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A Computable General Equilibrium (CGE) Analysis of the Impact of the Oklahoma Taxpayer and Citizen Protection Act of 2007

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Introduction

It is a rare occasion that policymakers craft and support legislation specifically designed to impose economic penalties on the jurisdiction whose affairs they administer. When such legislation is imposed, it is generally done so under the auspices of achieving a greater social objective. Increasingly, states are attempting to address social concerns believed to be insufficiently dealt with at the national level through legislation and enforcement at the subnational level. This pattern is particularly striking with regard to environmental and immigration issues.[1] A specific example of such a policy familiar to nearly all Oklahomans is The Oklahoma Taxpayer and Citizen Protection Act of 2007, known simply as House Bill 1804.

The explicit intent of HB 1804 is to address the burden that immigrant labor places on the public sector by precipitating the out-migration of foreign-born workers. That such an outflow of labor resources with the associated expenditures of labor income would impose a significant penalty on the state's economy could hardly be unanticipated. Rather, the economic penalty is, presumably, deemed acceptable if not simply the price of addressing a concern insufficiently addressed through current federal regulation and enforcement. The purpose of this report is to provide an estimate of the economic hardship imposed by HB 1804, contributing to a more complete and fruitful discussion of the issue. It is important to note that the presence of a significant economic penalty alone does not imply that the legislation is unwarranted. However, endorsing (opposing) the legislation without some estimate of the economic consequences of action (inaction) encourages the implementation of significant policies in spite of an incomplete discussion of the resulting impacts. The intent of this report is not to influence policy outcomes, but to encourage policy debate.

The remainder of this report is organized as follows: section one outlines the analysis undertaken for this report, identifies relevant economic considerations, and provides an overview of the foreign-born population in Oklahoma. Section two presents a summary of recent conditions in the Oklahoma economy and labor market, the economic model of the state constructed and employed in this analysis, as well as the estimated impacts to Oklahoma production. Section three concludes. Finally, an attached appendix provides a technical specification of the model.

[1] It is interesting to note that in both cases the right of the states to dictate environmental policy (such as fleet gas efficiency standards) and immigration policy is being challenged at the Federal level on the grounds that allowing states to do so would create inconsistent regulations between states.

Section I – Immigration and Policy Issues in Oklahoma

Impact analysis generally begins with identifying and constructing an appropriate economic model specific to the designated question and region of interest. Many impact models are inherently demand-sided in nature, useful in estimating the economic benefits associated with a change in the final demand for regionally produced goods and services. Such models can be classified generically as input-output models and are commonly used to provide impact estimates from projects such as new construction and development. The immigration legislation under consideration, however, is clearly a supply-side issue, with the intent of the bill to alter the state's level of productive resources. To assess the impacts resulting from the outflow of labor requires an alternative approach. All impact estimates provided in this report are generated by an Oklahoma-specific computable general equilibrium (CGE) model.

Static CGE models are essentially a mathematical representation of the relevant relationships in an economy at a given point in time. By changing the mathematical specification in a way that reflects an observed, real-world, policy change, the adjustments observed in the model can be used to estimate the adjustments expected in the economy. An abridged discussion of the CGE model constructed for this report as well as the estimated impacts can be found in section twoof this report, with a more complete discussion included in appendix A.

Isaac Newton's laws of motion provide a framework for analyzing the relationship between the forces acting on a body and the motion of the body. Newton's second law identifies the acceleration of an object as being determined by the net forces exerted on the object and the mass of the object.[2] That is, for a given mass, the trajectory and acceleration of an object is determined by the combined forces exerted on it. Similarly, an economy's trajectory and acceleration are determined by the combined economic pressures present in the economy. From this vantage point, HB 1804 and the resulting out-migration of foreign-born labor can be viewed as one of many economic forces present in the economy, with the combined forces determining the trajectory of our economy. Economic impact assessments are not forecasts; they do not attempt to identify the trajectory of the economy by analyzing the combined forces of all economic pressures. Rather, impact assessments identify the relative strength of a particular force, holding all other forces constant.

[2] The relationship between net physical forces determining the trajectory and acceleration of on object and net economic forces determining the trajectory and acceleration of an economy are particularly instructive. Newton's second law only holds when the unbalanced net force is introduced on an object previously experiencing balanced forces. The property of balanced forces, also called an inertial reference frame, suggests the object is initially at rest or moving at a constant velocity. Analogously, CGE models begin with the assumption that the initial year's data used to construct the model represents an economy at equilibrium, or at rest.

The present report, then, can be thought of as providing a measure of the adverse economic force created by the implementation and enforcement of HB 1804. If the trajectory of the economy is to be continued expansion at expected rates of growth, there must be positive economic forces sufficient to offset the penalty associated with the legislation. It is important to note as well, that the timing of the legislation is unfortunate. If the national economy slips into a recession, or if energy prices fall, or if the housing market in Oklahoma stalls, the combined pressures on the state's economy could become overwhelmingly negative with severe economic consequences. To date, however, Oklahoma has fared well in what is otherwise troubled economic conditions nationally. Sustained energy and housing prices combined with a robust national economic expansion would serve to absorb and counter some of the negative economic pressures associated with the labor outflow.

