

E_i is employment in industry i, and CR_i is the compensation rate of industry i.

The self-employed generate proprietors' income.

$$YPI_i = YLP_i - COMP_i \tag{1-9}$$

Where;

YPI_i is proprietors' income for industry i

Total labor and proprietors' income, *YLP*, (also referred to as earnings by place of work) for all industries in the region can be calculated as

$$YLP = \sum_{i=1}^{n} [E_i * ER_i] \tag{1-10}$$

Where;

ER_i is the earnings rate for industry i

Wage and salary disbursements, *WSD*, are predicted as

$$WSD_i = E_i * WR_i \tag{1-11}$$

Where;

WR_i is the wage rate for industry i

Property income, $YPROP$, is split into its major components of Dividends (YDIV), Interest (YINT), and Rent (YRENT), which each depend on the population and its age distribution, as well as historical regional differences in the type of property income received.

$$YDIV = \lambda_{YDIV} NP\left(YDIV'' / NP''\right) \tag{1-12a}$$

$$YINT = \lambda_{YINT} NP\left(YINT'' / NP''\right) \tag{1-12b}$$

$$YRENT = \lambda_{YRENT} NP\left(YRENT'' / NP''\right) \tag{1-12c}$$

$$YPROP = YDIV + YINT + YRENT \tag{1-12}$$

and

$$NP = L65 + m65 * G65 \tag{1-13}$$

Where $m65$ is the national ratio of per capita property income received (by type) for persons 65 years and older ($G65$) relative to property income received (by type) by persons younger than 65 ($L65$), and λ_j adjusts for regional differences and is calculated in the last historical year by solving equations (1-12) and (1-13).

Employee and self-employed contributions for government social insurance, $TWPER$, are predicted as

$$TWPER = \lambda_{TWPER} WSD\left(TWPER'' / WSD''\right) \tag{1-14}$$

Where λ_{TWPER} is a coefficient calculated in the last historical year to adjust for regional differences in the $TWPER$ per dollar of wage and salary disbursements, and WSD equals wage and salary disbursements.

Employer contributions for government social insurance, *EGSI*, are predicted as

$$EGSI = \lambda_{EGSI} WSD(EGSI'' / WSD'') \tag{1-15}$$

Where λ_{EGSI} is a coefficient calculated in the last historical year to adjust for regional differences in the *EGSI* per dollar of wage and salary disbursements.

The residence adjustment, RA, is used to convert place-of-work income (compensation, proprietors' income, and contributions for government social insurance) to place-of-residence income.

$$RA^k = GI^k - GO^k \tag{1-16}$$

$$rs_t^{k,l} = \frac{LF_t^l * (P_t^l)^{(1-\sigma)} * \left(D^{k,l}\right)^{-\beta}}{\sum_{k\neq l}^{n} LF_t^j * (P_t^j)^{(1-\sigma)} * \left(D^{j,k}\right)^{-\beta}} \tag{1-17}$$

$rs_t^{k,l}$ = the share of commuters who live in region l and work in region k in time period t.

LF_t^l= labor force in region l in time period t.

P_t^l= the consumer price index including housing price in region l in time period t.

$D^{k,l}$= the commute distance from region l to region k.

σ= Sigma value, the estimated parameter for consumer price.

β= Beta value, the estimated parameter for distance decay.

$$CI_t^{k,l} = \sum_{k\neq l}^{n} rs_t^{k,l} * \left(COMPT_t^k - COMP_t^{nFM,k} - TWPER_t^k - EGSI_t^k\right) \tag{1-18}$$

$CI_t^{k,l}$ = the commuter income flow from commuters who live in region l and work in region k in time period t.

$$GI_t^k = \sum_{k\neq l}^{n} CI_t^{l,k} \tag{1-19}$$

GI^k = Gross inflow of commuter dollars for residents of region k who work in all other areas.

$$GO_t^k = \sum_{k\neq l}^{n} CI_t^{k,l} \tag{1-20}$$

GO^k = Gross outflow from region k to all other areas (m).

Transfer payments by component, V_j, depend on the number of persons in each of three groups: persons 65 years and older, persons younger than 65 who are not working, and all persons who are not working. The components of transfer payments also are adjusted for historical regional differences.

$$V_j = \lambda V_j NV_j \left({V_j^u} \Big/ {NV_j^u} \right) \quad (1\text{-}21a)$$

$$V = \sum_j V \quad (1\text{-}21)$$

and

$$NV = VG_m(G65) + VL_m[L65 - EMPD] + [N - EMPD] \quad (1\text{-}22)$$

Where VG_m are per capita transfer payments (by four major types) for persons 65 years and older relative to per capita transfer payments (by four major types) for all persons not working, VL_m are per capita transfer payments (by four major types) for persons younger than 65 who are not working, relative to per capita transfer payments for all persons not working (by four major types), λV_j adjusts for regional differences and is calculated in the last historical year, and $EMPD$ and N are, respectively, total employed (scaled from residence adjustment) and population in the region.

The variable TAX depends on net income after subtracting transfer income. It is adjusted for regional differences by λ_{TAX} and changes as national tax rates change.

$$TAX = \lambda_{TAX}(YP - V)\left[{TAX^u} \Big/ {(YP^u - V^u)} \right] \quad (1\text{-}23)$$

Investment Equations

There are three types of fixed investment to be considered: residential, nonresidential, and equipment. Change in business inventories is the other component of investment, and is based on the national change in inventories as a proportion of sales applied to the size of the local industry.

The way in which the optimal capital stock (K^*) is calculated for each structure investment category (residential and non-residential) is explained in the factor and intermediate demand section below. Introducing time explicitly into the model, we can write equations that apply for residential and nonresidential fixed capital.

$$IL_{p,t} = \alpha[(K_t^*) - (1 - dr_t^u)K_{t-1}] \quad (1\text{-}24)$$

$$K_{t-1} = (1 - dr_{t-1}^u)K_{t-2} + IL_{t-1} \quad (1\text{-}25)$$

Using equation (1-24), the actual capital stock in equation (1-25) can be replaced with the sum of the surviving initial capital stock (K_0) and the surviving previous investment expenditures. The investment equation is

$$KG_{j,t}^{k} = K_{j0}^{k} - \underbrace{\left(K_{j0}^{k} * \prod_{i=1}^{t} (1 - dr_j) + \sum_{i=1}^{t-1} IL_{j,i}^{k} * \prod_{i+1}^{t} (1 - dr_{j,i}) \right)}_{K_{j,t}^{k}} \qquad (1\text{-}26a)$$

$$KGA_{j,t}^{k} = (1 - \lambda) * KG_{j,t}^{k} + \lambda KGA_{j,t-1}^{k} \qquad (1\text{-}26b)$$

$$IL_{j,t}^{k} = \alpha_j * KGA_{j,t}^{k} \qquad (1\text{-}26c)$$

$$I_{i,t}^{k} = \sum_j inv_{ij,t} IL_{j,t}^{k} \qquad (1\text{-}27)$$

$KG_{j,t}^{k}$ = Gap between current year's optimal and actual capital stock

$KGA_{j,t}^{k}$ = Moving average (two-year) of gap between optimal and actual capital stock for current year.

$KGA_{j,t-1}^{k}$ = Moving average of gap between optimal and actual capital stock for previous year.

$I_{i,t}^{k}$ = Investment demand for output from industry i, time t, region k

$IL_{j,t}^{k}$ = Investment demand for investment type j, time t, region k

$inv_{ij,t}$ = Coefficient denoting the proportion of investment category j supplied by industry i, time t.

$K_{j,t}^{k*}$ = Optimal capital stock, type j, time t, region k.

K_{j0}^{k} = Capital stock, type j, time 0, region k.

dr_j = Depreciation rate, type j.

α_j = Speed of adjustment, type j.

$\lambda = 0.5$ = speed of adjustment for moving average

(For additional details see Rickman, Shao and Treyz, 1993).

Producers' durable equipment investment is calculated somewhat differently from residential and nonresidential investment. Since a very large part of equipment investment is for replacement, and not net new purchases, the following equation is used:

$$IL_{PDE,t}^{k} = (1 - \lambda)((IL_{NRS,t}^{k} / IL_{NRS,t}^{u}) * IL_{PDE,t}^{u}) + \lambda((K_{NRS,t}^{k} / K_{NRS,t}^{u}) * IL_{PDE,t}^{u}) \qquad (1\text{-}28)$$

$IL_{PDE,t}^{k}$ = Investment demand for producers' durable equipment, time t, region k.

$IL_{NRS,t}^{k}$ = Investment demand for nonresidential, time t, region k.

$IL^{u}_{NRS,t}$ = Investment demand for nonresidential, time t, national (u).

$IL^{u}_{PDE,t}$ = Investment demand for producers' durable equipment, time t, national (u).

$K^{k}_{NRS,t}$ = Capital stock for nonresidential, time t, region k.

$K^{u}_{NRS,t}$ = Capital stock for nonresidential, time t, national (u).

$\lambda = 0.86$ = speed of adjustment for moving average

The national change in business inventories is allocated according to the regional share of employment.

$$CBI_i^l = \left(E_i^l \big/ E_i^u \right) * CBI_i^u \tag{1-29}$$

CBI_i^l = The change in business inventories, industry i, region l.

CBI_i^u = The change in business inventories, industry i, national (u).

E_i^l = Employment, industry i, region l.

E_i^u = Employment, industry i, national (u).

Government Spending Equations

The state and local government demand equations are driven based on the average per capita and per total value added demands for these services in the last history year (T).

$$TPNFVA\_PC\_A_t^l = 0.5\left(TPNFVA\_PC\_A_{t-1}^l\right) + 0.5\left(\frac{TPNFVA_t^l}{N_t^l} \div \frac{TPNFVA_t^u}{N_t^u}\right) \tag{1-30}$$

$$G_{state,T}^l = \lambda_{state}^l * N_T^l * \left(TPNFVA\_PC\_A_T^l\right)^{\beta} * \left(G_{state,T}^u \div N_T^u\right) \tag{1-31a}$$

$$G_{state,t}^l = \left[\, \left(TPNFVA\_PC\_A_t^l\right) \div \left(TPNFVA\_PC\_A_T^l\right) \,\right]^{\beta} * \left(\frac{G_{state,t}^u}{N_t^u} \div \frac{G_{state,T}^u}{N_T^u}\right) * \left(\frac{N_t^l}{N_T^l}\right) * G_{state,T}^l \tag{1-31b}$$

$$G_{local,T}^l = \lambda_{local}^l * N_T^l * \left(TPNFVA\_PC\_A_T^l\right)^{\gamma} * \left(G_{local,T}^u \div N_T^u\right) \tag{1-32a}$$

$$G^l_{local,t} = [\ (TPNFVA\_PC\_A^l_t) \div (TPNFVA\_PC\_A^l_T)\ ]^{\gamma} *$$
$$\left(\frac{G^u_{local,t}}{N^u_t} \div \frac{G^u_{local,T}}{N^u_T}\right) * \left(\frac{N^l_t}{N^l_T}\right) * G^l_{local,T} \qquad (1\text{-}32b)$$

Where;

$G^l_{state,t}$ = The demand for state services in region *l*, time *t*.

$G^l_{local,t}$ = The demand for local services in region *l*, time *t*.

λ^l_{state} = The local calibration factor for state government demand.

λ^l_{local} = The local calibration factor for local government demand.

N^l_t = The total population, region *l*, time *t*.

$TPNFVA^l_t$ = The total private non-farm value added, region *l*, time *t*.

$TPNFVA\_PC\_A^l_t$ = The moving average of total private non-farm value added per capita in region *l* relative to the nation, time *t*.

β = The elasticity of state government expenditures.

γ = The elasticity of local government expenditures.

Superscript *u* indicates similar values for the nation.

In the absence of adequate local demand estimates for state and local government separately, it is necessary to approximate these relative values based on assuming uniform productivity across all state and local government employees in the nation. It is important to note that local demand for local government services will be met in the local area, whereas the demand for state services in a local area may be met in part by state employees in the counties that provide state services, as set forth in the section on Market Shares below.

Block 2 – Labor and Capital Demand

Labor Demand Equations

The productivity of labor depends on access to a labor pool. In this instance, we have chosen to use employment by occupation as the measure of access to the specialized labor pool. Thus, the variety effect on the productivity of labor by occupation is expressed in the following equation:

$$FLO_{j,t}^{k} = 1 \div \left[\sum_{l=1}^{m} \frac{EO_{j,t}^{l}}{EO_{j,t}^{u}} * \left(1 + cc^{l,k}\right)^{1-\sigma_j} \right]^{\frac{1}{1-\sigma_j}} \tag{2-1a}$$

$$RCW_{i,t}^{k} = 1 \div \left[\sum_{l=1}^{m} \frac{E_{i,t}^{l}}{E_{i,t}^{u}} * \left(1 + cc^{l,k}\right)^{1-\sigma_i} \right]^{\frac{1}{1-\sigma_i}} \tag{2-1b}$$

$FLO_{j,t}^{k}$ = Labor productivity for occupation type j that depends on the relative access to labor in occupation j in region k, time t.

$RCW_{i,t}^{k}$ = Relative labor productivity due to industry concentration of labor.

$EO_{j,t}^{l}$ = Labor of occupation type j in region l, time t.

σ_j = Elasticity of substitution (i.e. cost elasticity).

$cc^{l,k}$ = Commuting time and expenses from l to k as a proportion of the wage rate.

$EO_{j,t}^{u}$ = Labor of occupation type j, national (u), time t.

$E_{i,t}^{l}$ = Employment in industry i, time t, in region l.

m = Number of regions in model including the rest of the nation region.

The value of σ_j is based on elasticity estimates made by REMI under a grant from the National Cooperative Highway Research Program (Weisbrod, Vary, and Treyz, 2001) based on cross-commuting among workers in the same occupation observed in 1300 Traffic Analysis Zones in Chicago. Key data inputs on travel times were provided by Cambridge Systematics, Inc.

In order to determine labor productivity changes by industry due to access to variety, a staffing pattern matrix is used as follows:

$$Fl_{i,t}^{k} = \left[\left[\left(\sum_{j=1}^{q} d_{j,i} * FLO_{j,t}^{k} \right) + RCW_{i,t}^{k} \right] \div 2 \right] \div FL_{i,T}^{k} \tag{2-1c}$$

$Fl_{i,t}^{k}$ = Labor productivity due to labor access to industry and relevant occupations by industry i, in region k, time t, normalized by $Fl_{i,T}^{k}$

$d_{j,i}$ = Occupation j's proportion of industry i's employment.

$FLO_{j,t}^{k}$ = The labor productivity for occupation j, region k, time t.

q = The number of occupations in industry i.

$FL_{i,T}^{k}$ = Labor productivity due to access by industry i in region k in the last year of history.

$RCW_{i,t}^{k}$ = Relative labor productivity due to industry concentration of labor.

Relative labor intensity is determined by the following equation based on Cobb-Douglas technology and the assumption that the optimal labor intensity is chosen when new equipment is installed.

$$L^k_{i,t} = L^k_{i,t-1} + \frac{I^k_{nrs,t}}{K^k_{nrs,t}} * \left[\underbrace{\left(RLC^k_{i,t}\right)^{b_{l,t}-1}\left(RCC^k_{i,t}\right)^{b_{j,t}}\left(RFC^k_{i,t}\right)^{b_{f,t}}}_{h^k_{i,t}} - L^k_{i,t-1} \right] \qquad (2\text{-}2)$$

$L^k_{i,t}$ = Relative labor intensity, industry i, time t, region k.

$b_{ji,t}$ = Contribution to value added of factor j, (labor, capital, and fuel respectively), industry i, time t, region k.

$I^k_{nrs,t}$ = Nonresidential investment, region k, time t.

$K^k_{nrs,t}$ = Nonresidential capital stock, region k, time t.

$RCC^k_{i,t}$ = Relative capital cost, industry i, time t, region k.

$RLC^k_{i,t}$ = Relative labor cost, industry i, time t, region k equals $\left(CR^k_{i,t} / CR^u_{i,t} \right)$, before accounting for labor productivity effects.

$RFC^k_{i,t}$ = Relative fuel cost industry i, time t, region k.

$h^k_{i,t}$ = Optimal labor intensity, industry i, time t, region k.

Simplified, the above equation can be written as,

$$L^k_{i,t} = L^k_{i,t-1} + \left(\frac{I^k_{nrs,t}}{K^k_{nrs,t}} \right) * \left(h^k_{i,t} - L^k_{i,t-1} \right) \qquad (2\text{-}3)$$

Where;

$$EPV^k_{i,t} = \frac{L^k_{i,t}}{L^k_{i,T}} * \left(\frac{E^k_{i,T}}{Q^k_{i,T}} * \frac{E^u_{i,t}/Q^u_{i,t}}{E^u_{i,T}/Q^u_{i,T}} \right) * (FI^k_{i,t})^{-\alpha_i} * epvindx_{i,t} \qquad (2\text{-}4)$$

$EPV^k_{i,t}$ = Employees per dollar of output in industry i, time t, region k.

$L^k_{i,t}$ = Labor intensity due to relative factor costs, industry i, time t, region k.

$E^u_{i,t} / Q^u_{i,t}$ = Employees per dollar of output in the nation (u) in time t.

α_i = Labor share of industry i.

$Fl^{k}_{i,t}$ = Labor productivity due to labor access by industry i, time t, divided by $FL^{k}_{i,T}$

$E^{u}_{i,T} / Q^{u}_{i,T}$ = Employees per dollar of output in the nation *(u)* in the last history year.

$E^{k}_{i,T} / Q^{k}_{i,T}$ = Employees per dollar of output in region k in the last history year.

Where;

$$Q^{k}_{i,T} = \frac{WSD^{k}_{i,T}}{WSD^{u}_{i,T}} * Q^{u}_{i,T} \tag{2-4a}$$

$L_{i,T}$ = Labor intensity due to relative factor costs in industry i in the last history year (T).

$epvindx_{i,t}$ = Change in region's detailed industry mix relative to the nation since the last year of history (=1 if detailed industry national forecast is not used).

In a multi-industry model, total employment in the area can be divided into three categories consisting of private non-farm industries, employment in the farm sector, and employment in government. Government is further divided into employment in state and local government sectors, and employment in federal civilian and military sectors. Output in private non-farm industries is determined by demand for inputs into the production process (intermediate demand) and demand from personal consumption, government, investment, and exports (final demand), and employees per unit of output (EPV_i). The equation for employment in private industry i for the single area model is

$$E_i = EPV_i * (QLI_i + QLC_i + QLG_i + QLINV_i + QXRMA_i + QXROU_i + QXROW_i)$$

$$i = 1,\ldots,n \tag{2-5}$$

Where;

$QLI_i \left(= \Sigma_j s^{k,k}_i * \alpha^{l}_{i,j} * Q_j\right)$ are sales of industry i's product dependent on local intermediate demand, $QLC_i \left(= s^{k,k}_i * C_i\right)$ are sales dependent on local consumer demand, $QLG_i \left(= s^{k,k}_i * G_i\right)$ are sales dependent on local and on state government demand, $QLINV_i \left(= s^{k,k}_i * IL_{p,i}\right)$ are sales dependent on local investment, and $QXRMA_i$ are sales to other areas in the in the multi-area model. $\sum_{l}^{n-1} s^{k,l}_i * D^l$ and $QXROU_i$ are sales to the rest of the nation, and $QXROW_i$ are sales to the rest of the world.

Federal government employment in the local area is a fixed proportion of government employment in the nation, based on the last observed proportion. The equations for federal civilian employment and federal military employment are

$$EG^k_{FC,t} = \frac{EG^k_{FC,T}}{EG^u_{FC,T}} * EG^u_{FC,t} \quad (2\text{-}6)$$

$$EG^k_{FM,t} = \frac{EG^k_{FM,T}}{EG^u_{FM,T}} * EG^u_{FM,t} \quad (2\text{-}7)$$

Where;

$EG^k_{FC,t}$ = Federal civilian employment in area k in time t (where T is the last history year)

$EG^k_{FM,t}$ = Federal military employment in area k in time t (where T is the last history year)

^{u} = As a superscript, denotes the federal union area.

State (EG_s) and local government (EG_L) employment are based on estimated output per state or local government employee. In the absence of such regional data the national average is used as the ratio of state and local output to state and local government employment. Changes in per capita state and local government in the U.S. and changes in the population that is served by state and/or local government drive state and local employment. Thus, non-farm employment, ENF, is

$$ENF = \sum_{i=1}^{n} E_i + EG_L + EG_S + EG_{F,C} + EG_{F,M} \quad (2\text{-}8)$$

Farm employment is estimated as a fixed share of national farm employment based on the last year of history. The equation for total employment (TE) is

$$TE = ENF + EF \quad (2\text{-}9)$$

Where EF is farm employment.