The focus of this report is on foreign-born residents in the state. Foreign-born residents are identified by the U.S. Census Bureau as any resident who was not a U.S. citizen at birth, including, undocumented residents, documented residents, and naturalized citizens. Attention is given to foreign-born residents for two primary reasons. The first reason is one of pragmatics. Data is readily available on foreign-born residents at both the state and national level. Respondents are not asked for their residency status, only for their country of birth and a description of their economic and social circumstances. The second reason reflects economic considerations. Aspects of HB 1804 seem designed (perhaps unintentionally) to have a particularly strong impact on families and communities of mixed residency status. For example, according to the summary of the provisions of 1804 provided by the organization Immigration Reform for Oklahoma Now, "section 3 replicates the federal provision that makes it a felony … for any person to transport, harbor, or shelter an alien in reckless disregard for their illegal immigrations status." Faced with a significantly higher probability of a felony arrest, family and community members residing in Oklahoma legally are more likely to leave Oklahoma with their undocumented counterparts. Additionally, it is likely that social networks in foreign-born communities consist of both documented and undocumented workers, so that as the undocumented social structure migrates to other regions it carries with it a portion of the documented social makeup. Indeed, anecdotal evidence suggests that out-migration occurring in response to HB 1804 is not limited to undocumented workers.[3]

The tables presented below are designed to provide an overview of the immigrant population within the state. Combined, the tables present a picture of a relatively small and diverse immigrant population in Oklahoma. The tables also reflect the expected conclusion that it is difficult to ascertain the precise number of documented and undocumented immigrants in the state at any given point in time. However, the data are consistent across independent groups,

[3] This phenomenon is commonly referred to as a chilling effect, whereby ethnic groups feel a cold reception regardless of immigration status and relocate to friendlier regions.

suggesting a fairly reliable range of estimates for both Oklahoma's documented and undocumented population.[4] Table 1 below provides a range of estimates for the total foreign-born population in Oklahoma. The foreign-born population includes all residents who were not a U.S. citizen at birth and does not ask respondents to identify their immigration status. Thus, the respondents would include undocumented residents, documented residents, and naturalized citizens. Finally, the survey does not gather data on individuals living in group quarters and would therefore exclude immigrants in nursing homes, penal institutions, college dormitories, etc. Based on recent years' data, estimates of the immigrant population in Oklahoma range from 111,000 to 175,000, comprising somewhere between 3.1% and 4.89% of the state's population.

Table 1 – Estimated Oklahoma Foreign Born Population

Source	**Year of Study**	**Immigrant Population**	**% of State Population[5]**
Pew Hispanic Center	2006	175,137	4.89%
Center for Immigration Studies	2005	153,000	4.27%
Center for Immigration Studies	2007	111,000	3.1%
Census 2000	2003	131,747[6]	3.68%

Identifying the proportion of the immigrant population that resides in Oklahoma illegally is another challenge. Using residual information in the unemployment data and known socio-economic characteristic of the undocumented population, estimates of the proportion of undocumented residents can be derived. Several agencies and organizations, such as the Department of Homeland Security, the Pew Hispanic Center, and the Center for Immigration Studies routinely provide such estimates. Again, they are consistent in nature and are assumed to provide the best available depiction of the undocumented population in Oklahoma. The Urban Institute Immigration Studies Program estimates Oklahoma's undocumented share of the state's total foreign-born population to be in the range of 30% to 39% using Census 2000 reports. Combining this range with the upper bound of 175,137 total foreign-born residents from table 1, we estimate the undocumented population in Oklahoma to be in the range of 52,500 to 70,000. This estimate is consistent with the range of estimates presented in table 2, below.

[4] Almost all data originates from either the American Community Survey or Current Population Survey of the U.S. Census Bureau and is then cross tabulated and presented by the various independent groups.
[5] Percent share calculations are based on 2006 Oklahoma Population of 3,579,212 from the American Community Survey – www.census.gov.
[6] Estimate taken from *The Foreign-Born Population: 2000, a Census 2000 Brief*, issued December 2003.

Table 2 – Estimated Undocumented Population

Source	Year of Study	Undocumented Population	% of State Population
Pew Hispanic Center	2006	50,000 – 75,000	1.4% - 2.1%
Immigration and Naturalization Services	2003	46,000[7]	1.29%
Federation for American Immigration Reform	2007	85,000	2.37%
Urban Institute Immigration Studies Program	2004	50,000 – 75000[8]	1.4% - 2.1%

Finally, Table 3 suggests a relatively diverse immigrant population with just over 55% identifying a Latin American nation as their country of birth and the remainder distributed across other regions of the world.[9] As the focus of this document is to provide a good first look at the economic impact of removing immigrant workers from labor force participation in Oklahoma, a detailed presentation of the socio-economic characteristics of the foreign-born population in Oklahoma is omitted. Interested parties are referred to the variety of reports presented by the Census Bureau, Pew Hispanic Center, and the Center for Immigration Studies for a more detailed description of the foreign-born population in Oklahoma and the United States, including data on age, gender, income, educational attainment, fertility rates, etc.