Capital Demand Equations

The optimal capital stock equation for non-residential structures (j=1) is:

$$K^{k^*}_{1,t} = \left(\frac{\sum_{i=1}^{n} kw_{i,t} * RLC^k_{i,t}}{\sum_{i=1}^{n} kw_{i,t} * RCC^k_{i,t}} \right) * \frac{AE^k_t}{AE^u_t} * K^{u*}_{1,t} * KP^k_1 \quad (2\text{-}10)$$

$K^{k^*}_{1,t}$ = Optimal capital stock for non-residential structures (j), time t, region k.

$kw_{i,t}$ = Industry i's share of total capital stock, time t.

$RLC^k_{i,t}$ = Relative labor cost, industry i, time t, region k

$RCC^k_{i,t}$ = Relative capital cost, industry i, time t, region k.

AE^k_t = Employment weighted by capital use, time t, region k (used instead of employment because the variation in capital use per employee across industries is very large).

AE^u_t = Capital weighted employment, time t, national capital per employee in the industry and adjustment for labor productivity.

$K^{u*}_{1,t}$ = National optimal capital stock for non-residential structures (j), time t.

KP^k_j = Capital preference parameter, for non-residential structures (j), region k, if calculated (otherwise = 1).

The term of $\sum kw_i * RLC_i$ (or $\sum kw_i * RCC_i$), in equation 2-10 above, is the average relative compensation rate (or average relative capital cost) weighted by capital in use. The equation used to determine the variable AE is

$$AE = \sum_{i=1}^{n} \frac{K^u_i \div TK^u}{E^u_i \div TE^u} * E_i * (FL_i)^\alpha = \sum_{i=1}^{n} kwe_i * E_i * (FL_i)^\alpha \qquad (2\text{-}11)$$

kwe_i = The average capital per employee in the u area

In equation 2-11, AE is the capital using economic activity in employment terms. $TK^u\left(=\sum K^u_i\right)$ and $TE^u\left(=\sum E^u_i\right)$ are total capital and total employment in the nation. It is necessary to use AE instead of E in equation 2-10, because the variation in capital use per employee across industries is very large. The term FL_i in equation 2-11 shows relative labor productivity based on labor force availability raised to labor share to reflect labor substitution for capital.

The optimal capital stock for residential housing (j=2) is based on the following equation:

$$K^{K*}_{2,t} = \left(RYD^K_t \big/ RYD^u_t \right) K^{u*}_{2,t} * KP^k_j \qquad (2\text{-}12)$$

Where $RYD^K_t \big/ RYD^u_t$ shares out the optimal national residential capital stock, based on the proportion of real disposable income in the region. The optimal capital stock of the nation for type $j(j=1,2)$ capital $\left(K^{u*}_{j,t}\right)$ is determined from equation 2-13.

$$K_{j,t}^{u*} = \left({I_{j,t}^{u}} \big/ {\alpha_j} \right) + \left(1 - dr_{j,t}^{u}\right) K_{j,t-1}^{u} \qquad (2\text{-}13)$$

Thus, if we know the speed (α_j) at which investment fills the gaps between the optimal $(K_{j,t}^{u*})$ and actual capital stock $(K_{j,t}^{u})$, and we know investment in the nation $(I_{j,t}^{u})$ and the depreciation rate of capital $(dr_{j,t}^{u})$, we can determine the optimal capital stock $(K_{j,t}^{u*})$.

Demand for Fuel

Demand for fuel is not explicit in the model. As evident in equation (2-2), the cost of fuel does enter the demands for labor and capital and plays an important role in the model. The treatment of fuel is unique in that the detailed intermediate outputs for oil and gas extraction, coal mining, petroleum and coal products manufacturing, electric power generation, transmission and distribution, and natural gas distribution are excluded from the intermediate industry transactions and treated as a value added factor for purposes of calculating relative costs and labor intensity. As value added factors, fuel, capital, and labor are the Cobb-Douglas substitutes in the production function.

Block 3 – Population and Labor Supply

Population

The population block includes a full cohort-component equation by single year of age, by gender, and by racial/ethnic group. The population at time *t* in region *l* equals the starting population, i.e. the population in the last time period *t-1*, plus components of population change: births, deaths, interregional retired migrants and economic migrants, and international migrants. The components of population change are estimated first based on assumptions of survival rates, fertility rates, and level of net inflow of migrants. When the population estimation is advanced for another year, each age group is updated for one age-year with effects of mortality and interregional and international migration; and a new birth cohort is added in as population of age 0 by applying fertility rates to female population aged 10 to 49. Special population, including military and dependents, prisoners, and college students, do not age. Thus, special population are taken out before aging the population and added back after everyone else is aged.

The population for region *l* at time *t* is

$$Pop_t^l = Pop_{t-1}^l + Births_t^l - Deaths_t^l + RTMIG_t^l + ECMIG_t^l + IntMIG_t^l \qquad (3\text{-}1)$$

where

Pop_t^l = The population in region *l* at time *t*.

$Births_t^l$ = The number of births during the time period *t-1* to *t* in region *l*.

$Deaths_t^l$ = The number of deaths during the time period *t-1* to *t* in region *l*.

$RTMIG_t^l$ = The net inflow of interregional retired migrants to region *l* during the time period *t-1* to *t*.

$ECMIG_t^l$ = The net inflow of interregional economic migrants to region *l* during the time period *t-1* to *t*.

$IntMIG_t^l$ = The net inflow of international migrants to region *l* during the time period *t-1* to *t*.

Births are determined by applying age-specific fertility rates to the starting female population in each relevant age group, net female international migrants, and net female economic migrants. The international migrants and economic migrants are divided by 2 because they are assumed to have lived in the regional for a half year on average. Births are specific by area and race/ethnicity.

$$Births_t^l = \sum_r^m \sum_i^n (FePop_{i,r,t-1}^l + FeIntMIG_{i,r,t}^l / 2 + FeECMIG_{i,r,t}^l / 2) \times FRate_{i,r,t}^l \quad (3\text{-}2)$$

where

$FePop_{i,r,t-1}^l$ = The female population of age *i* (*i*=10,…,49+) and race/ethnicity *r* (*r*=1,2,..,4) at time *t-1* in region *l*.

$FeIntMIG_{i,r,t}^l$ = The female international migrants of age *i* and race/ethnicity *r* during the time period *t-1* to *t* in region *l*.

$FeECMIG_{i,r,t}^l$ = The female economic migrants of age *i* and race/ethnicity *r* during the time period *t-1* to *t* in region *l*.

$FRate_{i,r,t}^l$ =The fertility rate for female population of age *i* and race/ethnicity *r* during the time period *t-1* to *t* in region *l*.

Deaths are determined by applying mortality rates to the sum of starting population, international migrants retired migrants, and economic migrants. Similar to the calculation of births, international migrants, retired migrants, and economic migrants are assumed to have lived in the region for a half year on average. The mortality rate is calculated by 1 minus the survival rate. The estimated deaths are specific by age, racial/ethnic group, and gender.

$$Deaths_t^l = \sum_g^2 \sum_r^m \sum_i^n (Pop_{g,r,i,t-1}^l + IntMIG_{g,r,i,t}^l / 2 + RTMIG_{g,r,i,t}^l / 2 + ECMIG_{g,i,r,t}^l / 2) \times (1 - SRate_{g,r,i,t}^l)$$

(3-3)

where

$Pop^l_{g,r,i,t-1}$ = The population of gender *g* (*g*= male, female), race/ethnicity *r* (*r*=1,2,..,4), and age *i* (*i*=0,1,…,100+)at time *t-1* in region *l*.

$IntMIG^l_{g,r,i,t}$ = The international migrants of gender *g*, race/ethnicity *r*, and age *i* during time *t-1* to *t* in region *l*.

$RTMIG^l_{g,r,i,t}$ = The international migrants of gender *g*, race/ethnicity *r*, and age *i* during time *t-1* to *t* in region *l*.

$ECMIG^l_{g,r,i,t}$ = The international migrants of gender *g*, race/ethnicity *r*, and age *i* during time *t-1* to *t* in region *l*.

$SRate^l_{g,r,i,t}$ = The survival rate for population of gender *g*, race/ethnicity *r*, and age *i* at time *t*.

Retired migrants are based in part by migration patterns for people at and above retirement age 65. In particular a "risk" probability model is used. For areas that experienced an inflow of retired migrants, the probability of a person over age 65 moving into the area is based on the proportion of that population captured in the past. This probability is applied each year in the future to the population age 65 and above in the nation. For areas experiencing net outward migration of the retired population, the past proportion of loss is applied to the number of people in the local area that are age 65 and older. When the data supports it, the above-65 population can be divided into gender and age categories.

In particular, the equation for retired migrants is

$$RTMIG^l_i = rm^l_i\left((1 - RTDUM_i) * N^l_i + RTDUM_i * N^u_i\right) \qquad (3\text{-}4)$$

Where;

$RTMIG^l_i$ = The net inflow or outflow of migrants of age *i* (*i*=65,66, …100+) to region *l*

rm^l_i = The net proportion of the relevant population that has historically migrated into or out of area *l*.

N^l_i = The 65 and above population in area *l*.

N^u_i = The 65 and above population in area *u*.

$$RTDUM_i = \begin{cases} 1 \text{ if } rm^l_i > 0 \\ 0 \text{ if } rm^l_i < 0 \end{cases}$$

The economic migration equation in the model is very important to forecasting the effects of alternative policies. It is based on the assumption that economic migrants will make their migration decisions based on the relative expected after-tax real earned income in alternative locations and the relative amenity attractiveness of these locations.

The migration equation is

$$ECMIG_t^l = \left[\lambda^l + \beta_1 \ln\left(REO_t^l\right) + \beta_2 \ln\left(RWR_t^l\right) + \beta_1 \ln\left(MIGPROD_t^l\right)\right] * LF_{t-1}^l \qquad (3\text{-}5)$$

Where;

$ECMIG_t^l$ = Net economic migrants (all migrants less than 65 years of age) in area *l*.

LF_{t-1}^l = The labor force last period in area *l*.

$REO_t^l = \dfrac{RAE_t^l / LF_t^l}{RAE_t^u / LF_t^u}$ = The relative employment opportunity in area *l* in period *t*.

RAE_t^l = Residence-adjusted employment in area *l* in period *t*.

If commuter data is available and consistent with the flow of residence adjusted income, residence adjusted employment (*RAE*) is calculated by subtracting gross employees in (GEI) from and adding gross employees out (GEO) to the total number of non-military jobs in the region:

$$RAE_t^l = (EMPT_t^l - EMP_t^{uFM,l}) - GEI_t^l + GEO_t^l \qquad (3\text{-}6)$$

If no commuter data is available or it is not consistent with the flow of residence adjusted income, residence adjusted employment (*RAE*) is calculated by scaling the non-military jobs in the region by the share of residence adjustment (RA) relative to total labor and proprietor's income (YLPT):

$$RAE_t^l = (1. + (RA_t^l / YLPT_t^l)) * (EMPT_t^l - EMP_t^{uFM,l}) \qquad (3\text{-}7)$$

$MIGPROD_t^l$ = The consumption access index in area *l* in period *t*.

$$RWR_t^l = \left(\frac{CR_t^l}{CR_t^u}\right) * \left(\frac{RYD_t^l / YP_t^l}{RYD_t^u / YP_t^u}\right)$$ = The relative real compensation rate in area *l* in period *t*. (3-8)

$CR_t^l = \sum_{i=1}^{n} \frac{E_{i,t}^l}{TE_{i,t}^l} * C_{i,t}^l$ = Local average compensation rate (3-9)

$CR_t^u = \sum_{i=1}^{n} \frac{E_{i,t}^l}{TE_{i,t}^l} * C_{i,t}^u$ = (*u*) average industry compensation weighted by the employment industry shares in *l*.

λ^l = A fixed effect that captures the relative attractiveness of area *l*.

β_1, β_2 = Estimated coefficients.

The total number of economic migrants is distributed to age, gender, and ethnicity cohorts based on a national distribution.

Labor Force Equations

$$LF_t^k = \sum_{i=I}^{n} PR_{i,t}^k * COH_{i,t}^k \tag{3-10}$$

$$PR_{i,t}^k = \beta_1^k * \left(REA_t^k\right)^{\beta_2} * \left(RWR_t^k\right)^{\beta_3} * PR_{i,t}^u \tag{3-11}$$

Where;

$PR_{i,t}^k$ = The participation rate (i.e. the proportion of the relevant population that is in the labor force).

LF_t^k = The labor force in area *k*.

$COH_{i,t}^k$ = The number of people in cohort *i* in area *k*.

β_1^k = The fixed effect for area *k*.

β_2, β_3 = The parameters estimated on the basis of pooled or national time series.

$REA_t^k = {EA_t^k}/{EA_t^u}$

$EA_t^k = EA_{t-1}^k + \lambda_E\left(EO_t^k - EA_{t-1}^k\right)$

$EA_t^u = EA_{t-1}^u + \lambda_E\left(EO_t^u - EA_{t-1}^u\right)$

EO_t^u = A synthetic labor force based on the local population at fixed national participation rates.

EO_t^k = The Residence Adjusted Employment.

RWR_t^k = The relative real compensation rate.

λ_E = An estimated parameter $0 < \lambda_E < 1$.

The β values by age cohorts, gender, and racial/ethnic groups have been estimated for 160 (20x2x4) age cohorts in the U.S. The β_1^k parameter is a fixed effect for area *k* calibrated to the measured labor force (see Treyz, Christopher, and Lou, 1996).

Block 4 – Compensation, Prices and Costs

Production Costs

$$\Omega_i^k = \left[\left(\frac{CADJ_i^k}{CR_i^u} \right)^{b_{1i}} * \prod_{j=2}^{6} \left(\frac{FC_j^k}{FC_j^u} \right)^{b_{j,i}} * \sum_{j=1}^{6} a^u_{j,i} + \sum_{j=7}^{n} a^I_{j,i} * CP_{i,T}^k \left(\frac{CIFP_{i,t}^k}{CIFP_{i,T}} \right) \right] * LAMOMG_{i,T}^k \quad (4\text{-}1)$$

Where;

Ω_i^k = The composite cost of production. (This is a composite cost because it incorporates productivity change due to access to material inputs).

$CADJ_i^k = CR_i^k \Big/ \left[\left(FLA_{i,t}^k \div FL_{i,T}^k \right) Flmult_i^k \right]$ = The productivity adjusted compensation rate in area *k*.

CR_i^k = The compensation rate in *k*.

FLA_i^k = The moving average of labor productivity in *k* in period *t* divided by $FL_{i,T}^k$.

$$FLA_{i,t}^k = (1 - \lambda) FL_{i,t}^k + \lambda FLA_{i,t-1}^k$$

$\lambda = 0.8$ = speed of adjustment for moving average

FC_j^k = $j = 2$, the price of structures; $j = 3$, the rental price of equipment; $j = 4, 5, 6$, the price of electricity, natural gas, and residual fuel, respectively.

$b_{j,i}$ = Contribution to value added of factor *j*, industry *i* as a proportion of all factor inputs.

$CADJ_i^u$ = The productivity-adjusted compensation rate in the nation (*u*).

$a_{j,i}^I$ = The proportion of input *j* in all the intermediate inputs modified by changes in the industry access effect of material input productivity (see equation 1-3).

$Flmult_i^k$ = An adjustment to reconcile the aggregated data to the primary source data.

$LAMOMG_{i,T}^k$ = An adjustment for aggregation and normalization in the last history year (*T*).

$\sum a_{j,i}^u$ = The proportion of all factor inputs in the total inputs into production.

$$CP_{i,t}^k = CP_{i,T}^k * \frac{CIFP_{i,t}^k}{CIFP_{i,T}^k} * \frac{1}{MCPRODA_{i,t}} \quad (4\text{-}2)$$

$CP_{i,T}^k$ = The composite input cost based on composite prices calculated in the database at the smallest geographic size available.

$CIFP^k_{i,t}$ = The delivered average price. The local share of the price includes the composite price of production because it is based on the productivity of the inputs due to access to those inputs.

Delivered Prices

$$CIFP^k_{i,t} = \left[\frac{\prod_{j=1}^{m} \left(\Omega^j_{i,t} * \left(ED^{j,k}_{i,t} \right)^{\gamma_i} \right)^{\frac{T^{j,k}_{i,t-1}}{D^k_{i,t-1}}}}{\prod_{j=1}^{m} \left(\Omega^j_{i,t-1} * \left(ED^{j,k}_{i,t-1} \right)^{\gamma_i} \right)^{\frac{T^{j,k}_{i,t-1}}{D^k_{i,t-1}}}} \right] * CIFP^k_{i,t-1} \tag{4-3}$$

Where;

$CIFP^k_{i,t}$ = The weighted average of the delivered prices of good i sold in k in time period t.

Ω^j_i = The cost of producing output in industry i sold in k.

$T^{j,k}_i$ = The trade flow for good i from j to k.

$ED^{j,k}_i$ = The "effective distance" from j to k for good i.

γ_i = A parameter that is estimated based on observed actual transportation costs.

Cost of Equipment

$$PEQP^l = \sum_{i=1}^{n} a^u_{i,EQP} CP^l_i \tag{4-4}$$

Where;

$PEQP^l$ = The cost of producers' durable equipment in l.

$a^u_{i,EQP}$ = industry i input to the final demand for producers' durable equipment.

$$rec_{equi} = \left(\frac{CEQP^k_x}{CEQP^u} \right) PEQP^k \tag{4-5}$$

$CEQP$ = Implicit rental cost of equipment for each dollar of equipment.

rec_{equi} = Relative implicit rental capital cost of equipment at local purchase prices for equipment.

Consumption Deflator

For consumption category j in time t we assume Cobb-Douglas substitutability of the sectors that are inputs into this consumption commodity.

$$CIFP_{j,t}^{l} = CIFP_{j,t}^{u} * \prod_{i} CIFP_{i,t}^{PCE_{i,j}} \tag{4-6}$$

Where;

$PCE_{i,j}$ = The proportion of commodity *j* obtained from industry *i*.

$CIFP_{j,t}^{l}$ = The delivered (*CIF*) consumer price of consumption commodity *j* in time *t* in area *l*.

$CIFP_{j,t}^{u}$ = The average delivered (*CIF*) consumer price of consumption commodity *j* in time *t* in the nation or larger monetary areas.

$CIFP_{i,t}^{l}$ = The delivered (*CIF*) price of industry *i* in region *l* in time *t*.

Consumer Price Index Based on Delivered Costs

$$CIFP_{t}^{l} = \left(\prod_{j=1}^{r} \left({CIFP_{j,t}^{l}} \Big/ {CIFP_{j,t-1}^{l}} \right)^{WC_{j,t-1}^{u}} \right) * CIFP_{t-1} \tag{4-7}$$

Where;

$CIFP_{t}^{l}$ = The consumer price index in region *l*.

$WC_{j,t}^{u}$ = The proportion of commodity *j* in time *t* in the total union of regions consumption.

$CIFP_{j,t}^{l}$ = The CIF consumer price of consumer commodity *j* in region *l*.

Consumer Price to be Used for Potential In or Out Migrants

$CIFPH_{t}^{l}$ = Equation (4-7) with the housing cost replaced by relative price of purchasing a house.

$CIFP_{j}^{l} = PH_{t}^{l}$

Where;

PH_{t}^{l} = Relative housing price at time *t* in area *l*.

$CIFP_{t}^{l}$ = The cost of living in area *l* when the relative price of buying a new house is used in the consumer price index for housing costs.

Housing Price Equations

The REMI housing price equation has two coefficients for all regions in the model: the estimated elasticity of response to a change in real disposable income and the estimated elasticity of response to a change in population. Both of these coefficients are currently based on state or metropolitan-level averages and used as standard default elasticity measurements evident in the Housing Price equation below.

$$PH_t = \left\{ \left(\varepsilon_1 \left(\frac{RYD_t \div RYD_t^u}{RYD_{t-1} \div RYD_{t-1}^u} - 1 \right) + \varepsilon_2 * \left(\frac{N_t \div N_t^u}{N_{t-1} \div N_{t-1}^u} - 1 \right) \right) + 1 \right\} * PH_{t-1} \qquad (4\text{-}8)$$

PH = Relative housing price.

RYD =Real disposable income.

ε_1 = the estimated (or user-entered) elasticity of response to a change in real disposable income.

ε_2 = the estimated (or user-entered) elasticity of response to a change in population.

N = Population.

N^u = Population in u.

The values of ε_1 and ε_2 are estimated for each state and metropolitan area through a regression analysis that compares the housing price changes to the number of houses using data from a historical time series. The user may also enter alternative values.

The region-specific approach estimates price responses to changes in demand, which vary by state or metropolitan-level area. Changes in demand have been estimated using building permit and housing unit data from Freddie Mac, Conventional Mortgage Home Price Index, State Indices.

The region-specific approach scales the previously estimated national housing price response according to the proportion of the regions' price response to the average U.S. price response. This may more accurately reflect the regions' change in demand, and will therefore yield a more accurate forecast.

The Compensation Equation

The final form of the compensation rate (CR) equation for area l is

$$CR_{i,t}^l = \left[\left(1 + \Delta CRD_{i,t}^l\right)\left(1 + k_t^u\right) \right] * CR_{i,t-1}^l \qquad (4\text{-}9)$$

Where;

$CR_{i,t}^l$ = Compensation rate in industry i in time t.

$\Delta CRD_{i,t}^l$ = The predicted change in the compensation rate in industry i due to changes in demand and supply conditions in the labor market in area l.

k_t^u = The change in the national compensation rate that cannot be explained by changes in the national (u) average compensation rate for all industries, which is due to change in demand and supply conditions and to industry mix changes in the nation.

$$\Delta CRD_{i,t}^{l} = \alpha_1\left[\left(\frac{E_t^l}{LF_t^l} \div \frac{EA_t^l}{LFA_t^l}\right)-1\right]+\alpha_2\left[\left(\frac{EO_{i,t}^l}{EOA_{i,t}^l}\right)-1\right] \qquad (4\text{-}10)$$

LF_t^l = The labor force.

LFA_t^l = A geometrically declining moving average of the labor force.

$$LFA_t^l = .2LF_t^l + .8LFA_{t-1}^l \qquad (4\text{-}11)$$

α_1 = Estimated parameter using pooled time series data.

α_2 = Estimated parameter using pooled time series data.

$$EA_t^l = (1-\lambda)E_t^l + \lambda EA_{t-1}^l \qquad (4\text{-}12)$$

$$\frac{EO_{i,t}^l}{EOA_{i,t}^l} = \sum_{j=1}^{q} d_{i,j}\frac{EO_{j,t}^l}{EOA_{j,t}^l} \qquad (4\text{-}13)$$

${EO_{i,t}^l}/{EOA_{i,t}^l}$ = The demand relative to past demand for the occupations used by industry *i*.

$$EOA_{j,t}^l = (1-\lambda)EO_{j,t}^l + \lambda EOA_{j,t-1}^l \qquad (4\text{-}14)$$

$d_{j,i}$ = Occupation *j*'s proportion of industry *i*.

$\lambda = 0.8$ = speed of adjustment for moving average

$$\Delta CRD_{i,t}^{u} = \alpha_1\left[\left(\frac{E_t^u}{LF_t^u} \div \frac{EA_t^u}{LFA_t^u}\right)-1\right]+\alpha_2\left[\left(\frac{EO_{i,t}^u}{EOA_{i,t}^u}\right)-1\right] \qquad (4\text{-}15)$$

Then, it is possible to predict the demand and supply effect on national (*u*) compensation and thus determine the national compensation change by industry.

Since

$$CR_{i,t}^u = (1+\Delta CRD_{i,t}^u) * CR_{i,t-1}^u \qquad (4\text{-}16)$$

The average compensation in year *t* in the nation (*u*) area, taking into account the change in the mix of industries as well as demand and supply labor market conditions, can be calculated as follows:

$$CRDM_t^u = \sum_{j=1}^{n} \frac{E_{i,t}^u}{E_t^u}\left(1 + \Delta CRD_{i,t}^u\right) * CR_{i,t-1}^u \tag{4-17}$$

Where;

$CRDM_t^u$ = The average compensation in the year t based on year t compensation mix changes, demand change for occupations, and demand vs. supply in the labor market.

$E_{i,t}^u$ = Employment in industry i in period t in the nation (u) area.

$E_t^u = \sum_{i=1}^{n} E_{i,t}^u$

Then k_t^u is determined as:

$$k_t^u = \frac{\left(\left(COMP_t^u \big/ E_t^u\right) - CRDM_t^u\right)}{\left(\left(COMP_{t-1}^u \big/ E_{t-1}^u\right)\right)} \times \frac{\left(\Sigma E_{i,t}^u * CR_{i,t-1}^u\right) \big/ E_{t-1}^u}{\left(\Sigma E_{i,t-1}^u * CR_{i,t-1}^u\right) \big/ E_t^u} \tag{4-18}$$

Where;

$COMP_t^u$ = Compensation in the nation (u) area in time period t.

k_t^u = all national (u) compensation changes not represented by changes in industry mix and labor market demand and supply conditions, relative to the hypothetical average compensation in t-1, using the u compensation rate for each industry in year t-1 and the current year's industry mix. This value, k, is then used in equation (4-9) to align the weighted average of the compensation changes over all of the component regions within the u area. Thus, the local areas will then reflect determinants of compensation changes, such as changes in labor market legislation, increased union militancy, cost of living adjustments, etc., at the u level, which are not due to labor force supply and demand changes or industry shifts.

The Wage and Salary Disbursements Equation

The wage equation follows the same form as the compensation equation, but the α_1 and α_2 parameters have been estimated separately so have different values.

The Earnings by Place of Work Equation

The earnings equation follows the same form as the compensation equation, but the α_1 and α_2 parameters have been estimated separately so have different values.

Block 5 - Market Shares

$$s_{i,t}^{k,l} = \frac{DQ_{i,T}^{k}\left(\frac{\Omega A_{i,t}^{k}}{\Omega A_{i,T}^{k}}\right)^{1-\sigma_i}\left(IMIX_{i,t}^{k}\right)^{\lambda_i}\left(ED_i^{k,l}\right)^{-\beta_i}}{\sum_{j=1}^{m} DQ_{i,T}^{j}\left(\frac{\Omega A_{i,t}^{j}}{\Omega A_{i,T}^{j}}\right)^{1-\sigma_i}\left(IMIX_{i,t}^{j}\right)^{\lambda_i}\left(ED_i^{j,l}\right)^{-\beta_i}} \tag{5-1}$$

$s_{i,t}^{k,l}$ = The share of the domestic demand in area l supplied by area k, for industry i in time period t.

$DQ_{i,T}^{k}$ = Domestic output in the last history year.

T = As a subscript, indicates the last history year.

$\Omega A_{i,T}^{k}$ = The cost of production in k in the last history year.

$\Omega A_{i,t}^{k}$ = The moving average of the cost of production in k.

$$\Omega A_{i,t}^{k} = (1-\lambda)\Omega_{i,t}^{k} + \lambda \Omega A_{i,t-1}^{k} \tag{5-2}$$

$\lambda = 0.8$ = speed of adjustment for moving average

ED = An effective distance equivalent to calibrate the model to detailed balanced trade flows at a low geographic level.

β_i = The distance decay parameter in a gravity model.

σ_i = The estimated price elasticity.

λ_i = A parameter between $0<\lambda_i<1$, as estimated econometrically, that shows the effect of the detailed industry mix on the change in k's share of the market due to differential growth rates predicted in u for the detailed industry and the difference in k's participation in these industries relative to u (see *IMIX* below).

For $l = 1,\dots m$ and n is the number of sub-national regions in the model. The value for σ_i is calculated by isolating movements along the demand curve. The movement along the curve yields an elasticity of substitution (σ_i) estimate. These estimates are obtained from a pooled non-linear search over all regions. The β_i value is found using a dynamic search for the distance decay parameter in a gravity model for each industry.

$$IMIX^k_{I,t} = \left\{ \frac{\left(\prod_{i \in I} \left(Q^u_{i,t} \big/ Q^u_{i,t-1} \right)^{wi^k_{i,t-1}} \right)}{\left(\prod_{i \in I} \left(Q^u_{i,t} \big/ Q^u_{i,t-1} \right)^{wi^u_{i,t-1}} \right)} \right\} IMIX_{I,t-1} \tag{5-3}$$

$$wi^k_{i,t-1} = \left(\frac{Q^k_{i,t-1}}{\sum_{i \in I} Q^k_{i,t-1}} \right) \qquad wi^u_{i,t-1} = \left(\frac{Q^u_{i,t-1}}{\sum Q^u_{i,t-1}} \right)$$

$$IMIX_{I,T} = 1$$

$IMIX$ = A variable using local shares at a detailed level in the numerator applied to u growth rates, and shares in the denominator applied to the same rates. Equals 1 if no detailed industry or forecasts are available.

$$sx^{k,row}_{i,t} = \frac{X^{k,row}_{i,T}}{X^{u,row}_{i,T}} * \left(\frac{\Omega A^k_{i,t}}{\Omega A^k_{i,T}} \right)^{1-\sigma_i} \tag{5-4}$$

Where;

$sx^{k,row}$ = Area k's share of national exports to the rest of the world (*row*).

$X^{k,row}_{i,T}$ = Area k's exports to the rest of the world in the last history year (T).

$X^{u,row}_{i,T}$ = The nation's (u) exports to the rest of the world in the last history year (T).

$\Omega A^k_{i,t}$ = A moving average (with geometrically declining weights) of the relative cost of production in time period t (T if the last history year of the series).

Q_i = Output of industry i.

$$sd^k_{i,t} = 1 - \left(\left(\frac{\frac{M^{l,row}_{i,T}}{M^{u,row}_{i,T}} * M^{u,row}_{i,t}}{D^l_{i,T}} \right) * \left(\frac{\Omega A^k_{i,T}}{\Omega A^k_{i,t}} \right)^{1-\sigma} * \left(\frac{\frac{D^l_{i,t}}{D^u_{i,t}}}{\frac{D^l_{i,T}}{D^u_{i,T}}} \right) \right) \tag{5-5}$$

Where;

$sd^l_{i,t}$ = The share of area l's demand for good i that is supplied from within the nation (u).

$M^{k,row}_{i,T}$ = area k's imports from the rest of the world in the last history year (T).

$M^{u,row}_{i,T}$ = imports of i into the nation (u) in the last history year (T).

For further information about the incorporation of the new economic geography as shown in this section and in section 4 above, please see Fan, Treyz, and Treyz, 2000.

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Economic Impact Study of the Proposed Grain Belt Express Clean Line Project

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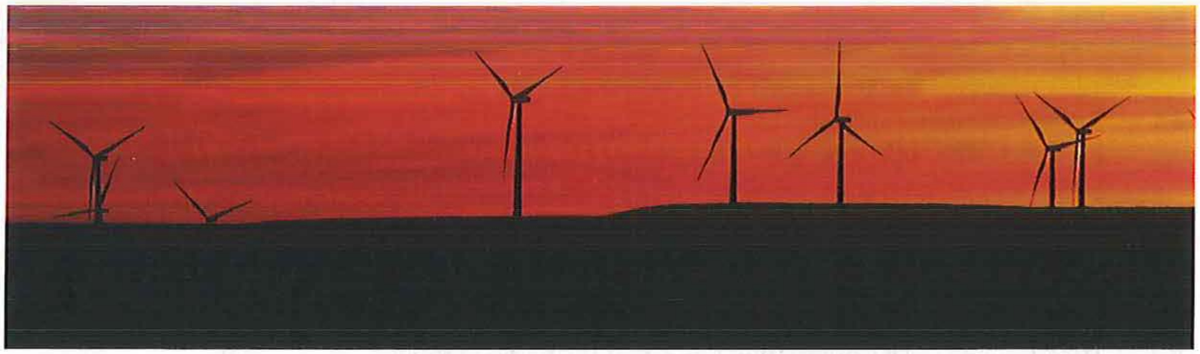

Photo by Jeff Cowell of Wichita, Kansas

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Executive Summary

Grain Belt Express Clean Line LLC ("Clean Line") is proposing to build the Grain Belt Express Clean Line, an approximately 700-mile, high voltage direct current transmission line that will connect wind resources in Kansas with energy demand centers in Missouri, Illinois, Indiana and states farther east. The construction of the proposed transmission line is expected to stimulate the construction of approximately 4,000 MW of additional wind farms in Kansas. This report summarizes the estimated impacts[1] of both the transmission line and the additional wind generation capacity.

We estimate that the construction of the Grain Belt Express Clean Line itself will – when we include the manufacturing of inputs to the line such as structures, wire, and real estate services – result in the creation of approximately 2,340 jobs per year for three years in Kansas, approximately 1,315 jobs per year for three years in Missouri, approximately 1,450 jobs per year for three years in Illinois, and approximately 38 jobs per year for three years in Indiana. In addition, the Grain Belt Express Clean Line will result in the creation of an estimated 296 permanent jobs stemming from operations and maintenance of the line, including 135 jobs in Kansas, 70 jobs in Missouri, 88 jobs in Illinois, and 3 jobs in Indiana. Fiscal impacts would also be substantial. During the three-year construction phase, individual income tax receipts, corporate income tax receipts, and sale tax receipts could average a combined total of $6.76 million per year in Kansas, $3.74 million per year in Missouri, $3.93 million per year in Illinois, and $74 thousand per year in Indiana.

Regarding the new wind farms that would serve the line, we estimate that the Grain Belt Express Clean Line could support as many as 33,618 manufacturing supply chain jobs in Kansas, Missouri, Illinois and Indiana ("the four-state region") during the construction phase and would result in the creation of approximately 528 permanent operations and maintenance jobs at those associated wind farms in Kansas. At the national level, economic impacts resulting from the construction of 4,000 MW of new wind generation capacity would include approximately 71,075 jobs during the construction phase and 3,360 jobs annually during the operating years.

Economic Impacts of Construction of the Grain Belt Express Clean Line

Construction

As seen in Table ES-1, when assuming 50 percent of manufacturing (structures and wire) and 100 percent of construction-related activities for the transmission line are completed by in-state firms in the four-state region, the potential total employment impact over the projected period would amount to approximately 5,143 jobs per year for three years. Projected income impacts are substantial as well; the total labor income impact over the projected period would amount to approximately $311.5 million per year for three years.

Table ES-1: Estimated Annual[1] Impacts of Construction of the Grain Belt Express Clean Line in 4-State Region

	Kansas	Missouri	Illinois	Indiana
Change in Final Demand[2]	$220.4	$118.1	$140.1	$3.3
Employment[3]	2,340	1,315	1,450	38
Labor Income	$131.5	$77.0	$100.8	$2.2
Output	$371.0	$206.0	$251.1	$5.7

1. Construction period = 3 years.
2. All spending and $ impacts are in millions of 2013 $ and are rounded.
3. All employment figures are full time equivalents.

[1] The impacts of construction and operation of the transmission line, including fiscal impacts—personal and corporate tax revenues—for Kansas, Missouri, Illinois, and Indiana presented here were estimated using the IMPLAN model. The labor, turbine, and supply chain impacts of construction and operation of the new wind farms that could result from construction of the proposed transmission line were estimated using the JEDI model.

Operation and Maintenance (O&M)

Clean Line estimates that annual operation and maintenance (O&M) costs, which will be incurred when the line is up and running, will amount to approximately one percent of total construction costs. In Kansas, this will result in $10.0 million in O&M expenditures each year. The corresponding amounts for Missouri, Illinois, and Indiana are $5.0 million, $7.0 million, and $0.2 million, respectively. As shown in Table ES-2, the total impacts of annual O&M expenditures in the four-state region are substantial. The potential total employment impact over the projected period would amount to approximately 296 jobs per year. The total labor income impact over the projected period would amount to approximately $18 million per year

Table ES-2: Estimated Annual O&M-Related Impacts of the Grain Belt Express Clean Line in 4-State Region

	Kansas	Missouri	Illinois	Indiana
Employment[1]	135	70	88	3
Labor Income[2]	$7.6	$4.1	$6.1	$0.19
Output	$17.7	$9.2	$13.1	$0.43

1. All employment figures are full time equivalents.
2. All monetary impacts are in millions of 2013 $ and are rounded.

Fiscal Impacts of the Grain Belt Express Clean Line

The IMPLAN model was used to estimate certain tax-related impacts of the projected increases in final demand in Kansas, Missouri, Illinois and Indiana. The tax impacts considered here include individual income tax, corporate income tax, and sales tax receipts. Referring to Table ES-3, it is estimated that in Kansas individual income tax receipts, corporate income tax receipts, and sale tax receipts could average a combined total of $6.76 million per year over the three-year construction period. In Missouri, Illinois, and Indiana the corresponding amounts are $3.74 million, $3.93 million, and $74 thousand per year over the three-year construction period.

Table ES-3: Estimated Fiscal Impacts of Construction of Grain Belt Express Clean Line in 4-State Region

	Kansas	Missouri	Illinois	Indiana
Individual Income Tax[1]	$8.47	$4.19	$4.18	$0.143
Corporate Income Tax	$1.17	$0.28	$1.12	$0.015
Sales Tax	$10.64	$6.75	$6.48	$0.063
Total	$20.28	$11.22	$11.78	$0.221
Annual Average[2]	$6.76	$3.74	$3.93	$0.074

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. Construction period = 3 years.

As was previously noted, once the transmission line is built and is in operation, O&M costs will contribute additional spending to the Kansas, Missouri, Illinois, and Indiana economies each year. Referring to Table ES-4, in Kansas individual income tax receipts, corporate income tax receipts, and sale tax receipts resulting from O&M expenditures are predicted to amount to approximately $379 thousand per year. In Missouri, Illinois, and Indiana the same revenue sources are predicted to yield approximately $189 thousand, $247 thousand, and $9 thousand per year, respectively.

Table ES-4: Summary of Estimated Annual Fiscal Impacts of O&M Expenditures

	Kansas	Missouri	Illinois	Indiana
Individual Income Tax[1]	$0.162	$0.074	$0.084	$0.004
Corporate Income Tax	$0.016	$0.004	$0.017	$0.000
Sales Tax	$0.201	$0.111	$0.146	$0.005
Total	$0.379	$0.189	$0.247	$0.009

1. All monetary impacts are in millions of 2013 $ and are rounded.

Economic Impacts of Additional Wind Generation Capacity

The construction of the Grain Belt Express Clean Line is expected to stimulate the development of approximately 4,000 MW of wind farms in Kansas. In order to model the economic impacts, it is assumed that the transmission line will connect eight new 500 MW wind farms to the transmission grid. All eight of the new wind farms will be located in Kansas. The JEDI model, which was used to estimate the economic impacts of the wind farms, contains default values for how these construction and operations and maintenance costs are allocated to the component parts. These default values, however, were not used to estimate the local content of the manufacture of the larger components of a wind turbine – the nacelle, tower, blades, and transportation. Instead, we based the allocation on the American Wind Energy

Association U.S. Wind Industry Annual Market Report 2012 conclusion that the domestic content of wind farms built in the United States rose to 67 percent at the end of 2011. Using 67 percent domestic content as a guideline, we estimated that 55 percent of the nacelles, 90 percent of the blades, and 90 percent of the structures used to construct wind farms would be manufactured in the United States.[2]

The assumed increase in wind development will yield economic benefits throughout the four-state region as a result of both direct expenditures on the construction of the wind farms and supply chain impacts resulting from the increased demand for the required inputs. To estimate the state-level economic impacts of the new wind generation capacity it was necessary to estimate the percentage of the wind turbine components that would be produced in each state. We constructed two different scenarios in which the four-state region provides either 30 percent or 90 percent of the domestic content. In each scenario, Kansas is assumed to provide half of the major wind turbine parts if the state is home to a current manufacturer of that component. The exact percentages by state and by component are reported in Table 4.5 on page 32.

Kansas

The total economic impact of the wind farms for the state of Kansas consists of two parts – (1) the economic impacts of the direct expenditures made in the state to build the 4,000 MW of wind farms located there, and (2) the supply chain impacts of the total 4,000 MW of wind farms that will be built in Kansas. Table ES-5 shows the total economic impact during the construction period in Kansas under the 30 percent and 90 percent scenarios. The total employment impacts during construction range from 15,542 to 19,656 jobs, and earnings range between $778.8 million and $1.026 billion. It is estimated that when the wind farms built in Kansas are up and running, they will generate 528 jobs and $25 million in earnings annually.

Table ES-5: Economic Impacts of Wind Farm Construction and Operation in Kansas

	Employment[1]	Earnings[2]	Output
Construction: 30% Scenario	15,542	$778.8	$2,283.5
Construction: 90% Scenario	19,656	$1,026.1	$3,267.7
Annual Operations: All Scenarios	528	$25.0	$73.3

1. All employment figures are full time equivalents.
2. All monetary impacts are in millions of 2013 $ and are rounded.

Missouri

The total economic impacts in Missouri of the wind farms constructed in Kansas include supply chain impacts and associated indirect effects. Table ES-6 shows the total economic impact during the construction period in Missouri under the 30 percent and 90 percent scenarios. The total employment impacts during construction range from 1,311 to 3,933 jobs, and earnings range between $79.8 million and $239.5 million under the 30 percent and 90 percent scenarios, respectively.