Table 3 – Foreign Born Population by Region of Birth[10]

Region of Birth	Population	% of State Population
Mexico	82,348	2.3%
South and East Asia	40,545	1.13%
Caribbean	1,231	0.03%
Central America	11,328	0.32%
South America	5,405	0.15%
Middle East	4.548	0.13%
All Other	29,732	0.83%

[7] Estimates presented in a 2003 study estimating the undocumented population in Oklahoma as of January 2000.
[8] Estimates presented in a 2004 study estimating the undocumented population in Oklahoma as of 2002.
[9] The U.S. Census Bureau defines Latin America as Central America (including Mexico), the Caribbean, and South America.
[10] Source: Pew Hispanic Center, "Statistical Portrait of the Foreign-Born Population in the United States, 2006"

Section 2 – The Oklahoma Economy and the Impacts of Out-Migration

In its simplest form, an economy consists of households, firms, and governments interacting strategically in the exchange of resources and commodities. Conceptually then, the Oklahoma economy refers to the interaction of Oklahoma households as the primary source of labor services in the state with Oklahoma firms who make use of the labor services provided in the production of Oklahoma goods and services. Governments of all levels (local, state, and federal) participate in this system of interactions both as employers of Oklahoma labor services and consumers of Oklahoma produced goods and services. Additionally, governments tax, subsidize, and redistribute resources and commodities between households and firms. Finally, all three primary institutions, households, firms and governments, interact with their counterparts outside the borders of the state. Given this conceptual framework, economics can be defined as the study of this system of interactions either in part or in whole.[11]

The intent of this report is to provide a first-look into the Oklahoma economy and the likely impacts resulting from the removal of a portion of its labor supplies associated with House Bill 1804. To this end, a mathematical representation of the Oklahoma economy is developed to capture the interactions of households, firms, and governments within the state. The equations of the model are then populated with economic and demographic data, both known and estimated, and solutions generated. By altering the equations of the model in a way the mimics an observed real-world policy change, we can observe the adjustments in the model and make inferences about the likely adjustments in the economy. The subsequent discussion outlines the model developed for this report, the data used to give economic meaning to numerical formulations, and a presentation of the model's predictions.

Impact assessment models come in variety of forms, from the custom crafted to the commercially marketed. Among the most commonly employed in impact analysis are the U.S. Bureau of Economic Analysis' Regional Input-Output Modeling System (RIMS II) and the IMPLAN economic modeling system developed and maintained by the Minnesota IMPLAN Group, Inc. The RIMS II and IMPLAN modeling systems have similar theoretical foundations. Both begin with data from a regional economy at a given point in time and use this snapshot of the economy to estimate the structural relationships between the output of a given sector and the associated required inputs from other, supporting sectors. By changing the demand for any

[11] The study of economics ranges from the very broad – macroeconomics as the study of the outcomes of the entire system of interactions, to the very narrow – behavioral economics as the study of individual decision-making by narrowly-defined economic agents.

sector's output, the model estimates the changes in output from the supporting sectors to provide an estimate of the aggregate impacts.[12]

While the RIMS II and IMPLAN models are commonly employed and widely accepted, both emerge from models characterized by restrictive assumptions. Among these assumptions is one that is particularly troublesome when evaluating impacts associated with changes to an economy's resource allocation, specifically, that relative prices are fixed. The assumption of fixed prices is less troublesome when analyzing the impacts associated with an initial change in demand, especially when the initial change in demand is small relative to the size of the economy as a whole. For this reason, RIMS II and IMPLAN models are typically used to estimate the impacts associated with the introduction of a new or expanding industry to an economy or of a specific construction or development project. In each of the above mentioned applications, the assumption that any one of these projects alone would not be sufficient to change output prices, real wages, or exchange rates seems plausible. However, employing an economic assessment model of this type to analyze the impacts of removing a portion of labor services from the economy would require an assumption that doing so would not have an impact on regional real wages. Clearly, the assumption that real wages remain constant in the face of a direct and significant change to the labor market is untenable. For this reason, RIMS II and IMPLAN models are generally deemed inadequate to address questions arising from changes to the supply side of an economy.

In light of the overly restrictive assumption of price rigidity just described, an alternative and sufficiently flexible model is needed and found in Computable General Equilibrium (CGE) models. CGE models allow real wages and regional prices to vary and strive to capture in the model the resulting price-induced substitution effects. CGE models are developed as a mathematical representation of an underlying economy. The functional forms of the relationships within an economy are designed explicitly to allow real-world responses as predicted by economic theory. Thus, a CGE model allows a producer to substitute between labor and capital as the relative prices between the two fluctuate. Likewise, producers can substitute between skilled and unskilled labor and households can substitute between locally produced goods and those produced outside the region. The flexibility afforded by CGE models lends itself to impact assessments originating from direct changes to a region's productive resources.

A simple, Oklahoma-based CGE model was developed to assess the impacts to the state economy associated with the expected out-migration of undocumented workers in response to HB 1804. The model consists of 19 productive sectors corresponding to the 2-digit North

[12] IMPLAN models go one step further by incorporating household and government demand as additional sectors of the economy.

American Industrial Classification System code, 1 government sector comprising federal, state, and local governments, and 1 household representing Oklahoma regional consumption and income. The model is specifically designed to identify impacts to Oklahoma production. Logical extensions would involve expanding the number of households by income classes to identify adverse impacts by income ranges. Likewise, a formal modeling of multiple layers of government would provide insights into the likely revenue and expenditure impacts at each level of governance. A more complete and technical presentation of the model developed and employed in the current report is found in the attached appendix.