Table ES-6: Economic Impacts of Wind Farm Construction in Missouri

	Employment[1]	Earnings[2]	Output
30% Scenario	1,311	$79.8	$329.0
90% Scenario	3,933	$239.5	$986.9

1. All employment figures are full time equivalents.
2. All monetary impacts are in millions of 2013 $ and are rounded.

Illinois

The total economic impacts in Illinois of the wind farms constructed in Kansas include supply chain impacts and associated indirect effects. Table ES-7 shows the total economic impact during the construction period in Illinois under the 30 percent and 90 percent scenarios. The total

Table ES-7: Economic Impacts of Wind Farm Construction in Illinois

	Employment[1]	Earnings[2]	Output
30% Scenario	1,471	$104.0	$381.1
90% Scenario	4,412	$311.9	$1,143.4

1. All employment figures are full time equivalents.
2. All monetary impacts are in millions of 2013 $ and are rounded.

[2] See p.30 for a more detailed discussion of the estimation process that was used.

employment impacts during construction range from 1,471 to 4,412 jobs, and earnings range between $104.0 million and $311.9 million under the 30 percent and 90 percent scenarios, respectively.

Indiana

The total economic impacts in Indiana of the wind farms constructed in Kansas include supply chain impacts and associated indirect effects. Table ES-8 shows the total economic impact during the construction period in Indiana under the 30 percent and 90 percent scenarios.

Table ES-8: Economic Impacts of Wind Farm Construction in Indiana

	Employment[1]	Earnings[2]	Output
30% Scenario	1,872	$113.5	$472.5
90% Scenario	5,617	$340.6	$1,417.5

1. All employment figures are full time equivalents.
2. All monetary impacts are in millions of 2013 $ and are rounded.

The total employment impacts during construction range from 1,872 to 5,617 jobs, and earnings range between $113.5 million and $340.6 million under the 30 percent and 90 percent scenarios, respectively.

United States

The total economic impact of the wind farms for the United States consist of two parts – (1) the economic benefit of the direct expenditures made in Kansas to build the 4,000 MW of wind farms, and (2) the supply chain impacts. Table ES-9 shows the total economic impact during the construction period in the United States assuming 55 percent of the nacelles, 90 percent of the blades, and 90 percent of the structures used to construct wind farms are manufactured in the United States. The total employment impacts during construction amount to 71,105 jobs; earnings increase by $4.4 billion. It is estimated that when the wind farms built are up and running, they will generate 3,360 U.S. jobs and $191 million in earnings annually.

Table ES-9: Economic Impacts of Wind Farm Construction and Operation in the United States

	Employment[1]	Earnings[2]	Output
Total Construction Impact	71,075	$4,421.7	$15,160.5
Total Annual Operating Impacts: All Scenarios	3,360	$190.7	$981.4

1. All employment figures are full time equivalents.
2. All monetary impacts are in millions of 2013 $ and are rounded.

1 Background

Grain Belt Express Clean Line LLC ("Clean Line") is proposing to build the Grain Belt Express Clean Line, an approximately 700-mile, high voltage direct current transmission line that will connect approximately 4,000 MW of wind generation in Kansas with energy demand centers in Missouri, Illinois, Indiana and states east. This report summarizes the estimated economic impacts of the Grain Belt Express Clean Line, including both the impacts of construction and operation of the transmission line and manufacturing of inputs to the line – e.g., structures, wire, real estate services – and the impacts of construction and operation of the wind farms this transmission line would enable.

Transmission Line Impacts

The impacts of construction and operation of the transmission line were modeled using the IMPLAN model.[3] The specific impacts analyzed include direct, indirect, and induced effects on employment, income, and output, as well as fiscal impacts – personal and corporate tax revenues and sales tax receipts – for Kansas, Missouri, Illinois, and Indiana. All impacts are reported at the state level for Kansas, Missouri, Illinois, and Indiana. In addition, national estimates of the employment, income, and output impacts of increased spending in the four-state region are reported. All estimated impacts are based on cost of construction and cost of operation and maintenance estimates provided by Clean Line.

Wind Farm Impacts

The construction of the proposed transmission line is also expected to stimulate the construction of additional wind farms in Kansas. The impacts of construction and operation of these new wind farms were estimated using the JEDI model[4], and include direct, indirect, and induced effects for both Kansas and Illinois. All impacts are reported at the state level for Kansas, Missouri, Illinois, and Indiana. All estimated impacts are based on estimates of the number of new wind farms, location (state) of each wind farm, number of turbines, and size of turbines (MW) provided by Clean Line Energy Partners. Wind farm cost estimates for the construction costs and operation and maintenance costs were based on the JEDI model estimates. The local share of turbines, component parts, materials and personnel were based on JEDI model estimates and information provided by Clean Line.

1.1 Limitations of the Study

It is also important to note what the analysis of the impacts of construction and operation of the transmission line and new wind farms does not include, specifically,

- The *net effects* of the proposed project, i.e., the potential impacts on existing power generation facilities resulting from the development of the wind farms associated with the Grain Belt Express Clean Line;
- The economic costs of any pass-through rates or taxes that electric customers could be required to pay by utility companies purchasing energy from the Grain Belt Express Clean Line or the proposed wind farms;
- Any environmental impacts, costs, or benefits;
- The potential impacts on electric prices and generation costs or fuel prices;
- The potential impacts of regulations associated with renewable energy, and

[3] IMPLAN is a PC-based program that allows construction of regional input-output models for areas as small as a county. The model allows aggregation of individual county databases for multicounty analysis. IMPLAN was originally developed for the US Department of Agriculture and is maintained and supported by the Minnesota IMPLAN Group, Inc. Stillwater, Minnesota. IMPLAN is a widely recognized and respected tool for economic impact analysis.

[4] The JEDI model was developed by Marshall Goldberg, Ph.D. for the National Renewable Energy Laboratory and calculates the number of jobs and the amount of money spent on salaries and economic activities generated in a specific location from the construction and operation of a wind power plant. Because the JEDI model is based upon the IMPLAN model multipliers, the two methods of analysis are compatible. The JEDI model is used by most modelers of wind farm economic impacts.

- The *net effects* of increased demand for the components of the transmission line, construction of the line, operation and maintenance expenditures, and the construction and operations of new wind farms on employment, income, and output in the affected regions.

2 Methodology

The impacts of construction and operation of the transmission line were estimated using the IMPLAN model. The specific impacts analyzed include direct, indirect, and induced effects on employment, labor income, and output, as well as fiscal impacts – personal and corporate tax revenues and sales tax receipts – for Kansas, Missouri, Illinois, and Indiana. The construction of the proposed transmission line is also expected to stimulate the construction of additional wind farms in Kansas. The impacts of construction and operation of these new wind farms were estimated using the JEDI model, and include direct, indirect, and induced effects for the four-state region.

2.1 IMPLAN

The economic impacts of the manufacture of the required components, construction of the line, and operation and maintenance expenses were estimated using the IMPLAN model and 2011 data for Kansas, Missouri, Illinois, and Indiana. Stated briefly, the model is used to estimate the total impacts of an increase in spending in a particular industry. IMPLAN is a micro-computer-based program that allows construction of regional input-output models for areas ranging in size from a single zip code region to the entire United States. The model allows aggregation of individual regional, e.g., county, databases for multi-region analysis.

Total impacts are calculated as the sum of direct, indirect, and induced effects. *Direct effects* are production changes associated with the immediate effects of final demand changes, such as an increase in spending for the manufacture of new structures that will be used to support a new transmission line. *Indirect effects* are production changes in backward-linked industries caused by the changing input needs of the directly affected industry, e.g., additional purchases to produce additional output such as the steel used in the construction of the new transmission structures. *Induced effects* are the changes in regional household spending patterns caused by changes in household income generated from the direct and indirect effects. An example of the latter is the increased spending of the incomes earned by newly hired steel workers.

The analysis summarized here focuses on the impacts of increased manufacturing of the different components of the transmission line, as well as construction of the line, on employment, employee compensation, and total expenditures (output). Employment includes total wage and salary employees as well as self-employed jobs in the region of interest. All of the employment figures reported here are full-time equivalents[5] (FTE). Employee compensation represents income, including benefits, paid to workers by employers, as well as income earned by sole proprietors. Total output represents sales (including additions to inventory), i.e., it is a measure of the value of output produced. Impacts are estimated on a state-wide basis for Kansas, Missouri, Illinois, and Indiana, as well as for the United States as a whole.

2.2 JEDI

The economic analysis of wind power development presented here utilizes the National Renewable Energy Laboratory's (NREL's) latest (release number W1.10.03) Jobs and Economic Development Impacts (JEDI) Wind Energy Model. The JEDI Wind Energy Model is an input-output model that measures the spending patterns and location-specific economic structures that reflect expenditures supporting varying levels of employment, income, and output. For example, JEDI reveals how purchases

[5] IMPLAN jobs include all full-time, part time, and temporary positions. When employment is counted as full and part-time, one cannot tell from the data the number of hours worked or the proportion that is full or part-time. A full-time-employed (FTE) worker is assumed to work 2,080 hours (= 52 weeks x 40 hours/week) in a standard year. Employment impacts have been rescaled to reflect the change in the number of FTEs.

of wind project materials not only benefit local turbine manufacturers but also the local industries that supply the concrete, rebar, and other materials. The JEDI model uses construction cost data, operating cost data, and data relating to the percentage of goods and services acquired in the state to calculate jobs, earnings, and economic activities that are associated with this information. The results are broken down into the construction period and the operation period of the wind project. Within each period, impacts are further divided into direct, indirect, and induced impacts.

Direct impacts during the construction period refer to the changes that occur in the onsite construction industries in which the direct final demand (i.e., spending on construction labor and services) change is made. The initial spending on the construction and operation of the wind farm creates a second layer of "indirect" impacts. *Indirect impacts* during the construction period consist of the changes in inter-industry purchases resulting from the direct final demand changes, and include construction spending on materials and wind farm equipment and other purchases of goods and offsite services. Concrete that is used in turbine foundations increases the demand for gravel, sand, and cement. Turbine parts/component manufacturers such as bearing producers, steel producers, and gear producers are also in this same category. Indirect impacts during operating years refer to the changes in inter-industry purchases resulting from the direct final demand changes. All land lease payments and property taxes show up in the operating-years portion of the results because these payments do not support the day-to-day operations and maintenance of the wind farm but instead are more of a latent effect that results from the wind farm being present. *Induced impacts* during construction refer to the changes that occur in household spending as household income increases or decreases as a result of the direct and indirect effects of final demand changes. Induced impacts during operating years refer to the changes that occur in household spending as household income increases or decreases as a result of the direct and indirect effects from final demand changes.

3 Economic Impacts of the Grain Belt Express Clean Line

3.1 Relevant Economic Sectors

In this section we describe the sectors in which direct spending will increase as a result of construction of the proposed transmission line. These sectors include those engaged in the manufacture of structures and wire, those engaged in the actual construction of the transmission line and the installation of converters, the real estate sector, and financial and architectural services.

Clean Line estimates that purchasing the necessary inputs (e.g., structures, wire, and converters) and construction of the proposed transmission line will cost approximately $2.2 billion. Expenditures are expected to be spread roughly evenly over a three-year period. Table 3.1 summarizes the estimated costs of each of the major components of the line – structures, wire, and converters – as well as the costs of constructing the line, including the cost of acquiring the right-of-way for the line's location and expenditures on financial and architectural services and electric power. While construction of the line constitutes the single largest component of the total cost (32.5 percent), the costs of manufacturing the structures and wire and installation of the converters are significant as well.

Table 3.1: Distribution of Transmission Line Construction Expenditures by IMPLAN Sector

Component	IMPLAN Sector #	IMPLAN Sector Title	Direct Spending[1]	Percent of Total Expenditures
Installation of Structures	36	Construction of other new nonresidential structures	$723.1	32.5%
Manufacture of Structures	186	Plate work and fabricated structural product manufacturing	$381.2	17.1%
Manufacture of Wire	272	Communication and energy wire and cable manufacturing	$211.0	9.5%
Architectural Services	369	Architectural, engineering, and related services	$74.5	3.3%
Right of Way	360	Real estate	$75.2	3.4%
Financial	359	Funds, trusts, and other financial vehicles	$24.6	1.1%
Electric Power	31	Electric power generation, transmission, and distribution	$14.4	0.6%
Manufacture of Transformer	244	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing	$13.4	0.6%
Installation of Converter/Transformer	36	Construction of other nonresidential structures	$237.6	10.7%
Converters[2]			$469.0	21.1%
Total			$2,224.0	100%

1. All spending is in millions of 2013 $ and rounded.
2. Because the converters are produced overseas, IMPLAN sector information is not relevant, i.e., there are no domestic impacts from construction of the converters.

As indicated in the notes accompanying Table 3.1, the project's converters will be produced overseas. It is therefore not appropriate to include the actual purchase price of the converters in the estimate of economic impacts that are reported here. The installation of converters in Kansas, Missouri, and Illinois, as well as a transformer in Indiana, however, does constitute increased spending in each of the four states and is therefore appropriately included when estimating the impacts of spending on the proposed line.[6]

[6] The economic impact study assumes all structures and conductor are manufactured domestically. The United States does have substantial capacity to manufacture structures and conductor. However, increasing investment in electric transmission in the United States raises the possibility that some companies may not have the ability to fulfill demand for some equipment, especially structures. The study does not address this scenario, as Clean Line will first seek to purchase from domestic manufacturers where possible.

Table 3.2 includes information from Table 3.1 and summarizes the allocation of the input and construction costs among the four states. The allocation of construction costs among the four-state region and the inputs to the transmission line reflects several important assumptions. First, it is assumed that costs will vary across states based on the percentage of total line length located in each state. Second, it is assumed that 50 percent of the costs of manufacturing the structures and wire required for the portion of line constructed in each state will be incurred in-state, while the remaining 50 percent of those costs will be incurred elsewhere in the United States (and outside of the four-state region). The 50 percent limitation reflects the fact that productive capacity in each of the affected sectors is much more constrained at the state level than it is at the national level. It is intended to avoid overstating the potential employment, income, and output impacts attributable to manufacturing-related activities in each of the four states where the proposed line would be built. Third, it is assumed that the cost of manufacturing the transformer that will be installed in Indiana will be incurred outside of the four-state region.

Table 3.2: Grain Belt Express Clean Line Inputs for IMPLAN

			Construction Budget				
Component	IMPLAN Sector	Direct Spending[1]	Kansas	Missouri	Illinois	Indiana	United States
Construction							
Installation of Structures	36	$723.1	$336.6	$192.3	$192.3	$1.9	$723.1
Manufacture of Structures[2]	186	$381.2	$88.7	$50.7	$50.7	$0.5	$381.2
Manufacture of Wire[2]	272	$211.0	$49.1	$28.1	$28.1	$0.3	$211.0
Architectural Services	369	$74.5	$34.7	$19.8	$19.8	$0.2	$74.5
Right of Way	360	$75.2	$35.0	$20.0	$20.0	$0.2	$75.2
Financial	359	$24.6	$11.4	$6.5	$6.5	$0.1	$24.6
Electric Power	31	$14.4	$6.7	$3.8	$3.8	$0.0	$14.4
Manufacture of Transformer	244	$13.4	$0.0	$0.0	$0.0	$0.0	$13.4
Installation of Converters/ Transformers	36	$237.6	$99.0	$33.0	$99.0	$6.6	$237.6
Subtotal		$1,755.0	$661.2	$354.2	$420.2	$9.8	$1,755.0
Converters		$469.0	$201.0	$67.0	$201.0	$13.4	$0.0
Total Cost of Construction		$2,224.0	$862.2	$421.2	$621.2	$23.2	$1,755.0
Average Annual O&M	39	$22.2	$10.0	$5.0	$7.0	$0.2	$22.2

1. All spending is in millions of 2013 $ and rounded.
2. Assumes 50 percent in-state share of manufacturing.

According to Clean Line's estimates, excluding the cost of the converters (which will be purchased overseas), the total costs of building the proposed line, $1,755 million, are distributed among the four states and the remainder of the United States as follows: approximately $661.2 million (37.7 percent) in Kansas, $354.2 million (20.2 percent) in Missouri, $420.2 million (23.9 percent) in Illinois, and $9.8 million (0.6 percent) in Indiana. The remaining $309.6 million (17.6 percent) of spending, which consists of 50 percent of the spending on the manufacture of the structures and wire and 100 percent of the costs of a transformer, will be incurred outside the four-state region. It is assumed that annual Operation and Maintenance (O&M) expenses (incurred when the line is up and running) will amount to approximately 1 percent of the total costs of construction, including in-state manufacturing and construction costs, manufacturing costs incurred outside the four-state region, and the cost of the converter or transformer installed in each state. Estimated annual O&M costs incurred in each state are shown in the last row of Table 3.2.

3.2 Manufacturing and Construction Impacts at the State Level

To estimate the economic impacts of construction of the transmission line, changes in final demand (i.e., the projected increase in total spending attributable to the manufacture and construction of the proposed transmission line) in each of the relevant sectors were analyzed using the IMPLAN model. Impacts were then aggregated across the different components and types of impacts. Impacts were estimated separately for each the segments of the line that will be located in Kansas, Missouri, Illinois, and Indiana. In addition, impacts were estimated at both the state and national levels. In the former, indirect and induced impacts are limited by spending associated with the construction of the line that occurs in other states. Estimating the impacts at the national level captures the majority of this "out-of-state" spending, resulting in larger indirect and induced impacts than those associated with in-state spending.

3.2.1 Kansas

Table 3.3 summarizes the direct, indirect, induced, and total impacts of increases in final demand for the components –wire, structures – of the new transmission line, installation of the converters, construction of the line, and architectural, financial, energy, and right-of-way requirements associated with the segment of the line constructed in Kansas.

Table 3.3: Estimated State-Level Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Kansas

Component	Change in Final Demand[1]	Impact	Direct	Indirect	Induced	Total	Annual Average[4]
Installation of Structures	$336.6	*Employment*[2]	2,657	536	956	4,149	1,383
		Labor Income[3]	$159.8	$32.7	$42.6	$235.1	$78.4
		Output	$336.6	$117.6	$140.4	$594.6	$198.2
Manufacture Structures	$88.7	*Employment*	299	144	149	592	197
		Labor Income	$21.9	$7.9	$6.6	$36.5	$12.2
		Output	$88.7	$23.4	$21.9	$134.0	$44.7
Manufacture Wire	$49.1	*Employment*	78	49	51	178	59
		Labor Income	$6.8	$3.2	$2.3	$12.2	$4.1
		Output	$49.1	$11.0	$7.5	$67.5	$22.5
Architectural Services	$34.7	*Employment*	248	71	119	438	146
		Labor Income	$20.3	$3.6	$5.3	$29.2	$9.7
		Output	$34.7	$9.5	$17.4	$61.6	$20.5
Right of Way	$35.0	*Employment*	232	54	28	313	104
		Labor Income	$3.1	$2.4	$1.2	$6.8	$2.3
		Output	$35.0	$8.6	$4.1	$47.7	$15.9
Financial	$11.4	*Employment*	38	54	16	108	36
		Labor Income	$0.7	$2.3	$0.7	$3.7	$1.2
		Output	$11.4	$9.0	$2.3	$22.8	$7.6
Electric Power	$6.7	*Employment*	6	9	7	23	8
		Labor Income	$1.0	$0.5	$0.3	$1.8	$0.6
		Output	$6.7	$2.1	$1.1	$9.9	$3.3
Installation of Converters/ Transformers	$99.0	*Employment*	782	158	281	1,221	407
		Labor Income	$47.0	$9.6	$12.5	$69.2	$23.1
		Output	$99.0	$34.6	$41.3	$174.9	$58.3
Totals	$661.2	*Employment*	4,340	1,075	1,607	7,021	2,340
		Labor Income	$260.7	$62.2	$71.5	$394.4	$131.5
		Output	$661.2	$215.9	$235.9	$1,113.0	$371.0

1. All spending and $ impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.
4. Assumes a three-year construction period.

Referring to Table 3.3, assuming 50 percent of all manufacturing-related activities (structures and wire) and 100 percent of all construction-related activities directly tied to the transmission line are completed by in-state firms, manufacturing of structures and wire; construction of the transmission line; installation of a converter; the payment of fees for the required right-of-way, architectural, and financial services; and the purchase of electric power would generate substantial economic impacts in Kansas. In total, it is estimated that approximately 2,340 jobs would be created in each year of the three-year period during which the line is being constructed. More than 61 percent (886) of the total *direct* jobs (1,447) created in each of the three years would result from the construction of the proposed line. Labor income impacts would also be substantial with $86.9 million per year in direct impacts. Factoring in indirect and induced income impacts increases the annual average labor income impact to $131.5.

3.2.2 Missouri

Table 3.4 summarizes the direct, indirect, induced, and total impacts of increases in final demand for the components –wire, structures – of the new transmission line, installation of the converters, construction of the line, and architectural, financial, energy, and right-of-way requirements associated with the segment of the line constructed in Missouri.

Table 3.4: Estimated State-Level Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Missouri

Component	Change in Final Demand[1]	Impact	Direct	Indirect	Induced	Total	Annual Average[4]
Installation of Structures	$192.3	*Employment*[2]	1,490	355	657	2,502	834
		Labor Income[3]	$93.0	$23.2	$31.5	$147.7	$49.2
		Output	$192.3	$60.6	$96.4	$349.4	$116.5
Manufacture Structures	$50.7	*Employment*	171	102	106	379	126
		Labor Income	$12.5	$6.2	$5.1	$23.8	$7.9
		Output	$50.7	$16.9	$15.6	$83.2	$27.7
Manufacture Wire	$28.1	*Employment*	46	33	33	112	37
		Labor Income	$3.4	$2.3	$1.6	$7.3	$2.4
		Output	$28.1	$6.9	$4.9	$39.9	$13.3
Architectural Services	$19.8	*Employment*	138	47	82	267	89
		Labor Income	$11.8	$2.6	$3.9	$18.4	$6.1
		Output	$19.8	$6.4	$12.0	$38.2	$12.7
Right of Way	$20.0	*Employment*	126	36	20	182	61
		Labor Income	$1.8	$1.8	$1.0	$4.6	$1.5
		Output	$20.0	$5.6	$3.0	$28.6	$9.5
Financial	$6.5	*Employment*	19	28	13	60	20
		Labor Income	$0.6	$1.5	$0.6	$2.7	$0.9
		Output	$6.5	$5.0	$1.9	$13.4	$4.5
Electric Power	$3.8	*Employment*	4	6	5	15	5
		Labor Income	$0.6	$0.3	$0.2	$1.1	$0.4
		Output	$3.8	$1.0	$0.7	$5.6	$1.9
Installation of Converters/ Transformers	$33.0	*Employment*	256	61	113	429	143
		Labor Income	$16.0	$4.0	$5.4	$25.3	$8.4
		Output	$33.0	$10.4	$16.5	$59.9	$20.0
Totals	$354.2	*Employment*	2,250	667	1,030	3,946	1,315
		Labor Income	$139.7	$41.9	$49.4	$231.0	$77.0
		Output	$354.2	$112.8	$151.1	$618.1	$206.0

1. All spending and $ impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.
4. Assumes a three-year construction period.

Referring to Table 3.4, assuming 50 percent of all manufacturing-related activities (structures and wire) and 100 percent of all construction-related activities and directly tied to the transmission line are completed by in-state firms, manufacturing of structures and wire; construction of the transmission line; installation of a converter; the payment of fees for the required right-of-way, architectural, and financial services; and the purchase of electric power would generate substantial economic impacts in Missouri. In total, it is estimated that approximately 1,315 jobs would be created in each year of the three-year period during which the line is being constructed. More than 66 percent (497) of the total direct jobs (750) created in each of the three years would result from the construction of the proposed line. Labor income impacts would also be substantial with $46.6 million per year in direct impacts. Factoring in indirect and induced income impacts increases the annual average labor income impact to $77 million.

3.2.3 Illinois

Table 3.5 summarizes the direct, indirect, induced, and total impacts of increases in final demand for the components –wire, structures – of the new transmission line, installation of the converters, construction of the line, and architectural, financial, energy, and right-of-way requirements associated with the segment of the line constructed in Illinois.

Table 3.5: Estimated State-Level Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Illinois

Component	Change in Final Demand[1]	Impact	Direct	Indirect	Induced	Total	Annual Average[4]
Installation of Structures	$192.3	Employment[2]	1,355	299	619	2,273	758
		Labor Income[3]	$101.0	$22.6	$34.0	$157.7	$52.6
		Output	$192.3	$65.4	$101.2	$358.9	$119.6
Manufacture Structures	$50.7	Employment	161	88	103	352	117
		Labor Income	$14.2	$6.3	$5.7	$26.1	$8.7
		Output	$50.7	$16.7	$16.9	$84.3	$28.1
Manufacture Wire	$28.1	Employment	41	28	39	107	36
		Labor Income	$5.3	$2.3	$2.2	$9.8	$3.3
		Output	$28.1	$6.8	$6.4	$41.3	$13.8
Architectural Services	$19.8	Employment	135	42	74	252	84
		Labor Income	$12.0	$2.9	$4.1	$18.9	$6.3
		Output	$19.8	$6.6	$12.2	$38.6	$12.9
Right of Way	$20.0	Employment	93	22	17	132	44
		Labor Income	$2.0	$1.3	$0.9	$4.3	$1.4
		Output	$20.0	$4.0	$2.8	$26.8	$8.9
Financial	$6.5	Employment	18	22	13	52	17
		Labor Income	$0.8	$1.7	$0.7	$3.1	$1.0
		Output	$6.5	$4.4	$2.1	$13.0	$4.3
Electric Power	$3.8	Employment	3	4	5	12	4
		Labor Income	$0.6	$0.3	$0.3	$1.2	$0.4
		Output	$3.8	$1.0	$0.8	$5.6	$1.9
Installation of Converters/ Transformers	$99.0	Employment	697	154	319	1,170	390
		Labor Income	$52.0	$11.7	$17.5	$81.2	$27.1
		Output	$99.0	$33.7	$52.1	$184.8	$61.6
Totals	$420.2	Employment	2,502	659	1,189	4,350	1,450
		Labor Income	$188.0	$49.1	$65.3	$302.3	$100.8
		Output	$420.2	$138.7	$194.3	$753.3	$251.1

1. All spending and $ impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.
4. Assumes a three-year construction period.

Referring to Table 3.5, assuming 50 percent of all manufacturing-related activities (structures and wire) and 100 percent of all construction-related activities and directly tied to the transmission line are completed by in-state firms, manufacturing of structures and wire; construction of the transmission line; installation of a converter; the payment of fees for the required right-of-way, architectural, and financial services; and the purchase of electric power would generate substantial economic impacts in Illinois. In total, it is estimated that approximately 1,450 jobs would be created in each year of the three-year period during which the line is being constructed. More than 54 percent (452) of the total direct jobs (834) created in each of the three years would result from the construction of the proposed line. Labor income impacts would also be substantial with $62.7 million per year in direct impacts. Factoring in indirect and induced income impacts increases the annual average labor income impact to $100.8 million.

3.2.4 Indiana

Table 3.6 summarizes the direct, indirect, induced, and total impacts of increases in final demand for the components –wire, structures – of the new transmission line, installation of the converters, construction of the line, and architectural, financial, energy, and right-of-way requirements associated with the segment of the line constructed in Indiana.

Table 3.6: Estimated State-Level Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Indiana

Component	Change in Final Demand[1]	Impact	Direct	Indirect	Induced	Total	Annual Average[4]
Installation of Structures	$1.9	*Employment*[2]	15	3	6	23	8
		Labor Income[3]	$0.95	$0.16	$0.26	$1.37	$0.46
		Output	$1.92	$0.60	$0.87	$3.39	$1.13
Manufacture Structures	$0.5	*Employment*	2	1	1	3	1
		Labor Income	$0.13	$0.05	$0.04	$0.22	$0.07
		Output	$0.51	$0.15	$0.14	$0.80	$0.27
Manufacture Wire	$0.3	*Employment*	0	0	0	1	0
		Labor Income	$0.04	$0.02	$0.01	$0.07	$0.02
		Output	$0.28	$0.06	$0.05	$0.39	$0.13
Architectural Services	$0.2	*Employment*	2	0	1	3	1
		Labor Income	$0.11	$0.02	$0.03	$0.16	$0.05
		Output	$0.20	$0.06	$0.10	$0.36	$0.12
Right of Way	$0.2	*Employment*	1	0	0	2	1
		Labor Income	$0.02	$0.01	$0.01	$0.04	$0.01
		Output	$0.20	$0.05	$0.02	$0.27	$0.09
Financial	$0.1	*Employment*	0	0	0	0	0
		Labor Income	$0.01	$0.01	$0.00	$0.02	$0.01
		Output	$0.07	$0.04	$0.01	$0.11	$0.04
Electric Power	$0.04	*Employment*	0	0	0	0	0
		Labor Income	$0.01	$0.00	$0.00	$0.01	$0.00
		Output	$0.04	$0.01	$0.01	$0.05	$0.02
Installation of Converters/ Transformers	$6.6	*Employment*	50	9	20	80	27
		Labor Income	$3.26	$0.55	$0.90	$4.70	$1.57
		Output	$6.60	$2.07	$2.97	$11.64	$3.88
Totals	$9.8	*Employment*	70	14	28	113	38
		Labor Income	$4.51	$0.82	$1.26	$6.59	$2.20
		Output	$9.81	$3.04	$4.16	$17.02	$5.67

1. All spending and $ impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.
4. Assumes a three-year construction period.

Referring to Table 3.6, assuming 50 percent of all manufacturing-related activities (structures and wire) and 100 percent of all construction-related activities and directly tied to the transmission line are completed by in-state firms, manufacturing of structures and wire; construction of the transmission line; installation of a transformer; the payment of fees for the required right-of-way, architectural, and financial services; and the purchase of electric power would generate measurable economic impacts in Indiana. In total, it is estimated that approximately 38 jobs would be created in each year of the three-year period during which the line is being constructed. Approximately 74 percent (17) of the total direct jobs (23) created in each of the three years would result from the installation of the transformer. Labor income impacts would amount to $1.5 million per year in direct impacts. Factoring in indirect and induced income impacts increases the annual average to $2.2 million.

3.2.5 Assessment of Estimated State-Level Impacts

We have already stated that the impacts reported in Tables 3.3 – 3.6 reflect the assumption that 50 percent of manufacturing-related activities and 100 percent of construction-related activities would be completed by in-state firms; however, this assumption warrants further consideration. In particular, we need to examine whether it is *reasonable* to expect that industries in each state would be able to handle the projected increase in demand.

The reasonableness of the approach employed here can be addressed, to a first approximation, by examining the potential for existing industries in each state to accommodate the projected increases in demand considered here. Table 3.7 summarizes employment levels in each of the affected industries in Kansas, Missouri, Illinois, and Indiana in 2011, as well as the projected annual increases in employment in each of the seven directly impacted sectors (*Construction of other new nonresidential structures; Plate work and fabricated structural product manufacturing; Communication and energy wire and cable manufacturing; Architectural, engineering, and related services; Real estate; Funds, trusts, and other financial vehicles; and Electric power generation, transmission, and distribution*) in both absolute and percentage terms.

Table 3.7: Comparison of Baseline Employment to Projected Annual Impacts in Kansas, Missouri, Illinois, and Indiana

Component	Employment[1]	Kansas	Missouri	Illinois	Indiana
Installation of Structures	*Current*	26,081	53,411	78,598	53,875
	Projected Increase	1383	834	758	8
	% Change	5.3%	1.6%	1.0%	0.0%
Manufacture Structures	*Current*	2,256	2,716	6,987	4,734
	Projected Increase	197	126	117	1
	% Change	8.7%	4.7%	1.7%	0.0%
Manufacture Wire	*Current*	575	239	684	304
	Projected Increase	59	37	36	0
	% Change	10.3%	15.7%	5.2%	0.0%
Architectural Services	*Current*	18,462	29,017	61,275	27,611
	Projected Increase	146	89	84	1
	% Change	0.8%	0.3%	0.1%	0.0%
Right of Way	*Current*	50,647	121,734	240,916	109,293
	Projected Increase	104	61	44	1
	% change	0.2%	0.0%	0.0%	0.0%
Financial	*Current*	3,105	8,587	22,989	3,105
	Projected Increase	36	20	17	0
	% Change	1.2%	0.2%	0.1%	0.0%
Electric Power	*Current*	6,040	8,636	18,595	11,203
	Projected Increase	8	5	4	0
	% Change	0.1%	0.1%	0.0%	0.0%
Installation of Converters/ Transformers	*Current*	26,081	53,411	78,598	53,875
	Projected Increase	407	143	390	27
	% Change	1.6%	0.3%	0.5%	0.1%
Totals	*Employment*				
	Labor Income				
	Output	$9,999.9	$9,999.9	$9,999.9	$9,999.9

1. All employment figures are full time equivalents.
2. Assumes a three-year construction period.

Referring to Table 3.7, in Illinois and Indiana, all seven of the affected sectors should be able to absorb the increased demand associated with manufacturing of the required components and construction of the proposed transmission line. The only possible exception is manufacturing of the required wire in Illinois. The *Communications and energy wire and cable manufacturing* sector would experience an estimated 5.2 percent increase in employment in Illinois. Considering, however, the current state of the economy in

Illinois (the unemployment is currently 9 percent), and the fact that the predicted increase in jobs is 36 FTE positions, there is likely sufficient excess capacity within the industry in Illinois to absorb the projected increase.

Turning to Missouri, six of the seven affected sectors should be able to absorb the increased demand associated with manufacturing of the required components and construction of the proposed transmission line. Referring to Table 3.7, the only possible exception is manufacturing of the needed wire. The *Communications and energy wire and cable manufacturing* sector would experience an estimated 15.7 percent increase in employment in Missouri. As was the case in Illinois, however, the current state of the economy in Missouri (the unemployment is currently 6.5 percent), and the fact that the predicted increase in jobs is 37 FTE positions, there is likely sufficient excess capacity within the industry in Missouri to absorb the projected increase.

Finally, considering Kansas, it is reasonable to expect that five of the seven sectors should be able to absorb the increased demand associated with manufacturing of the required components and construction of the proposed transmission line. The only possible exceptions include manufacturing of the wire and structures required for that portion of the line that will be constructed in Kansas. As shown in Table 3.7, the *Communications and energy wire and cable manufacturing* sector would experience an estimated 10.3 percent increase in employment, while the *Plate work and fabricated structural product manufacturing* sector would experience an estimated 8.7 percent increase in employment in Kansas. With an unemployment rate currently at 5.5 percent, some might argue that Kansas is nearing full employment overall. That being said, the predicted increase in FTE positions in each sector – 197 in *Plate work* and 59 in *Communications and energy wire* – do not appear to be excessively large.[7]

[7] If we were to take the position that neither sector would be able to absorb more than a 6% increase in employment, the effect would be to reduce the total number of additional jobs associated with the manufacturing of the required components and construction of the proposed transmission line in Kansas by 87 FTE jobs, or less than 4%, in each year of the assumed three-year construction period.

3.3 Manufacturing and Construction Impacts at the National Level

The state-level impacts reported in Tables 3.3 – 3.6 summarize the estimated impacts of the increased spending that is assumed to occur *within* each state's respective boundaries. It is important to recognize, however, that some of the spending associated with the manufacture and construction of the proposed transmission line in each state will actually occur outside of the state. For example, it is assumed that 50 percent of the direct spending on the manufacturing of the wire that will be used in the portion of the transmission line located in a particular state will be paid to one or more wire manufacturers located in that state. In fact, however, it is reasonable to expect that some of the materials the in-state manufacturers use to produce the wire in question may come from vendors located *outside* of the particular state. The spending on materials produced out-of-state is viewed as a "leakage" from the particular state insofar as it will yield no subsequent indirect or induced spending within that state. This "leakage" will, however, lead to indirect and induced spending elsewhere. To the extent that this spending occurs elsewhere in the United States, one or more of the remaining states will benefit from the construction, operation, and maintenance of the proposed transmission line as well. In addition, recall that 50 percent of the manufacturing of structures and wire associated with that portion of the transmission line that would be built in each state, as well as the transformer that would be installed in Indiana, are assumed to occur elsewhere in the United States.

To capture the indirect and induced impacts of the sources of additional spending described in the preceding paragraph (i.e., "leakages," the 50 percent of direct spending on the manufacture of structures and wire explicitly assumed to occur outside of each state, and the manufacture of the transformer to be installed in Indiana), additional analysis was conducted. To be specific, the impacts of the state-specific expenditures summarized in Tables 3.3 – 3.6 were re-estimated for the region consisting of the entire United States. To hold constant the characteristics of each industry that is assumed to experience the initial increase in final demand in each state (e.g., 50 percent in-state manufacture of structures and wire in Kansas), the national model was recalibrated to reflect the industry-specific characteristics in each sector (IMPLAN sectors 36, 186, 244, 272, 359, 360, 369) and state in which final demand would initially increase. If the specific U.S. industry relationships (output per worker, ratio of employee compensation to output, etc.) were not revised to reflect the relevant state-specific (i.e., Kansas, Missouri, Illinois, Indiana) relationships, the differences reported in Tables 3.8 – 3.11 would be due not only to internalizing trade flows at the national level, but to differences in the industry at the state versus national level as well.

The results of the estimation of national-level impacts of spending on the manufacture and construction of the proposed transmission line are reported in Tables 3.8 – 3.11. It is important to note that the *direct impacts* reported in Tables 3.8 – 3.11 match those reported in Tables 3.3 – 3.6, respectively. This is due to the recalibration described above. Inspection of the indirect and induced impacts shows that these effects are larger at the national level than they are at the state level. Once again, this reflects the capture of indirect and induced spending that would occur outside of the four-state region.

3.3.1 Kansas – US

The national-level impacts of increases in final demand for the components – wire, structures – of the new transmission line, installation of the converters, construction of the line, and right-of-way requirements associated with the segment of the line constructed in Kansas are summarized in Table 3.8.

Table 3.8: Estimated National-Level Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Kansas

Component	Change in Final Demand[1]	Impact	Direct	Indirect	Induced	Total	Annual Average[4]
Installation of Structures	$336.6	*Employment*[2]	2,657	1,125	1,907	5,689	1,896
		Labor Income[3]	$159.8	$81.5	$106.3	$347.6	$115.9
		Output	$336.6	$273.4	$339.6	$949.5	$316.5
Manufacture Structures	$88.7	*Employment*	299	384	391	1,074	358
		Labor Income	$21.9	$26.9	$21.8	$70.7	$23.6
		Output	$88.7	$100.6	$69.6	$258.9	$86.3
Manufacture Wire	$49.1	*Employment*	78	162	158	399	133
		Labor Income	$6.8	$12.6	$8.8	$28.2	$9.4
		Output	$49.1	$70.9	$28.2	$148.2	$49.4
Architectural Services	$34.7	*Employment*	248	119	220	587	196
		Labor Income	$20.3	$7.5	$12.3	$40.1	$13.4
		Output	$34.7	$19.5	$39.2	$93.3	$31.1
Right of Way	$35.0	*Employment*	232	86	63	381	127
		Labor Income	$3.2	$4.7	$3.5	$11.4	$3.8
		Output	$35.0	$15.0	$11.0	$61.0	$20.3
Financial	$11.4	*Employment*	38	82	55	175	58
		Labor Income	$0.7	$6.0	$3.1	$9.8	$3.3
		Output	$11.4	$16.6	$9.8	$37.9	$12.6
Electric Power	$6.7	*Employment*	6	14	16	36	12
		Labor Income	$1.0	$1.0	$0.9	$2.9	$1.0
		Output	$6.7	$3.5	$2.9	$13.1	$4.4
Installation of Converters/ Transformers	$99.0	*Employment*	782	331	561	1,673	558
		Labor Income	$47.0	$24.0	$31.3	$102.2	$34.1
		Output	$99.0	$80.4	$99.9	$279.3	$93.1
Totals	$661.2	*Employment*	4,340	2,304	3,371	10,015	3,338
		Labor Income	$260.7	$164.2	$187.9	$612.8	$204.3
		Output	$661.2	$579.8	$600.1	$1,841.2	$613.7

1. All spending and $ impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.
4. Assumes a three-year construction period.

According to Table 3.8, assuming 50 percent of all manufacturing-related activities (structures and wire) and 100 percent of all construction-related activities directly tied to the transmission line are completed by in-state firms, the indirect and induced impacts of spending on manufacturing of structures and wire; construction of the transmission line; installation of a converter; the payment of fees for the required right-of-way, architectural, and financial services; and the purchase of electric power associated with that segment of the proposed transmission line located in Kansas increase substantially when the scope of the analysis is expanded to the national level. Total employment impacts increase by approximately 998[8] jobs per year, to approximately 3,338 full-time equivalent jobs per year over the three-year construction period. Total labor income increases by $72.8 million per year, to $204.3 million per year for three years.

[8] The difference in FTE jobs and labor income is calculated by comparing the relevant values in Tables 3.8 and 3.3. The same approach is employed in discussing the results in Tables 3.9-3.11.

3.3.2 Missouri – US

The national-level impacts of increases in final demand for the components –wire, structures – of the new transmission line, installation of the converters, construction of the line, and right-of-way requirements associated with the segment of the line constructed in Missouri are summarized in Table 3.9.