Given the mathematical framework of the model, the hollow equations are made whole with the introduction of relevant economic data. The majority of data concerning the flows of resources and commodities between sectors are taken from IMPLAN, a national vendor of regional economic data as well as the impact software previously referenced. This data set is supplemented with economic and demographic data taken from the U.S. Census Bureau, Bureau of Economic Analysis, and Bureau of Labor Statistics. Given this initial data set, the specific parameters of the equations are determined that reproduce the data set as a baseline case.[13] With a baseline case in hand, equations are altered in a way consistent with the policy under study. In the case of this report, the equations capturing the migration decisions of foreign-born workers are changed in a way that induces out-migration. Observing the changes to the model outcomes after the system has returned to a new solution allows one to make straightforward before and after comparisons.[14]

The ensuing discussion provides an overview of the current size and structure of the Oklahoma economy. As mentioned earlier, Oklahoma has enjoyed moderate and sustained production and employment growth despite high energy prices and financial market uncertainties driven by falling home prices nationally. However, Oklahoma is hardly immune from the adverse economic forces of a national recession should it materialize. Finally, an overview of the current Oklahoma labor market is presented followed by a presentation of the model's results.

An Overview of the Oklahoma Economy

Oklahoma's 2007 Gross State Product (GSP) is estimated to be just under $144 billion.[15] GSP refers to the market value of final goods and services produced within the state. Thus, GSP calculations have two components, real output and market prices. To control for fluctuations in market prices and isolate changes in production levels, Real GSP is calculated using price indices

[13] The process of using a base year's data to specify the parameters of a CGE model is known as calibration. The current model is calibrated to 2004 data.

[14] The model employed is a static model – it only shows the changes from an initial equilibrium solution to a new equilibrium solution with no time dimension capturing the dynamic path by which the new solution is reached.

[15] See the *2008 Oklahoma Economic Outlook, February Update* from the Center for Applied Economic Research at the William S. Spears School of Business, Oklahoma State University.

that account for inflation. Table 4 presents real production levels for each of the sectors included in the model over the previous ten years. Isolating the last two columns of table 4, the industries which constitute a relatively large share of economic output (greater than $5 billion) and have experienced relatively high growth rates over the period 2002 -2006 (greater than 12%) are identified in bold italics. With the exception of real estate sector, production data indicates that the remaining industries rely heavily on low-skill labor in the production process. Regardless of the immigrant status of the employees in these sectors, they will likely be among the hardest hit by the outflow of foreign-born workers and resulting increases in low skill wages.

Table 4 – Oklahoma Real Gross State Product,
Millions of Chained 2000 dollars[16]

Industry	1997	2002	2006	% Change: 2002-2006
Agriculture, Forestry, Fishing and Hunting	1,176	1,785	1,897	6.27
Mining	5,634	5,823	***7,317***	***25.66***
Utilities	1,972	2,247	2,728	21.41
Construction	3,289	3,470	3,569	2.85
Manufacturing	11,658	10,920	***13,222***	***21.08***
Wholesale Trade	4,180	5,373	5,557	3.42
Retail Trade	6,360	7,636	***8,764***	***14.77***
Transportation and Warehousing	2,942	3,301	3,857	16.84
Information	2,709	3,902	4,838	23.99
Finance and Insurance	3,755	4,581	4,800	4.78
Real Estate and Rental and Leasing	7,814	9,231	***10,535***	***14.13***
Professional and Technical Services	3,398	4,048	4,870	20.31
Management of Companies and Enterprises	920	1,154	1,591	37.87
Administrative and Waste Services	2,752	2,685	3,262	21.49
Educational Services	431	437	469	7.32
Health Care and Social Assistance	5,459	6,141	***7,054***	***14.87***
Arts, Entertainment, and Recreation	392	461	625	35.57
Accommodation and Food Services	2,025	2,156	2,372	10.02
Other Services	2,417	2,285	2,214	-3.11
Government	14,233	15,319	15,951	4.13
Total Real Gross State Product	**$82,858**	**$92,933**	**$105,748**	**13.79**

Oklahoma's population is estimated to be just over 3.6 million, an increase of approximately 4% over the estimated 3.45 million residents in 2000. Most of Oklahoma's counties have experienced rates of population growth below the national average while several western and

[16] Source: U.S. Department of Commerce / Bureau of Economic Analysis, June 2007

northwestern counties have experienced declining populations. These trends seem to be indicative of broader movements in U.S. migratory behavior.[17] Table 5 provides a breakdown of the population's participation in the labor market. Table 5 indicates that Oklahoma's total labor force is slightly more the 1.7 million workers of which approximately 77,000, or 4.5%, are unemployed. These figures suggest a labor market in Oklahoma that is already relatively tight – that is there does not appear to be generous amounts of slack labor in the system. In fact, an unemployment rate of 4.5% is likely consistent with the unemployment expected at any given point in time in a dynamic market economy.