Table 3.9: Estimated National-Level Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Missouri

Component	Change in Final Demand[1]	Impact	Direct	Indirect	Induced	Total	Annual Average[4]
Installation of Structures	$192.3	Employment[2]	1,490	631	1,095	3,216	1,072
		Labor Income[3]	$93.0	$45.7	$61.0	$199.7	$66.6
		Output	$192.3	$153.3	$194.9	$540.6	$180.2
Manufacture Structures	$50.7	Employment	171	219	223	614	205
		Labor Income	$12.5	$15.4	$12.5	$40.4	$13.5
		Output	$50.7	$57.4	$39.8	$147.9	$49.3
Manufacture Wire	$28.1	Employment	46	96	88	230	77
		Labor Income	$3.4	$7.4	$4.9	$15.7	$5.2
		Output	$28.1	$41.8	$15.7	$85.5	$28.5
Architectural Services	$19.8	Employment	138	66	126	331	110
		Labor Income	$11.8	$4.2	$7.0	$23.0	$7.7
		Output	$19.8	$10.9	$22.5	$53.2	$17.7
Right of Way	$20.0	Employment	126	47	35	208	69
		Labor Income	$1.8	$2.6	$2.0	$6.4	$2.1
		Output	$20.0	$8.3	$6.2	$34.5	$11.5
Financial	$6.5	Employment	19	42	30	91	30
		Labor Income	$0.6	$3.1	$1.7	$5.4	$1.8
		Output	$6.5	$8.4	$5.4	$20.4	$6.8
Electric Power	$3.8	Employment	4	8	9	21	7
		Labor Income	$0.6	$0.6	$0.5	$1.7	$0.6
		Output	$3.8	$2.1	$1.6	$7.5	$2.5
Installation of Converters/ Transformers	$33.0	Employment	256	108	188	552	184
		Labor Income	$16.0	$7.8	$10.5	$34.3	$11.4
		Output	$33.0	$26.3	$33.4	$92.8	$30.9
Totals	$354.2	Employment	2,250	1,218	1,795	5,263	1,754
		Labor Income	$139.7	$86.8	$100.1	$326.5	$108.8
		Output	$354.2	$308.5	$319.7	$982.4	$327.5

1. All spending and $ impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.
4. Assumes a three-year construction period.

According to Table 3.9, assuming 50 percent of all manufacturing-related activities (structures and wire) and 100 percent of all construction-related activities directly tied to the transmission line are completed by in-state firms, the indirect and induced impacts of spending on manufacturing of structures and wire; construction of the transmission line; installation of a converter; the payment of fees for the required right-of-way, architectural, and financial services; and the purchase of electric power associated with that segment of the proposed transmission line located in Missouri increase substantially when the scope of the analysis is expanded to the national level. Total employment impacts increase by approximately 439 jobs per year, to approximately 1,754 full-time equivalent jobs per year over the three-year construction period. Total labor income increases by $31.8 million per year, to $108.8 million per year for three years.

3.3.3 Illinois – US

The national-level impacts of increases in final demand for the components –wire, structures – of the new transmission line, installation of the converters, construction of the line, and right-of-way requirements associated with the segment of the line constructed in Illinois are summarized in Table 3.10.

Table 3.10: Estimated National-Level Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Illinois

Component	Change in Final Demand[1]	Impact	Direct	Indirect	Induced	Total	Annual Average[4]
Installation of Structures	$192.3	*Employment*[2]	1,355	574	1,122	3,051	1,017
		Labor Income[3]	$101.0	$41.5	$62.6	$205.1	$68.4
		Output	$192.3	$139.4	$199.9	$531.6	$177.2
Manufacture Structures	$50.7	*Employment*	161	206	230	596	199
		Labor Income	$14.2	$14.5	$12.8	$41.5	$13.8
		Output	$50.7	$54.1	$40.9	$145.6	$48.5
Manufacture Wire	$28.1	*Employment*	41	84	97	222	74
		Labor Income	$5.3	$6.6	$5.4	$17.4	$5.8
		Output	$28.1	$37.0	$17.3	$82.3	$27.4
Architectural Services	$19.8	*Employment*	135	65	127	326	109
		Labor Income	$12.0	$4.1	$7.1	$23.2	$7.7
		Output	$19.8	$10.6	$22.6	$53.0	$17.7
Right of Way	$20.0	*Employment*	93	34	31	158	53
		Labor Income	$2.0	$1.9	$1.7	$5.7	$1.9
		Output	$20.0	$6.3	$5.6	$31.8	$10.6
Financial	$6.5	*Employment*	18	38	29	85	28
		Labor Income	$0.8	$2.8	$1.6	$5.2	$1.7
		Output	$6.5	$7.7	$5.2	$19.5	$6.5
Electric Power	$3.8	*Employment*	3	7	9	19	6
		Labor Income	$0.6	$0.5	$0.5	$1.6	$0.5
		Output	$3.8	$1.8	$1.6	$7.2	$2.4
Installation of Converters/ Transformers	$99.0	*Employment*	697	295	578	1,570	523
		Labor Income	$52.0	$21.4	$32.2	$105.6	$35.2
		Output	$99.0	$71.8	$102.9	$273.6	$91.2
Totals	$420.2	*Employment*	2,502	1,303	2,223	6,028	2,009
		Labor Income	$188.0	$93.4	$123.9	$405.3	$135.1
		Output	$420.2	$328.6	$396.0	$1,144.8	$381.6

1. All spending and $ impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.
4. Assumes a three-year construction period.

According to Table 3.10, assuming 50 percent of all manufacturing-related activities (structures and wire) and 100 percent of all construction-related activities directly tied to the transmission line are completed by in-state firms, the indirect and induced impacts of spending on manufacturing of structures and wire; construction of the transmission line; installation of a converter; the payment of fees for the required right-of-way, architectural, and financial services; and the purchase of electric power associated with that segment of the proposed transmission line located in Illinois increase substantially when the scope of the analysis is expanded to the national level. Total employment impacts increase by approximately 559 jobs per year, to approximately 2,009 full-time equivalent jobs per year over the three-year construction period. Total labor income increases by $34.3 million per year, to $135.1 million per year for three years.

3.3.4 Indiana – US

The national-level impacts of increases in final demand for the components –wire, structures – of the new transmission line, installation of the converters, construction of the line, and right-of-way requirements associated with the segment of the line constructed in Indiana are summarized in Table 3.11.

Table 3.11: Estimated National-Level Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Indiana

Component	Change in Final Demand[1]	Impact	Direct	Indirect	Induced	Total	Annual Average[4]
Installation of Structures	$1.9	*Employment*[2]	15	6	11	32	11
		Labor Income[3]	$0.95	$0.45	$0.61	$2.01	$0.67
		Output	$1.92	$1.50	$1.96	$5.39	$1.80
Manufacture Structures	$0.5	*Employment*	2	2	2	6	2
		Labor Income	$0.13	$0.15	$0.13	$0.41	$0.14
		Output	$0.51	$0.56	$0.40	$1.47	$0.49
Manufacture Wire	$0.3	*Employment*	0	1	1	2	1
		Labor Income	$0.04	$0.07	$0.05	$0.16	$0.1
		Output	$0.28	$0.40	$0.16	$0.85	$0.3
Architectural Services	$0.2	*Employment*	2	1	1	4	1
		Labor Income	$0.11	$0.05	$0.07	$0.23	$0.08
		Output	$0.20	$0.12	$0.22	$0.54	$0.18
Right of Way	$0.2	*Employment*	1	1	0	2	1
		Labor Income	$0.02	$0.03	$0.02	$0.07	$0.02
		Output	$0.20	$0.09	$0.06	$0.35	$0.12
Financial	$0.1	*Employment*	0	0	0	1	0
		Labor Income	$0.01	$0.03	$0.02	$0.05	$0.02
		Output	$0.07	$0.08	$0.05	$0.20	$0.07
Electric Power	$0.04	*Employment*	0	0	0	0	0
		Labor Income	$0.01	$0.01	$0.01	$0.02	$0.01
		Output	$0.04	$0.02	$0.02	$0.08	$0.03
Installation of Converters/ Transformers	$6.6	*Employment*	50	21	38	109	36
		Labor Income	$3.26	$1.54	$2.11	$6.90	$2.30
		Output	$6.60	$5.15	$6.74	$18.49	$6.16
Totals	$9.8	*Employment*	70	32	54	156	52
		Labor Income	$4.51	$2.32	$3.01	$9.84	$3.28
		Output	$9.81	$7.93	$9.61	$27.36	$9.12

1. All spending and $ impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.
4. Assumes a three-year construction period.

According to Table 3.11, assuming 50 percent of all manufacturing-related activities (structures and wire) and 100 percent of all construction-related activities directly tied to the transmission line are completed by in-state firms, the indirect and induced impacts of spending on manufacturing of structures and wire; construction of the transmission line; installation of a transformer; the payment of fees for the required right-of-way, architectural, and financial services; and the purchase of electric power associated with that segment of the proposed transmission line located in Indiana increase substantially when the scope of the analysis is expanded to the national level. Total employment impacts increase by approximately 14 jobs per year, to approximately 52 full-time equivalent jobs per year over the three-year construction period. Total labor income increases by $1.08 million per year, to $3.28 million per year for three years.

3.3.5 Manufacturing Outside of the Four-State Region

It was also necessary to estimate the impacts of the 50 percent of manufacturing of structures and wire required for the transmission line that was assumed to occur outside of the four-state region, as well as the transformer that will be installed in Indiana. Those results are reported in Table 3.12.

Table 3.12: Estimated National-Level Impacts of Manufacturing 50 percent of Structures and Wire, and Transformers Outside of Four-State Region

Component	Change in Final Demand[1]	Impact	Direct	Indirect	Induced	Total	Annual Average[4]
Manufacture Structures	$190.6	*Employment*[2]	630	808	848	2,286	762
		Labor Income[3]	$49.3	$56.8	$47.3	$153.3	$51.1
		Output	$190.6	$211.6	$151.0	$553.2	$184.4
Manufacture Wire	$105.5	*Employment*	161	335	351	847	282
		Labor Income	$16.9	$26.1	$19.5	$62.6	$20.9
		Output	$105.5	$146.6	$62.5	$314.5	$104.8
Manufacture of Transformers	$13.4	*Employment*	57	49	62	168	56
		Labor Income	$3.8	$3.9	$3.5	$11.2	$3.7
		Output	$13.4	$13.3	$11.1	$37.8	$12.6
Totals	$309.5	*Employment*	848	1,192	1,261	3,301	1,100
		Labor Income	$70.0	$86.8	$70.3	$227.1	$75.7
		Output	$309.5	$371.5	$224.6	$905.6	$301.9

1. All spending and $ impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.
4. Assumes a three-year construction period.

Referring to Table 3.12, the 50 percent of manufacturing of structures and wire required for the transmission line that is assumed to occur outside of the four-state region, as well as the transformer that would be installed in Indiana would generate substantial economic impacts at the national level. In total, approximately 1,100 jobs would be created in each year of the three-year period during which the line is being constructed. Labor income impacts would also be substantial with $23.3 million per year in direct impacts. Factoring in indirect and induced income impacts increases the annual average to $75.7 million.

3.4 Operations and Maintenance Impacts at the State Level

Clean Line estimates that annual operation and maintenance (O&M) costs, which would be incurred when the line is up and running, would amount to approximately one percent of total construction costs. In Kansas, this amounts to $10.0 million of additional spending each year. The corresponding amounts for Missouri, Illinois, and Indiana are $5.0 million, $7.0 million, and $0.2 million, respectively. The estimated impacts of annual O&M expenditures in each state are summarized in Tables 3.13 – 3.16.

3.4.1 Kansas

As shown in Table 3.13, the direct effects of annual O&M expenditures in Kansas include 88 jobs and $5.3 million in labor income. These impacts increase to 135 jobs and $7.6 million of labor income when indirect and induced impacts are factored in.

Table 3.13: Estimated Impacts of Annual O&M-Related Expenditures on Grain Belt Express Clean Line in Kansas (Total annual spending = $10.0 million)

Impact[1]	Direct	Indirect	Induced	Total
Employment[2]	88	16	31	135
Labor Income[3]	$5.3	$0.9	$1.4	$7.6
Output	$10.0	$3.2	$4.5	$17.7

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.

3.4.2 Missouri

As shown in Table 3.14, the direct effects of annual O&M expenditures in Missouri include 43 jobs and $2.7 million in labor income. These impacts increase to 70 jobs and $4.1 million of labor income when indirect and induced impacts are factored in.

Table 3.14: Estimated Impacts of Annual O&M-Related Expenditures on Grain Belt Express Clean Line in Missouri (Total annual spending = $5.0 million)

Impact[1]	Direct	Indirect	Induced	Total
Employment[2]	43	9	18	70
Labor Income[3]	$2.7	$0.5	$0.9	$4.1
Output	$5.0	$1.5	$2.7	$9.2

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.

3.4.3 Illinois

As shown in Table 3.15, the direct effects of annual O&M expenditures in Illinois include 54 jobs and $4.1 million in labor income. These impacts increase to 88 jobs and $6.1 million of labor income when indirect and induced impacts are factored in.

Table 3.15: Estimated Impacts of Annual O&M-Related Expenditures on Grain Belt Express Clean Line in Illinois (Total annual spending = $7.0 million)

Impact[1]	Direct	Indirect	Induced	Total
Employment[2]	54	10	24	88
Labor Income[3]	$4.1	$0.7	$1.3	$6.1
Output	$7.0	$2.1	$3.9	$13.1

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.

3.4.4 Indiana

As shown in Table 3.16, the direct effects of annual O&M expenditures in Indiana include 2 jobs and $130 thousand in labor income. These impacts increase to 3 jobs and $190 thousand of labor income when indirect and induced impacts are factored in.

Table 3.16: Estimated Impacts of Annual O&M-Related Expenditures on Grain Belt Express Clean Line in Indiana (Total annual spending = $0.2 million)

Impact[1]	Direct	Indirect	Induced	Total
Employment[2]	2	0	1	3
Labor Income[3]	$0.13	$0.02	$0.04	$0.19
Output	$0.24	$0.07	$0.12	$0.43

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.

3.5 Operations and Maintenance Impacts at the National Level

As was the case with state-level manufacturing and construction-related impacts, to capture the indirect and induced effects of leakages from state-level spending at the national level, the impacts of the state-specific O&M-related expenditures summarized in Tables 3.13 – 3.16 were re-estimated for the region consisting of the entire United States. The results are reported in Tables 3.17 – 3.20.

3.5.1 Kansas - US

As shown in Table 3.17, the indirect and induced impacts of O&M-related expenditures associated with that segment of the proposed transmission line located in Kansas increase when the scope of the analysis is expanded to the national level. Total employment impacts increase by 42, to 177 full-time equivalent jobs. Total labor income increases by $3.1 million, to $10.7 million.

Table 3.17: Estimated National-Level Impacts of Annual O&M-Related Expenditures on Grain Belt Express Clean Line in Kansas (Total annual spending = $10.0 million)

Impact[1]	Direct	Indirect	Induced	Total
Employment[2]	88	30	58	177
Labor Income[3]	$5.3	$2.1	$3.3	$10.7
Output	$10.0	$7.2	$10.4	$27.6

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.

3.5.2 Missouri - US

As shown in Table 3.18, the indirect and induced impacts of O&M-related expenditures associated with that segment of the proposed transmission line located in Missouri increase when the scope of the analysis is expanded to the national level. Total employment impacts increase by 18, to 88 full-time equivalent jobs. Total labor income increases by $1.2 million, to $5.3 million.

Table 3.18: Estimated National-Level Impacts of Annual O&M-Related Expenditures on Grain Belt Express Clean Line in Missouri (Total annual spending = $5.0 million)

Impact[1]	Direct	Indirect	Induced	Total
Employment[2]	43	15	29	88
Labor Income[3]	$2.7	$1.0	$1.6	$5.3
Output	$5.0	$3.5	$5.2	$13.8

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.

3.5.3 Illinois - US

As shown in Table 3.19, the indirect and induced impacts of O&M-related expenditures associated with that segment of the proposed transmission line located in Illinois increase when the scope of the analysis is expanded to the national level. Total employment impacts increase by 27, to 115 full-time equivalent jobs. Total labor income increases by $1.6 million, to $7.7 million.

Table 3.19: Estimated National-Level Impacts of Annual O&M-Related Expenditures on Grain Belt Express Clean Line in Illinois (Total annual spending = $7.0 million)

Impact[1]	Direct	Indirect	Induced	Total
Employment[2]	54	19	42	115
Labor Income[3]	4.1	1.3	2.4	7.7
Output	$7.0	$4.4	$7.5	$19.0

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.

3.5.4 Indiana - US

As shown in Table 3.20, the indirect and induced impacts of O&M-related expenditures associated with that segment of the proposed transmission line located in Indiana increase when the scope of the analysis is expanded to the national level. Total employment impacts increase by 1, to 4 full-time equivalent jobs. Total labor income increases by $70 thousand, to $260 thousand.

Table 3.20: Estimated National-Level Impacts of Annual O&M-Related Expenditures on Grain Belt Express Clean Line in Indiana (Total annual spending = $0.2 million)

Impact[1]	Direct	Indirect	Induced	Total
Employment[2]	2	1	1	4
Labor Income[3]	$0.13	$0.05	$0.08	$0.26
Output	$0.24	$0.17	$0.25	$0.66

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.

3.6 Summary of Estimated Manufacturing and Construction and O&M-Related Impacts

This section provides an aggregate view of the various impacts reported in Tables 3.3 – 3.6 and Tables 3.8 – 3.20.

3.6.1 Manufacturing and Construction

Table 3.21 summarizes the average annual impacts of manufacture of the inputs to, and construction of, the proposed transmission line at the state and national levels that would occur in each year of the three year construction period.

Table 3.21: Estimated Average Annual Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Kansas, Missouri, Illinois, Indiana, the Four-State Region, and the United States

		Kansas	Missouri	Illinois	Indiana	Four-State Region	United States
Component	**Impacts**[1]	**Annual Avg.**[4]	**Annual Avg.**	**Annual Avg.**	**Annual Avg.**	**Annual Avg.**	**Annual Avg.**
Installation of Structures	*Employment*[2]	1,383	834	758	8	2,982	3,996
	Labor Income[3]	$78.4	$49.2	$52.6	$0.46	$180.6	$251.5
	Output	$198.2	$116.5	$119.6	$1.13	$435.4	$675.7
Manufacture Structures	*Employment*	197	126	117	1	442	1525
	Labor Income	$12.2	$7.9	$8.7	$0.07	$28.9	$102.1
	Output	$44.7	$27.7	$28.1	$0.27	$100.7	$369.0
Manufacture Wire	*Employment*	59	37	36	0	133	566
	Labor Income	$4.1	$2.4	$3.3	$0.02	$9.8	$41.3
	Output	$22.5	$13.3	$13.8	$0.13	$49.7	$210.5
Architectural Services	*Employment*	146	89	84	1	320	416
	Labor Income	$9.7	$6.1	$6.3	$0.05	$22.2	$28.8
	Output	$20.5	$12.7	$12.9	$0.12	$46.3	$66.7
Right of Way	*Employment*	104	61	44	1	210	250
	Labor Income	$2.3	$1.5	$1.4	$0.01	$5.2	$7.9
	Output	$15.9	$9.5	$8.9	$0.09	$34.4	$42.6
Financial	*Employment*	36	20	17	0	73	118
	Labor Income	$1.2	$0.9	$1.0	$0.01	$3.2	$6.8
	Output	$7.6	$4.5	$4.3	$0.04	$16.4	$26.0
Electric Power	*Employment*	8	5	4	0	17	26
	Labor Income	$0.6	$0.4	$0.4	$0.00	$1.4	$2.1
	Output	$3.3	$1.9	$1.9	$0.02	$7.0	$9.3
Installation of Converters/ Transformers	*Employment*	407	143	390	27	966	1302
	Labor Income	$23.1	$8.4	$27.1	$1.57	$60.1	$83.0
	Output	$58.3	$20.0	$61.6	$3.88	$143.7	$221.4
Manufacture Transformer	*Employment*	0	0	0	0	0	56
	Labor Income	$0.0	$0.0	$0.0	$0.0	$0.0	$3.7
	Output	$0.0	$0.0	$0.0	$0.0	$0.0	$12.6
Totals	*Employment*	2,340	1,315	1,450	38	5,143	8,255
	Labor Income	$131.5	$77.0	$100.8	$2.2	$311.4	$527.2
	Output	$371.0	$206.0	$251.1	$5.7	$833.8	$1,633.8

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.
4. Assumes a three-year construction period.

The various figures reported in Table 3.21 for Kansas, Missouri, Illinois, Indiana, and the four-state region can be viewed as an upper bound on the impacts in question. Thus, for example, assuming 50 percent of all manufacturing-related activities (structures and wire) and 100 percent of all construction-related activities directly tied to the transmission line are completed by in-state firms in Kansas, Missouri, Illinois, and Indiana, over the projected period the employment impact in the four-state region could potentially average approximately 5,143 jobs per year for three years. As shown in the last column of Table 3.21, when spending that occurs outside of the four-state region is accounted for, average employment impacts would increase to 8,255 jobs per year. Projected income impacts would be substantial as well. Assuming, once again, that 50 percent of manufacturing-related activities and 100 percent of construction-related activities are completed by in-state firms in each of the four states, over the projected period the labor income impact in the four-state region would average approximately $311.4 million per year for three years. When spending occurring in the remainder of the country is accounted for, average labor income impacts would increase to $527.2 million per year for three years.

3.6.2 Operations and Maintenance

Table 3.22 summarizes the annual impacts of operations and maintenance of the proposed transmission line at the state and national levels. Unlike the construction-related impacts, which would cease after the three-year construction period, the O&M impacts would be sustained for the foreseeable future as these recur on an annual basis.

Table 3.22: Estimated Annual O&M-Related Impacts[1] of the Grain Belt Express Clean Line in Kansas, Missouri, Illinois, Indiana, the Four-State Region, and the United States

Impact[1]	Kansas	Missouri	Illinois	Indiana	Four-State Region	U.S.
Employment[2]	135	70	88	3	296	383
Labor Income[3]	$7.6	$4.1	$6.1	$0.19	$18.0	$24.0
Output	$17.7	$9.2	$13.1	$0.43	$40.4	$61.0

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.
3. Labor Income = Employee compensation + Proprietor income.

4 Economic Impacts of Associated Wind Farms

It is estimated that the Grain Belt Express Clean Line will connect approximately 4,000 MW of new wind farm capacity to the transmission grid. For this analysis, we assumed that the 4,000 MW will be built in western Kansas and comprise eight new wind farms. We further assumed that each wind farm will be 500 MW in size and entail construction costs of $1,700 per kW and operation and maintenance costs of $20 per kW. The JEDI model, which was used to estimate the economic impacts of construction of the new wind farms, contains default values that are used to allocate the construction and operation and maintenance costs to their component parts.

To estimate the economic impacts of the construction of the wind farms and the manufacture of the related components at the national and state levels, it is necessary to estimate the share of the wind turbine components that will be manufactured in the United States for the national impacts and the share of the components that will be manufactured in Kansas, Missouri, Illinois, and Indiana for the state analyses. The default values within the JEDI model were used for the local share of the operations and maintenance costs and the balance of plant costs. However, these default values were not used to estimate the local share of the manufacture of the larger components of a wind turbine – the nacelle, structure, blades, and transportation – which comprise 75 percent of the construction costs. Instead, we based the allocation on the American Wind Energy Association U.S. Wind Industry Annual Market Report 2012 conclusion that the domestic content of wind equipment (turbines, blades and structures) built in the United States rose to 67 percent in 2011. Blades and towers are easier to source and build domestically so it is reasonable to assume that a higher percentage of those components will be sourced domestically. Using 67 percent domestic content as a guideline, we assumed that 55 percent of the nacelles, 90 percent of the blades, and 90 percent of the structures will be produced in the United States. This yielded an overall cost-weighted average of domestic content of 66.56 percent. We assumed that 100 percent of the transportation is sourced within the United States.

To estimate the state-level economic impacts it was necessary to estimate the percentage of components that would be produced in each state. As is shown in Tables 4.1– 4.4, and as discussed more generally in the American Wind Energy Association U.S. Wind Industry Annual Market Report 2012, all four states have robust supply chains. Because it is impossible to know the identity and geographic location of the companies that will build the components for the proposed wind farms until they are actually built, we estimated the potential economic impacts of construction of the eight new wind farms using two different scenarios. Given the overall domestic content from the national model, we assumed that the four-state region would produce either 30 percent of the domestic content (low scenario) or 90 percent of the domestic content (high scenario) of the components that would go into construction of the new wind farms.

Table 4.1 : Major Kansas Wind Turbine Component Manufacturers

Company	Component
Atkinson Industries, Pittsburgh, KS	Machining/Fabrication
Electromech Technologies, Wichita, KS	Distributed Wind Turbines Drive Train
Enertech Manufacturing, Newton, KS	Distributed Wind Turbines
J.R. Custom Metal Production, Wichita, KS	Power Transmission - Machining/ Fabrication
Jupiter Group, Junction City, KS	Material- Composites
Draka, Hutchinson, KS	Electrical Power Transmission
Siemens, Hutchinson, KS	Turbines

Table 4.2: Major Missouri Wind Turbine Component Manufacturers

Company	Component
ABB Inc., St. Louis, MO & Jefferson City, MO	Electrical
Able Manufacturing, Joplin, MO	Machining/Fabrication
AZZ Central Electric, Fulton, MO	Electrical Power Converter
CG Power Systems, Washington, MO	Power Transmission
Continental Disc Corporation, Liberty, MO	Power Transmission Brakes
FAG Bearings, Joplin, MO	Bearings
Lincoln Industrial, St. Louis, MO	Machinery
Nordic Windpower, Kansas City, MO	Turbines
Schaeffler Group, Joplin, MO	Bearings
Sika Corporation, Grandview, MO	Material - Composites
Vest- Fiber, Moberly, MO	Nacelle Components
Zoltek, St. Peters, MO	Composites

Table 4.3: Major Illinois Wind Turbine Component Manufacturers

Company	Component
Afton Chemical, Sauget, IL	Power Transmission/Lubricants
Aldridge Electric, Chicago, IL	Electrical/Power Transmission
Amico, Bourbonnais, IL	Power Transmission Machining/Fabrication
Armacell, Chicago, IL	Material Composites
Brad Foote Gear Works, Cicero, IL	Power Transmission Gears
Castrol, Naperville, IL	Power Transmission Lubricants
Centa Corp., Aurora, IL	Power Transmission Couplings
Chicago Industrial Fasteners Sugar Grove, Aurora, IL	Structural Fasteners
Coleman Cable, Waukegan, IL	Electrical Power Transmission
Deublin Company, Waukegan, IL	Electrical Generator Components
Earle M. Jorgenson Company, Schaumburg, IL	Material Steel
Excel Gear, Roscoe. IL	Power Transmission Gears
Finkl and Sons, Chicago, IL	Structural Castings
G&W Electric, Bolingbrook, IL	Electrical Power Transmission
Gleason, Rockford, IL	Equipment Manufacturing Machinery
Harger Lightning and Grounding, Grays Lake, IL	Equipment Other Equipment
Harting Inc., Elgin, IL	Electrical Power Transmission
Hydac Technology Corp, Glendale Height, IL	Power Transmission Hydraulics
Ingersoll Cutting Tools, Rockford, IL	Equipment Manufacturing Machinery
Ingersoll Machine Tools, Rockford, IL	Power Transmission Machining/Fabrication
NTN Bearings, Macomb, IL	Power Transmission Bearings
S&C Electric Company, Chicago, IL	Electrical Power Converter
Smalley Steel Ring Company, Lake Zurich, IL	Power Transmission Bearings
Southwire Company, Flora, IL	Wire & Cable
Specialty Metal Fabricators, Minonk, IL	Structural Steel Products
Stanley Machining & Tool, Hampshire, IL	Power Transmission Machining/Fabrication
Stanley Machining & Tool, Carpentersville, IL	Power Transmission Machining/Fabrication
Titan Tool Works, Carol, Stream, IL	Equipment, Construction
Trinity Structural Towers, Inc., Clinton, IL	Towers
Universal Steel, Crete, IL	Material Steel
Winergy, Elgin, IL	Gearboxes

Table 4.4: Major Indiana Wind Turbine Component Manufacturers

Company	Component
Ambassador Steel Corp., Auburn, IN	Material Steel
AOC LLC, Valparaso, IN	Composites
ATI Casting Service, La Porte, IN	Structural Castings
Bedford Machine & Tool, Bedford, IN	Power transmission Machining/Fabrication
Brevini Wind, Yorktown, IN	Gearboxes
Carlisle Industrial Brake and Friction, Bloomington, IN	Power transmission Brakes
Coleman Cable, Lafayette, IN	Electrical power transmission
Draka, Kouts, IN	Electrical
Global Blade Technology, Evansville, IN	Blades
Industrial Steel Construction, Gary, IN	Equipment Manufacturing machinery
Industrial Steel Construction, Heidtman Steel Products, IN	raw material supplier
KTR Corporation, Michigan City, IN	Power Transmission - coupling
NSK Americas, Franklin, IN	Power transmission - bearings
Oerlikon Fairfield, Lafayette, IN	gears
O'Neal Steel, Indianapolis, IN	steel products
Standard Locknut, Westfield, IN	Bearings
Transhield Inc., Elkhart, IN	Protective covers
Universal Steel America, Gary, IN	Structural/steel

In general, because the eight new wind farms will be located in Kansas, it is reasonable to assume that half of the domestically-sourced content would be produced in Kansas and that the remainder of the domestically sourced content would be evenly divided among the remaining three states. Combining this assumption with the assumed percentages of the different components that would be produced domestically and the 30 percent and 90 percent scenarios described above yields the percentages reported in Table 4.5, which summarizes the different scenarios that were estimated and the percentage of wind turbine components assumed to be produced in each state. For example, as shown in Table 4.5,under the 30 percent scenario, Kansas would produce 8.25 percent of the turbines (one half of 55 percent times 30 percent), while each of the remaining states would produce 2.75 percent of the turbines (one third of one half of 55 percent times 30 percent). However, certain states do not currently host a tower or blade manufacturer. Although it is possible that a manufacturer might build a new facility in such a state, we assumed no new facilities would be built in the relevant time frame. Currently, Kansas has no blade or tower manufacturers; Illinois has no blade manufacturer; and Missouri has no tower manufacturer. In each of these cases, we held the assumed four-state region supply share constant and shifted the assumed share from a state that had no manufacturer for that component to the remaining states in the region. Because the wind turbine nacelle has numerous component parts, we chose to keep the allocation the same even if a nacelle assembly plant was not located in a particular state.

Table 4.5: Baseline Scenarios for Location of Wind Turbine Components

		Kansas		Missouri		Illinois		Indiana	
Component	U.S.	30%	90%	30%	90%	30%	90%	30%	90%
Turbines	55%	8.25%	24.75%	2.75%	8.25%	2.75%	8.25%	2.75%	8.25%
Blades	90%	0.00%	0.00%	13.50%	40.50%	0.00%	0.00%	13.50%	40.50%
Structures	90%	0.00%	0.00%	0.00%	0.00%	13.50%	40.50%	13.50%	40.50%
Transportation	100%	15.0%	45.0%	5.00%	15.00%	5.00%	15.00%	5.00%	15.00%

4.1 Kansas

The economic impact in Kansas has two parts: the direct impact of the construction of the wind farms that are built in Kansas (4,000 MW) and the indirect and induced impacts that include the supply chain impacts. Table 4.6 displays the direct expenditure estimates from the JEDI model under the two scenarios outlined earlier for the 4,000 MW of wind farms built in Kansas. The only change that occurs among the scenarios is the amount of installed project costs that are spent in Kansas. Spending in Kansas is $1.5 billion in the 30 percent scenario and $2.2 billion in the 90 percent scenario. The JEDI model estimates annual operational expenses for the 4,000 MW of Kansas wind farms at $1.1 billion. Total direct operating and maintenance costs amount to $80 million, with $21 million spent in Kansas. Taxes, financing costs, land leases and other expenses amount to $1,046 million, with $24 million spent in Kansas. The local spending in Kansas is determined by the JEDI model using its default values. These annual costs stay the same in the 30 percent and 90 percent scenario because the source of the equipment does not have an effect on the operations and maintenance costs.

Table 4.6: Kansas Direct Expenditure Estimates from JEDI Model for 4,000 MW of Kansas Wind Farms

	30% Scenario	90% Scenario
Installed Project Cost[1]	$6,800	$6,800
Local (Kansas) Spending	$1,522	$2,194
Total Annual Operational Expenses (O&M, financing costs, lease payments, and taxes)	$1,126	$1,126
Direct Operating and Maintenance Costs	$80	$80
Local (Kansas) Spending	$21	$21
Other Annual Costs (Taxes, financing costs, land leases, etc.)	$1,046	$1,046
Local (Kansas) Spending	$24	$24

1. All spending is in millions of 2013 $ and is rounded.

As shown in Table 4.7, in the 30 percent scenario, employment impacts during construction include 1,989 jobs for project development and on-site labor, 10,863 jobs due to turbine and supply chain impacts, and 2,690 jobs from induced impacts, for a total of 15,542 jobs. During the operating years, 181 on-site jobs will be created, local revenue and supply chain impacts will result in 242 jobs, and induced impacts will contribute another 104 jobs, resulting in a total of 528 new jobs. During construction, earnings will increase by a total of $779 million and total output will increase by approximately $2.3 billion. During the operating years, earnings will increase by $25 million and total output will increase by $73 million annually. As shown in Table 4.8, impacts increase to 19,656 new jobs and $3.3 billion in output during construction under the 90 percent scenario.

Table 4.7: Kansas Wind Farms Economic Impacts from JEDI Model for 4,000 MW of Kansas Wind Farms – Summary Results for 30 Percent Scenario

Impacts[1]	Employment[2]	Earnings	Output
During Construction Period			
Project Development and Onsite Labor Impacts	1,989	$103.5	$122.7
Turbine and Supply Chain Impacts	10,863	$563.9	$1,805.4
Induced Impacts	2,690	$111.3	$355.4
Total	15,542	$778.8	$2,283.5
During Operating Years (annual)			
Onsite Labor Impacts	181	$9.3	$9.3
Local Revenue and Supply Chain Impacts	242	$11.3	$50.2
Induced Impacts	104	$4.3	$13.7
Total	528	$25.0	$73.3

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

Table 4.8: Kansas Wind Farms Economic Impacts from JEDI Model for 4,000 MW of Kansas Wind Farms – Summary Results for 90 Percent Scenario

Impacts[1]	Employment[2]	Earnings	Output
During Construction Period			
Project Development and Onsite Labor Impacts	1,989	$103.5	$122.7
Turbine and Supply Chain Impacts	14,034	$772.2	$2,665.1
Induced Impacts	3,633	$150.3	$480.0
Total Impacts	19,656	$1,026.1	$3,267.7
During Operating Years (annual)			
Onsite Labor Impacts	181	$9.3	$9.3
Local Revenue and Supply Chain Impacts	242	$11.3	$50.2
Induced Impacts	104	$4.3	$13.7
Total Impacts	528	$25.0	$73.3

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

Sections 4.2 – 4.4 describe the estimated impacts on the Missouri, Illinois, and Indiana economies that are attributable to the wind farms we assume would be built in Kansas as a result of the Grain Belt Express Clean Line transmission line. Because all of the wind farms are assumed to be built in Kansas, we consider only the supply chain aspects of the new wind farm capacity for Missouri, Illinois, and Indiana. The total direct expenditure estimates for the two scenarios (30 percent and 90 percent) are the same direct expenditures reported in Table 4.6. Once again, the only difference between the two scenarios is the amount of the project costs that are assumed to be spent in each of the three remaining states.

4.2 Missouri

As shown in Table 4.5, we assume that 2.75 percent of the turbine components, 13.5 percent of the blades and 5 percent of the transportation would be sourced from Missouri under the 30 percent scenario. In the 90 percent scenario, 8.25 percent of the turbine components, 40.5 percent of the blades, and 15 percent of the transportation would be sourced from Missouri. Referring to Table 4.9, total spending in Missouri would range from $209 million under the 30 percent scenario to $627 million under the 90 percent scenario.

Table 4.9: Missouri Direct Expenditure Estimates from JEDI Model for 4,000 MW of Wind Farms Built in Kansas

Expenditures[1]	30% Scenario	90% Scenario
Installed Project Cost	$6,800	$6,800
Local (Missouri) Spending	$209	$627
Total Annual Operational Expenses (O&M, financing costs, lease payments, and taxes)	$1,134	$1,134
Direct Operating and Maintenance Costs	$80	$80
Local (Missouri) Spending	$0	$0
Other Annual Costs (Taxes, financing costs, land leases, etc.)	$1,054	$1,054
Local (Missouri) Spending	$0	$0

1. All spending is in millions of 2013 $ and is rounded.

Tables 4.10 and 4.11 summarize the estimated impacts in Missouri under the 30 percent and 90 percent scenarios. Estimated employment impacts range from approximately 1,311 to 3,933 jobs, and output impacts range from $329 million to $987 million. There are no operating year impacts because the wind farms are assumed to be located outside of Missouri.

Table 4.10: Missouri Supply Chain Economic Impacts from JEDI Model for 4,000 MW of Wind Farms Built in Kansas – Summary Results for 30 Percent Scenario

Impacts[1]	Employment[2]	Earnings	Output
During Construction Period			
Project Development and Onsite Labor Impacts	0	$0	$0
Turbine and Supply Chain Impacts	980	$65.3	$284.3
Induced Impacts	331	$14.5	$44.7
Total Impacts	1,311	$79.8	$329.0

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

Table 4.11: Missouri Supply Chain Economic Impacts from JEDI Model for 4,000 MW of Wind Farms Built in Kansas – Summary Results for 90 Percent Scenario

Impacts[1]	Employment[2]	Earnings	Output
During Construction Period			
Project Development and Onsite Labor Impacts	0	$0	$0
Turbine and Supply Chain Impacts	2,939	$196.0	$852.9
Induced Impacts	994	$43.5	$134.0
Total Impacts	3,933	$239.5	$986.9

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

4.3 Illinois

As shown in Table 4.5, we assume that 2.75 percent of the turbine components, 13.5 percent of the structures, and 5 percent of the transportation would be sourced from Illinois under the 30 percent scenario. For the 90 percent scenario, 8.25 percent of the turbine components, 40.5 percent of the structures, and 15 percent of the transportation would be sourced in Illinois. Referring to Table 4.12, total spending in Illinois in each of these scenarios would range from $218 million under the 30 percent scenario to $654 million under the 90 percent scenario.

Table 4.12: Illinois Direct Expenditure Estimates from JEDI Model for 4,000 MW of Wind Farms Built in Kansas

Expenditures[1]	30% Scenario	90% Scenario
Installed Project Cost	$6,800	$6,800
Local (Illinois) Spending	$218	$654
Total Annual Operational Expenses (O&M, financing costs, lease payments, and taxes)	$1,142	$1,142
Direct Operating and Maintenance Costs	$80	$80
Local (Illinois) Spending	$0	$0
Other Annual Costs (Taxes, financing costs, land leases, etc.)	$1,062	$1,062
Local (Illinois) Spending	$0	$0

1. All spending is in millions of 2013 $ and is rounded.

Tables 4.13 and 4.14 summarize the estimated impacts in Illinois under the 30 percent and 90 percent scenarios. Estimated employment impacts range from approximately 1,471 to 4,412 jobs, and output impacts range from $381 million to $1.14 billion. There are no operating year impacts because the wind farms are assumed to be located outside of Illinois.

Table 4.13: Illinois Supply Chain Economic Impacts from JEDI Model for 4,000 MW of Wind Farms Built in Kansas – Summary Results for 30 Percent Scenario

Impacts[1]	Employment[2]	Earnings	Output
During Construction Period			
Project Development and Onsite Labor Impacts	0	$0	$0
Turbine and Supply Chain Impacts	1,061	$81.6	$315.4
Induced Impacts	410	$22.4	$65.7
Total Impacts	1,471	$104.0	$381.1

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

Table 4.14: Illinois Supply Chain Economic Impacts from JEDI Model for 4,000 MW of Wind Farms Built in Kansas – Summary Results for 90 Percent Scenario

Impacts[1]	Employment[2]	Earnings	Output
During Construction Period			
Project Development and Onsite Labor Impacts	0	$0	$0
Turbine and Supply Chain Impacts	3,182	$244.7	$946.3
Induced Impacts	1,230	$67.2	$197.1
Total Impacts	4,412	$311.9	$1,143.4

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

4.4 Indiana

As shown in Table 4.5, we assume that 2.75 percent of the turbine components, 13.5 percent of the blades, 13.5 percent of the structures, and 5 percent of the transportation would be sourced from Indiana under the 30 percent scenario. In the 90 percent scenario, 8.25 percent of the turbine components, 40.5 percent of the blades, 40.5 percent of the structures, and 15 percent of the transportation would be sourced from Indiana. Referring to Table 4.15, total spending in Indiana in each of these scenarios would range from $316 million under the 30 percent scenario to $949 million under the 90 percent scenario.

Table 4.15: Indiana Direct Expenditure Estimates from JEDI Model for 4,000 MW of Wind Farms Built in Kansas

Expenditures[1]	30% Scenario	90% Scenario
Installed Project Cost	$6,800	$6,800
Local (Indiana) Spending	$316	$949
Total Annual Operational Expenses (O&M, financing costs, lease payments, and taxes)	$1,178	$1,178
Direct Operating and Maintenance Costs	$80	$80
Local (Indiana) Spending	$0	$0
Other Annual Costs (Taxes, financing costs, land leases, etc.)	$1,098	$1,098
Local (Indiana) Spending	$0	$0

1. All spending is in millions of 2013 $ and is rounded.

Tables 4.16 and 4.17 summarize the estimated impacts in Indiana under the 30 percent and 90 percent scenarios. Estimated employment impacts range from approximately 1,872 to 5,617 jobs, and output impacts range from $472 million to $1.42 billion. There are no operating year impacts because the wind farms are assumed to be located outside of Indiana.