Table 5 – Oklahoma Labor Market Characteristics
December 2007 – Seasonally Adjusted

Category - Definition	Estimate
Civilian Non Institutional Population – civilian persons 16 years of age and older not currently confined to institutional quarters (penal, mental care facilities, etc.)	2,740,240
Labor Force – members of the civilian non institutional labor force currently working for pay or profit or, if not, actively seeking such	1,735,392
Labor Force Participation Rate – share of civilian non institutional population actively engaged, either employed or unemployed, in the labor market	63.3%[18]
Employed – members of civilian non institutional population currently working for pay or profit	1,658,165
Unemployed – members of civilian non institutional population not working for pay or profit, but actively seeking employment	77,227
Unemployment Rate – share of the labor force that is unemployed	4.5%

Current estimates put an upper bound on Oklahoma's foreign-born population at approximately 175,000. The census includes in the foreign-born category all individuals not born a U.S. citizen, regardless of current residency status. It would, therefore, include documented residents, undocumented residents, and naturalized citizens. The surveys are not administered to individuals in group living quarters and would not capture foreign-born residents in university dormitories, penal institutions, mental and long-term health care

[17] Witness a recent article in *The Economist*, January 2008.
[18] Oklahoma's labor force participation rate is less than the national average labor force participation rate of 66.0% in December of 2007.

facilities, etc. As this report is focused on the economic impact of induced labor market changes, estimates of foreign-born residents in group quarters, and largely outside the labor market process, are not required. These estimates are available in other reports and would be required to estimate the public costs of foreign-born residents.[19] In what follows, the present report takes 175,000 as a reasonable approximation of the foreign-born population in Oklahoma and estimates labor market characteristics for this group. Inferring an age distribution on Oklahoma's foreign-born population consistent with the national distribution, it is estimated that approximately 80% of the residents are of working age and approximately 75% of these are labor force participants.[20] Combining the age distribution with labor force participation rate suggests a foreign-born labor force of just under 105,000 workers, or roughly 6% of the state's total labor force. The educational attainment of immigrant workers varies significantly across regions of birth with Latin American residents exhibiting relatively lower rates of educational attainment and South and East Asia residents exhibiting significantly higher rates of educational attainment. Again, using national data on educational attainment, combined with a comparison of Oklahoma labor skill requirements relative to national averages, we estimate that 65% of foreign-born workers are low skill (having completed a high school equivalent or less) and 35% are high skill.[21] Table 6 summarizes these assumptions and provides the initial values used in analysis.

[19] See, for example, the estimate of public costs of providing education, health, and incarceration services to undocumented residents provided by the Federation for Immigration Reform.

[20] The 75% labor force participation rate is subjective, but consistent with known labor market characteristics of the foreign-born. For example, the Urban Institute Immigration Studies Program estimates labor force participation rates of 96% for undocumented men and 62% for undocumented women.

[21] As expected, model results are only mildly sensitive to changes in the allocation of labor across skill groups. Moving towards a relatively higher skilled foreign-born population increases the adverse economic impacts experienced by the economy and vice versa.

Table 6 – Foreign-Born Labor Market Characteristics,
Model Estimates

Category - Definition	Estimate
Total foreign-born population, excluding residents of group living quarters	175,000
Total foreign-born labor force	103,730
Foreign-born labor force as a share of total Oklahoma labor force	6.0%
Total High-Skill Foreign-Born Labor Force	36,305
Total Low-Skill Foreign-Born Labor Force	67,425

Presentation of Results

The model is run and results presented for three scenarios associated with low, medium, and high foreign-born outflows respectively. The low outflow scenario corresponds to an initial reduction in foreign-born labor of approximately 25,000 workers; the medium outflow corresponds to an initial reduction in foreign-born labor of approximately 50,000 workers, and the high outflow scenario to a reduction of nearly 90,000 workers. Migratory decisions of foreign-born workers are modeled as a function of the real wage, or the wage rate received relative to the region's cost of living. Out-migration is driven by a perceived increase in Oklahoma's cost of living. For undocumented workers, the cost of living increase may be real and related to an increased probability of detection and deportation or a decreased probability of securing employment or public benefits. Likewise, the cost of living increase may be perceived by both documented and undocumented workers as the manifestation of intolerance, the dissolution of immigrant communities, etc.[22] For the purposes of our model, it does not matter whether out-migration occurs for real or perceived reasons, only that out-migration occurs in accordance with the design of the bill. By manipulating the cost of living parameter, we induce out-migration and observe the changes to the system.

The model consists of 19 sectors, 1 representative household, 1 layer of government, and 4 labor supplies (high and low skilled for both native born and foreign born workers). The model is run twice for each scenario. The first run prohibits offsetting in-migration. In this manner, we can estimate a short run impact of immediate out-migration. Given the passage of time, it is expected that workers from surrounding regions would in-migrate to fill some of the void left

[22] See *Caught in the Crossfire – Schools in Oklahoma grapple with new laws targeting illegal immigration*, neatoday bulletin, January 2008

by departing immigrant labor, with the resulting impacts loosely associated with the long run. Note that if the short run impacts are interpreted as year 1 impacts, the long run impacts represent recurring impacts. That is, in future years to state's production will be below its baseline estimate by approximately the amount of the reported long run impact.[23] Finally, the model assumes that low-skill workers are disproportionately represented by undocumented and otherwise highly mobile workers. Therefore, an increase in the perceived cost of living to immigrant workers tends to drive higher initial relative out-migration of low skill labor.

A review of the economic description of Oklahoma provided combined with economic intuition can provide insights into the expected interactions within the model. First, the out-migration of predominantly low-skill immigrant workers from an already tight labor market puts upward pressure on wages paid to low-skill workers as employers compete over the now reduced pool of available labor. Faced with a reduced supply of resources and higher resource costs, industries cut production. The decrease in production comes with a reduction in the quantity of all inputs employed, not just low-skill labor, so high-skill labor is released back into the economy. The increased supply of high-skill labor puts downward pressure on wage rates paid to high-skilled labor. Combined, the increased costs of production suggest that Oklahoma produced goods and services are now less competitive with their rival's output produced outside the state.[24] For an economy with the industrial makeup of Oklahoma (many of the state's largest sectors are relatively labor intensive), the aggregate impacts could be significant. Indeed, the model's conclusions are consistent with the process just described.

Table 7 presents that impacts associated with a low (25,000 worker) outflow of foreign-born labor. The model reports both short run (no offsetting in migration) and long run (some offsetting in migration) results. The results are presented as a percent change from the base year's data for both periods. Finally, the models predicted percent change in Oklahoma gross state product is applied to current data to facilitate interpretation of the magnitude of the response. Again, gross state product is a measure of the value of all final goods and services produced within the state. It is the broadest and most common measure of the size and strength of an economy, reflecting the state's ability to turn Oklahoma resources into Oklahoma output.

[23] For a similar analysis, see *Undocumented Immigrants in Texas: A Financial Analysis of the Impact to the State Budget and Economy*, from the Office of the Comptroller, Texas, December 2006.

[24] For illustration purposes, imagine a construction company that finds it cannot hire sufficient laborer (low-skilled workers) to continue building at its previous rate. As the company reduces its production (decrease the number of construction projects it pursues), it releases contractors, framers, etc. (high-skilled labor) into the economy, putting downward pressure on their wages.

Table 7 – Economic Impacts of Foreign-born Out Migration,
Short Run and Long Run Estimates, 25,000 Worker Outflow

	Short Run		Long Run	
Category	**Percent Change**	**Estimated Impact**	**Percent Change**	**Estimated Impact**
Gross State Product	- 0.583%	$785,513,330	-0.473%	$636,899,230
Real Wage – Low Skill	1.966%	N/A	0.696%	N/A
Real Wage – High Skill	- 3.897%	N/A	-0.383%	N/A

Table 7 reflects the adjustment process from short to long run through changes in the real wage rate. Note that in the short run, the pressures are significant on both low and high-skill wages. In the long run, allowing for in-migration of new workers, the pressures on real wages are moderated. However, because of the decreased competitiveness of Oklahoma produced goods and services, Oklahoma production (GSP) is lower even in the long run.[25]

In the short run, an outflow of approximately 25,000 foreign born workers would generate a 0.583% reduction in gross state product. Applying this outcome to 2006 data suggests that, in the presence of a similar policy, gross state product would have been diminished by over $785 million.

Table 8 reports similar findings for the medium (50,000 worker) outflow scenario.

Table 8 – Economic Impacts of Foreign-born Out Migration,
Short Run and Long Run Estimates, 50,000 Worker Outflow

	Short Run		Long Run	
Category	**Percent Change**	**Estimated Impact**	**Percent Change**	**Estimated Impact**
Gross State Product	- 1.320%	$1,777,931,804	-0.955%	$1,285,917,050
Real Wage – Low Skill	4.566%	N/A	1.408%	N/A
Real Wage – High Skill	- 7.779%	N/A	-0.764%	N/A

[25] Long run percent changes, such as -0.473%, are best interpreted as observing a value of gross state product that is 0.473% below what would have otherwise been experienced in the absence of the policy. Similar analysis performed in Texas suggests that the impacts remain in the system for many years. See footnote 23.

Anecdotal evidence suggests that the impacts reported in table 8 are the most consistent with the outflow of workers observed and ongoing. The impact associated with such an out migration is significant, a nearly $1.8 billion reduction in the size of the Oklahoma economy relative to 2006 levels in the short run. In the long run, the size of the economy is reduced by over $1.3 billion annually, relative to 2006 levels of production. The substantial impacts are largely reflective of Oklahoma's inability to attract and replace such significant portion of its labor supply.

Table 9 reports the findings for the high outflow scenario. In this scenario, the penalty is structured in a way that causes an initial out migration of nearly all low-skill foreign born labor. It is presented largely to facilitate comparisons with a similar study undertaken in Texas using an analogous approach. The Texas analysis sought to provide estimates of the impacts of undocumented workers in the state and to this end analyzed the impact of their complete removal with no offsetting in migration (the short run case in the present discussion). The Texas model reports n initial reduction in Texas gross state product of 2.1%, consistent with our estimate of a 2.27% reduction in Oklahoma gross state product reported in table 9, below.

Table 9 – Economic Impacts of Foreign-born Out Migration,
Short Run and Long Run Estimates, 90,000 Worker Outflow

	Short Run		Long Run	
Category	**Percent Change**	**Estimated Impact**	**Percent Change**	**Estimated Impact**
Gross State Product	- 2.268%	$3,053,884,680	-1.397%	$1,881,074,470
Real Wage – Low Skill	7.915%	N/A	2.016%	N/A
Real Wage – High Skill	- 13.124%	N/A	-0.976%	N/A

Conclusion

In an effort to address the burden on the public sector of undocumented workers, Oklahoma recently passed the Oklahoma Taxpayer and Citizen Protection Act. The legislation is designed to encourage undocumented workers to leave the state by increasing the probability of detection, detention, and deportation while simultaneously reducing the probability of securing employment and public benefits within the state. Due to the mixed residency status of many foreign-born families and communities, it is unlikely that the legislation's incentives to out

migrate are limited to undocumented workers. To this end, this report estimates the impacts of significant out migration of foreign-born workers to the size of the Oklahoma economy.