Table 4.16: Indiana Supply Chain Economic Impacts from JEDI Model for 4,000 MW of Wind Farms Built in Kansas – Summary Results for 30 Percent Scenario

Impacts[1]	Employment[2]	Earnings	Output
During Construction Period			
Project Development and Onsite Labor Impacts	0	$0	$0
Turbine and Supply Chain Impacts	1,398	$94.3	$412.2
Induced Impacts	475	$19.2	$60.3
Total Impacts	1,872	$113.5	$472.5

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

Table 4.17: Indiana Supply Chain Economic Impacts from JEDI Model for 4,000 MW of Wind Farms Built in Kansas – Summary Results for 90 percent Scenario

Impacts[1]	Employment[2]	Earnings	Output
During Construction Period			
Project Development and Onsite Labor Impacts	0	$0	$0
Turbine and Supply Chain Impacts	4,193	$283.0	$1,236.7
Induced Impacts	1,424	$57.5	$180.8
Total Impacts	5,617	$340.6	$1,417.5

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

4.5 United States

To estimate impacts at the national level, we assumed that 55 percent of the nacelles, 90 percent of the blades, and 90 percent of the structures would be manufactured in the United States along with 100 percent of the transportation for all 4,000 MW of new generating capacity. Table 4.18 summarizes the resulting direct expenditure estimates.

Table 4.18: United States Direct Expenditure Estimates from JEDI Model of 4,000 MW of Wind Farms

Expenditure[1]	Amount
Installed Project Cost	$6,800
Local (U.S.) Spending	$5,269
Total Annual Operational Expenses (O&M, financing costs, lease payments, and taxes)	$1,144
Direct Operating and Maintenance Costs	$80
Local (U.S.) Spending	$52
Other Annual Costs (Taxes, financing costs, land leases, etc.)	$1,064
Local (U.S.) Spending	$1,064

1. All spending is in millions of 2013 $ and is rounded.

Table 4.19 summarizes the national economic impacts resulting from the 4,000 MW of wind farms. During construction, approximately 71,075 jobs will be created and during the operating years, 3,360 jobs will be created. Total output is predicted to increase by approximately $15.1 billion during construction and $981 million during operation.

Table 4.19: United States Direct Expenditure Estimates from JEDI Model of 4,000 MW of Wind Farms – Summary Results

Impacts[1]	Employment[2]	Earnings	Output
During Construction Period			
Project Development and Onsite Labor Impacts	3,157	$219.5	$271.7
Turbine and Supply Chain Impacts	39,524	$2,691.7	$10,024.3
Induced Impacts	28,394	$1,510.5	$4,864.6
Total Impacts	71,075	$4,421.7	$15,160.5
During Operating Years (annual)			
Onsite Labor Impacts	200	$11.3	$11.3
Local Revenue and Supply Chain Impacts	1,342	$82.7	$658.5
Induced Impacts	1,818	$96.7	$311.5
Total Impacts	3,360	$190.7	$981.4

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

5 Fiscal Impacts: Transmission Line Construction and Operations

The IMPLAN model was also used to estimate various tax-related impacts of a projected increase in final demand in the economy. The tax impacts considered here include individual income tax, corporate income tax, and sales tax revenues in Kansas, Missouri, Illinois, and Indiana attributable to the manufacture of required components and construction of that segment of the Grain Belt Express Clean Line that will be located in each state. The impacts reported here do not reflect any specific tax-related incentives that any one of the states might offer to Clean Line.

5.1 Manufacturing and Construction

Projected increases in tax revenues in Kansas, Missouri, Illinois, and Indiana attributable to increased spending on manufacturing of structures and wire; construction of the transmission line; installation of a transformer; the payment of fees for the required right-of-way, architectural, and financial services; and the purchase of electric power associated with the line are summarized in Tables 5.1 – 5.4.

5.1.1 Kansas

As shown in Table 5.1, it is estimated that the direct, indirect, and induced impacts resulting from the manufacturing and construction of that segment of the Grain Belt Express Clean Line located in Kansas would yield $8.47 million in income taxes paid by individuals, $1.17 million in corporate income taxes, and $10.64 million in sales tax revenues over the three-year construction period. This translates to an average annual increase in tax revenues attributable to these three revenue streams of $6.76 million per year over the three-year period.

Table 5.1: Estimated Fiscal Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Kansas

Component	Individual Income Tax[1]	Corporate Income Tax	Sales Tax	Total	Annual Average[2]
Installation of Structures	$5.06	$0.53	$6.23	$11.82	$3.94
Manufacture Structures	$0.78	$0.13	$1.15	$2.06	$0.69
Manufacture Wire	$0.26	$0.06	$0.38	$0.70	$0.23
Architectural Services	$0.62	$0.05	$0.65	$1.32	$0.44
Right of Way	$0.15	$0.20	$1.59	$1.94	$0.65
Financial	$0.08	$0.02	$0.18	$0.28	$0.09
Electric Power	$0.04	$0.03	$0.45	$0.52	$0.17
Installation of Converter	$1.49	$0.16	$0.00[3]	$1.64	$0.55
Totals	$8.47	$1.17	$10.64	$20.28	$6.76

1. All impacts are in millions of 2013 $ and are rounded.
2. Assumes a three-year construction period.
3. Sales taxes from converter installation are set at 0 on the assumption that the converter stations might qualify for a tax relief exemption.

5.1.2 Missouri

As shown in Table 5.2, it is estimated that the direct, indirect, and induced impacts resulting from the manufacturing and construction of that segment of the Grain Belt Express Clean Line located in Missouri would yield $4.19 million in income taxes paid by individuals, $280 thousand in corporate income taxes, and $6.75 million in sales tax revenues over the three-year construction period. This translates to an average annual increase in tax revenues attributable to these three revenue streams of $3.74 million per year over the three-year period.

Table 5.2: Estimated Fiscal Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Missouri

Component	Individual Income Tax[1]	Corporate Income Tax	Sales Tax	Total	Annual Average[2]
Installation of Structures	$2.68	$0.13	$3.96	$6.77	$2.26
Manufacture Structures	$0.43	$0.03	$0.78	$1.24	$0.41
Manufacture Wire	$0.13	$0.01	$0.25	$0.40	$0.13
Architectural Services	$0.33	$0.01	$0.43	$0.78	$0.26
Right of Way	$0.08	$0.05	$0.94	$1.07	$0.36
Financial	$0.05	$0.01	$0.14	$0.20	$0.07
Electric Power	$0.02	$0.01	$0.25	$0.28	$0.09
Installation of Converter	$0.46	$0.02	$0.00	$0.48	$0.16
Totals	$4.19	$0.28	$6.75	$11.22	$3.74

1. All impacts are in millions of 2013 $ and are rounded.
2. Assumes a three-year construction period.
3. Sales taxes from converter installation are set at 0 on the assumption that the converter stations might qualify for a tax relief exemption.

5.1.3 Illinois

As shown in Table 5.3, it is estimated that the direct, indirect, and induced impacts resulting from the manufacturing and construction of that segment of the Grain Belt Express Clean Line located in Illinois would yield $4.18 million in income taxes paid by individuals, $1.12 million in corporate income taxes, and $6.48 million in sales tax revenues over the three-year construction period. This translates to an average annual increase in tax revenues attributable to these three revenue streams of $3.93 million per year over the three-year period.

Table 5.3: Estimated Fiscal Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Illinois

Component	Individual Income Tax[1]	Corporate Income Tax	Sales Tax	Total	Annual Average[2]
Installation of Structures	$2.18	$0.45	$3.78	$6.41	$2.14
Manufacture Structures	$0.36	$0.12	$0.76	$1.24	$0.41
Manufacture Wire	$0.14	$0.06	$0.25	$0.45	$0.15
Architectural Services	$0.26	$0.05	$0.41	$0.71	$0.24
Right of Way	$0.06	$0.16	$0.90	$1.12	$0.37
Financial	$0.04	$0.03	$0.14	$0.21	$0.07
Electric Power	$0.02	$0.02	$0.25	$0.28	$0.09
Installation of Converter	$1.12	$0.23	$0.00	$1.35	$0.45
Totals	$4.18	$1.12	$6.48	$11.78	$3.93

1. All impacts are in millions of 2013 $ and are rounded.
2. Assumes a three-year construction period.
3. Sales taxes from converter installation are set at 0 on the assumption that the converter stations might qualify for a tax relief exemption.

5.1.4 Indiana

As shown in Table 5.4, it is estimated that the direct, indirect, and induced impacts resulting from the manufacturing and construction of that segment of the Grain Belt Express Clean Line located in Indiana would yield $143 thousand in income taxes paid by individuals, $15 thousand in corporate income taxes, and $63 thousand in sales tax revenues over the three-year construction period. This translates to an average annual increase in tax revenues attributable to these three revenue streams of $74 thousand per year over the three-year period.

Table 5.4: Estimated Fiscal Impacts of Manufacturing and Construction of Grain Belt Express Clean Line in Indiana

Component	Individual Income Tax[1]	Corporate Income Tax	Sales Tax	Total	Annual Average[2]
Installation of Structures	$0.030	$0.003	$0.037	$0.069	$0.023
Manufacture Structures	$0.005	$0.001	$0.007	$0.012	$0.004
Manufacture Wire	$0.002	$0.000	$0.002	$0.004	$0.001
Architectural Services	$0.004	$0.000	$0.004	$0.008	$0.003
Right of Way	$0.001	$0.001	$0.009	$0.011	$0.004
Financial	$0.000	$0.000	$0.001	$0.002	$0.001
Electric Power	$0.000	$0.000	$0.003	$0.003	$0.001
Installation of Transformer	$0.102	$0.010	$0.000	$0.112	$0.037
Totals	$0.143	$0.015	$0.063	$0.221	$0.074

1. All impacts are in millions of 2013 $ and are rounded.
2. Assumes a three-year construction period.
3. Sales taxes from transformer installation are set at 0 on the assumption that the transformer station might qualify for a tax relief exemption.

5.2 Operations and Maintenance

As we discussed in Section 3, once the transmission line is built and is in operation, O&M costs will contribute $10.0 million of additional spending to the Kansas economy each year. The corresponding amounts for Missouri, Illinois, and Indiana are $5.0 million, $7.0 million, and $0.2 million, respectively. The estimated tax-related impacts of annual O&M expenditures in each state are summarized in Tables 5.5 – 5.8.

Table 5.5: Estimated Annual Fiscal Impacts of Grain Belt Express Clean Line O&M Expenditures in Kansas

Impact[1]	Total
Individual Income Tax	$0.162
Corporate Income Tax	$0.016
Sales Tax	$0.201
Total	$0.379

1. All impacts are in millions of 2013 $ and are rounded.

5.2.1 Kansas

Referring to Table 5.5, in Kansas annual individual income tax revenues, corporate income taxes, and sales tax revenues are predicted to amount to $162 thousand, $16 thousand, and $201 thousand per year, respectively. The combined total is $379 thousand in additional tax revenues each year.

Table 5.6: Estimated Annual Fiscal Impacts of Grain Belt Express Clean Line O&M Expenditures in Missouri

Impact[1]	Total
Individual Income Tax	$0.074
Corporate Income Tax	$0.004
Sales Tax	$0.111
Total	$0.189

1. All impacts are in millions of 2013 $ and are rounded.

5.2.2 Missouri

Referring to Table 5.6, in Missouri annual individual income tax revenues, corporate income taxes, and sales tax revenues are predicted to amount to $74 thousand, $4 thousand, and $111 thousand per year, respectively. The combined total is $189 thousand in additional tax revenues each year.

Table 5.7: Estimated Annual Fiscal Impacts of Grain Belt Express Clean Line O&M Expenditures in Illinois

Impact[1]	Total
Individual Income Tax	$0.084
Corporate Income Tax	$0.017
Sales Tax	$0.146
Total	$0.247

1. All impacts are in millions of 2013 $ and are rounded.

5.2.3 Illinois

Referring to Table 5.7, in Illinois annual individual income tax revenues, corporate income taxes, and sales tax revenues are predicted to amount to $84 thousand, $17 thousand, and $146 thousand per year, respectively. The combined total is $247 thousand in additional tax revenues each year.

5.2.1 Indiana

Referring to Table 5.8, in Indiana annual individual income tax revenues and sales tax revenues are predicted to amount to $4 thousand and $5 thousand per year, respectively. The combined total is $9 thousand in additional tax revenues each year.

Table 5.8: Estimated Annual Fiscal Impacts of Grain Belt Express Clean Line O&M Expenditures in Indiana

Impact[1]	Total
Individual Income Tax	$0.004
Corporate Income Tax	$0.000
Sales Tax	$0.005
Total	$0.009

1. All impacts are in millions of 2013 $ and are rounded.

6 Summary of Economic Impacts

The construction of the proposed Grain Belt Express Clean Line has the potential to yield substantial economic impacts in Kansas, Missouri, Illinois, Indiana, and the nation over the projected three-year construction period. Referring to Table 6.1, manufacturing of structures and wire and construction of the line could potentially increase employment by approximately 2,340 jobs in Kansas, 1,315 jobs in Missouri, 1,450 jobs in Illinois, and 38 jobs in Indiana in each year of the three-year construction period. Labor income would increase $131.5 million per year in Kansas, $77 million in Missouri, $100.8 million in Illinois, and $2.2 million in Indiana during the same time frame.

Table 6.1: Estimated Annual Average Manufacturing- and Construction-Related Impacts of the Grain Belt Express Clean Line in Kansas, Missouri, Illinois, Indiana, and the United States

Impact[1, 2]	Kansas	Missouri	Illinois	Indiana	U.S.
Employment	2,340	1,315	1,450	38	8,255
Labor Income	$131.5	$77.0	$100.8	$2.2	$527.2
Output	$371.0	$206.0	$251.1	$5.7	$1,633.8

1. All impacts are in millions of 2013 $ and are rounded.
2. Assumes a three-year construction period

Once completed, operation and maintenance of the line would continue to yield economic benefits to each state. Referring to Table 6.2, potential annual employment impacts in Kansas include 143 jobs and $6 million in labor income. Missouri could see an additional 70 jobs and $4.1 million of labor income each year. The corresponding totals in Illinois are 88 jobs and $6.1 million in additional labor income. In Indiana, there would be 3 additional jobs and $190 thousand in additional labor income.

Table 6.2: Estimated Annual O&M-Related Impacts[1] of the Grain Belt Express Clean Line in Kansas, Missouri, Illinois, Indiana, and the United States

Impact[1]	Kansas	Missouri	Illinois	Indiana	U.S.
Employment[2]	135	70	88	3	383
Labor Income[3]	$7.6	$4.1	$6.1	$0.19	$24.0
Output	$17.7	$9.2	$13.1	$0.43	$61.0

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents
3. Labor Income = Employee compensation + Proprietor income

Table 6.3 lists fiscal impacts attributable to manufacture and construction of the transmission line. Tax revenues from the sources listed there could amount to $6.76 million in Kansas, $3.74 million in Missouri, $3.93 million in Illinois, and $74 thousand in Indiana each year of the three-year period.

Table 6.3: Estimated Annual[1] Fiscal Impacts[2] of Construction of Grain Belt Express Clean Line in 4-State Region

Impact	Kansas	Missouri	Illinois	Indiana
Individual Income Tax	$2.82	$1.40	$1.39	$0.048
Corporate Income Tax	$0.39	$0.09	$0.37	$0.005
Sales Tax	$3.55	$2.25	$2.16	$0.021
Total	$6.76	$3.74	$3.93	$0.074

1. Construction period = 3 years
2. All monetary impacts are in millions of 2013 $ and are rounded.

Finally, as shown in Table 6.4, annual tax revenues from the sources listed there resulting from operation and maintenance of the line could amount to $379 thousand in Kansas, $189 thousand in Missouri, $247 thousand in Illinois, and 9 thousand in Indiana.

Table 6.4: Summary of Estimated Annual Fiscal Impacts[1] of O&M Expenditures

	Kansas	Missouri	Illinois	Indiana
Individual Income Tax	$0.162	$0.074	$0.084	$0.004
Corporate Income Tax	$0.016	$0.004	$0.017	$0.000
Sales Tax	$0.201	$0.111	$0.146	$0.005
Total	$0.379	$0.189	$0.247	$0.009

1. All monetary impacts are in millions of 2013 $ and are rounded.

The construction of additional wind farms which the proposed transmission line is expected to stimulate has the potential to result in significant economic impacts as well. Table 6.5 summarizes the estimated total economic impacts during the construction period in Kansas under the 30 percent and 90 percent scenarios. The potential total employment impacts during construction range from 15,542 to 19,656 jobs, with output expanding by $2.2 billion to $3.3 billion under the 30 percent and 90 percent scenarios, respectively. We also estimate that during operations, the wind farms built in Kansas would result in 528 jobs, $25 million in earnings, and $73 million in output annually.

Table 6.5: Kansas Wind Farms Economic Impacts

Impacts[1]	Employment[2]	Earnings	Output
Total Construction Impacts 30% Scenario	15,542	$778.8	$2,283.5
Total Construction Impacts 90% Scenario	19,656	$1,026.1	$3,267.7
Total Operating Year Impacts – All Scenarios	528	$25.0	$73.3

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

While Missouri, Illinois and Indiana would experience smaller overall impacts than Kansas because the new wind farms would not be built in those states, substantial economic benefits would still accrue to those states. As shown in Table 6.6, the total employment impacts of supply chain effects during construction would range from 1,311 to 3,933 jobs in Missouri, from 1,471 to 4,412 in Illinois and from 1,872 to 5,617 in Indiana.

Table 6.6: Missouri, Illinois, and Indiana Wind Farms Economic Impacts

State	Total Construction Impacts[1]	Employment[2]	Earnings	Output
Missouri	30% Scenario	1,311	$79.8	$329.0
	90 % Scenario	3,933	$239.5	$986.9
Illinois	30% Scenario	1,471	$104.0	$381.1
	90 % Scenario	4,412	$311.9	$1,143.4
Indiana	30% Scenario	1,872	$113.5	$472.5
	90 % Scenario	5,617	$340.6	$1,417.5

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

Finally, the economic impacts of the wind farms on the United States as a whole are summarized in Table 6.7. Construction of the wind farms could result in 71,075 jobs, $4.4 billion in earnings, and $15.2 billion in output. Operation of the new wind farms could generate approximately 3,360 jobs, $191million in earnings, and $981 million in output annually.

Table 6.7: National Economic Impacts of Wind Farm Construction and Operation

Total Impacts[1]	Employment[2]	Earnings	Output
Construction Impacts	71,075	$4,421.7	$15,160.5
Annual Operating Impacts	3,360	$190.7	$981.4

1. All monetary impacts are in millions of 2013 $ and are rounded.
2. All employment figures are full time equivalents.

APPENDIX

Qualifications

Dr. David G. Loomis

Dr. David G. Loomis is president of Strategic Economic Research, LLC and Professor of Economics at Illinois State University where he teaches in the Master's Degree program in electricity, natural gas and telecommunications economics. Dr. Loomis is Director of the Center for Renewable Energy and Executive Director of the Institute for Regulatory Policy Studies. As part of his duties, he leads the Illinois Wind Working Group under the U.S. Department of Energy. Dr. Loomis is part of a team of faculty that has designed a new undergraduate curriculum in renewable energy at Illinois State University. Dr. Loomis earned his Ph.D. in economics at Temple University.

Dr. Loomis co-authored several industry reports relevant to this report, including *The Economic Impact of Wind Energy in Illinois* (co-authored with Sarah Noll and Jared Hayden, 2012) and *The Economic Impact of the Wind Turbine Supply Chain in Illinois* (co-authored with J. Lon Carlson and James E. Payne, 2010).

Prior to joining the faculty at Illinois State University, Dr. Loomis worked at Bell Atlantic (Verizon) for 11 years. He has published articles in the *Energy Policy, Energy Economics, Electricity Journal, Review of Industrial Organization, Utilities Policy, Information Economics and Policy, International Journal of Forecasting, International Journal of Business Research, Business Economics* and the *Journal of Economics Education.*

Dr. J. Lon Carlson

Dr. J. Lon Carlson is an independent consultant who recently retired as an Associate Professor in the Department of Economics at Illinois State University and Director of Outreach for the Institute for Regulatory Policy Studies. His research on energy issues and environmental economics has appeared in several outlets, including *The Electricity Journal, Energy Policy, Natural Resources Journal, the Boston College Environmental Affairs Law Review, the Journal of the Air and Waste Management Association, and the Journal of Applied Economics Letters.*

Dr. Carlson has also co-authored several economic impact analyses that utilized the IMPLAN model, including *The Economic Impact of the Wind Turbine Supply Chain in Illinois* (co-authored with David G. Loomis and James E. Payne, 2010) and was a principal author of an Environmental Impact Statement that was completed for Western Area Power Administration by Argonne National Laboratory in 1995. Dr. Carlson has held positions at Argonne National Laboratory and the U.S. Government Accountability Office, and has worked as a consultant for a number of government agencies. He received his Ph.D. in Economics from the University of Illinois at Urbana-Champaign in 1984.