Owing to the complex linkages within and interconnected nature of the economy, the impacts of out migration cannot be confined to foreign-born labor and the industries that are their primary employers alone. Indeed, among the primary conclusions of this report is that the impacts spread quickly to the high-skill labor market where wages and employment fall, and likewise through all industries that rely substantially on low-skill labor for production.

Oklahoma's foreign-born population is estimated to be between 111,000 and 175,000 residents. Of these, it is estimated that approximately 52,500 to 70,000 or undocumented. Similarly, it is estimated that approximately 103,000 foreign-born residents in Oklahoma are participants in the labor process, with approximately two-thirds classified and low-skill workers. Combining these characteristics of Oklahoma's foreign-born labor force with national data on Oklahoma production, a model of the Oklahoma economy is constructed to analyze the impacts stemming from the out migration of a portion of the foreign-born labor supply.

The model is run for three scenarios, with results loosely correlating to the short run and long run presented. The most plausible scenario would seem to be an out migration of approximately 50,000 immigrant workers, or approximately one-half of the total foreign-born labor supply. If such an outflow were to occur, the impacts on the Oklahoma economy would be significant, reducing the size of the economy by 1.32% in the short run – a reduction of nearly $1.8 billion relative to 2006 production levels. The impacts likely remain in the system for many years, with annual reductions in gross state product of almost a full percent.

A potential $1.8 billion reduction in Gross State Product is substantial, although not unexpected. The Oklahoma economy is simply not large enough and sufficiently diverse in its industry makeup to accommodate a 3% reduction in the size of its labor force. The ongoing debate over immigration and the costs associated with providing public services to undocumented workers is undeniably complex. The discussion is certain to continue and likely to remain contentious. However, the potential severity of the self-imposed economic penalty is both real and alarming, seemingly requiring considerable benefits to merit its existence.

Appendix A: Technical Specification

CGE Models

Computable General Equilibrium (CGE) models are tools economists use to estimate the effects of a range of policies including tax, development, environmental, regional and international. While economists have a variety of tools at their disposal, CGE models are the most appropriate when inputs are constrained. For instance, typical impact models use input-output (IO) methodology to address the broader long-run impacts of changes to final demand for one or a variety of industries. Such IO models are useful when input constraints are nonexistent as is typical of long run impact studies. In the long run, labor and capital tend to be mobile allowing the fixed coefficient structure of the IO model to yield an appropriate result. The fixed coefficient nature of IO models is untenable when input constraints exist (Isard et al, 1998). Such constraints require flexible models that are functionally tied to economic conditions. CGE models that incorporate Constant Elasticity of Substitution (CES) production functions allow for some substitutability among value added inputs. CES functions can also be used to model consumption allowing substitution between goods and services as relative prices change.

One major benefit of CGE models is their ability to provide a realistic simulation of the imperfect substitutability of local and imported goods. This so-called Armington (1969) function provides for the rational substitution of similar goods as the relative prices of substitutes change. Armington functions are standard CES functions modified to accommodate import and domestic choices.

By their nature, CGE models allow an infinite number of production, consumption, trade, and government functional forms. Depending on the question asked, a CGE model could detail very specifically one area of the economy while aggregating other nonessential areas. For instance, some models answer explicit fiscal questions and thus focus on the specifics of taxation, revenue, and government spending while aggregating the consumption and production sides of the economy. Other models might provide relevance to income distribution debates by modeling household essentials but aggregating production, government and trade. The question being asked, dictates the nature of the model specification. The specific nature of the Oklahoma Immigration Model (OIM) is detailed below.

Oklahoma Immigration Model (OIM) Specification

The Oklahoma Immigration model focuses on the impact to production of the loss of labor input due to the outmigration resulting from the passage of HB 1804. As with any economy, changes to production have broader impacts on other production sectors, local households and local government. Within the economy, linkages between institutions, commodities and factors cause the impacts to be spread throughout. Figure A-1 details the economic flows modeled in the OIM.

The OIM has 19 producing sectors, 1 representative household, and 1 local government. The model consists of 333 equations (Table 1) and 334 variables. All model variables are capitalized throughout the text. Benchmark values of model variables are annotated in lower case followed by the number zero "0" indicating the initial, or benchmark, value. All model parameters are represented by lower case Greek letters. The price of capital is fixed leaving 333 free variables. Figure A-2 identifies the multiple levels of the model structure. A description of the model is given below.

Figure A-1 – Regional Economic Flows

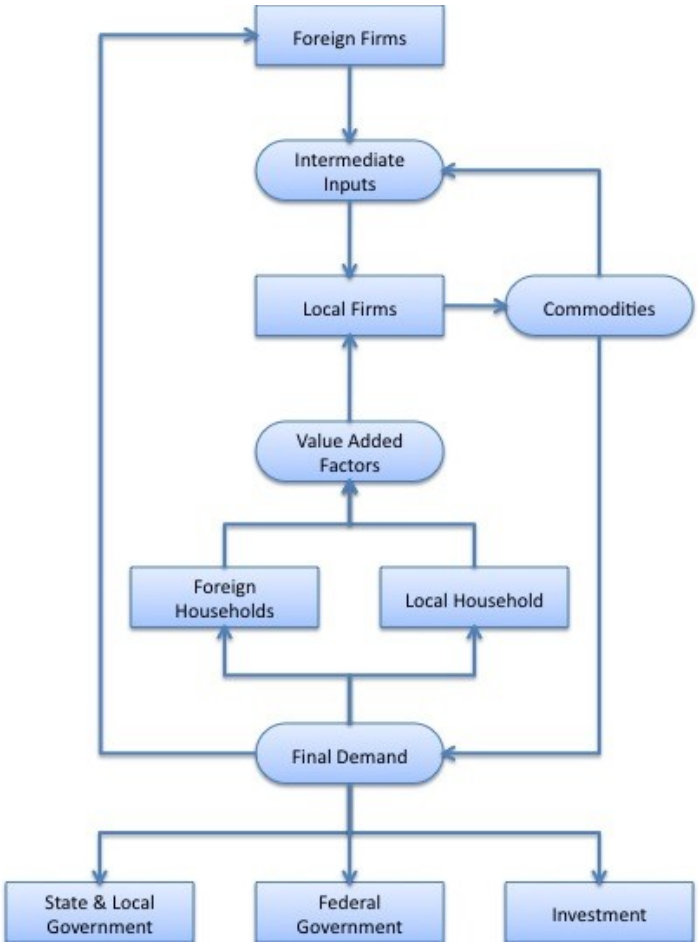
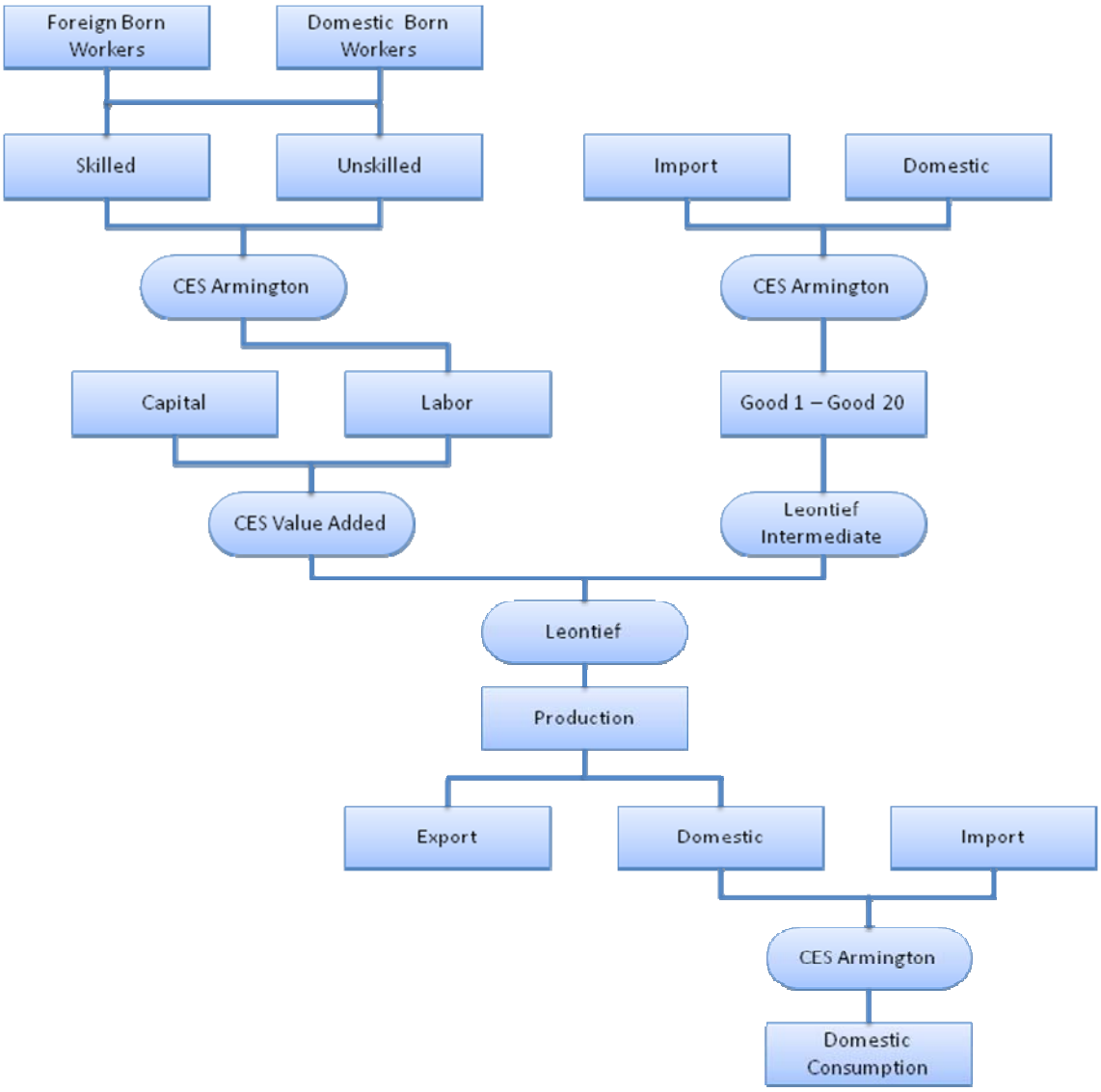


Figure A-2 – OIM Equation Schematic



Production

Firms produce goods using a variety of inputs. Specifically, they use high and low skilled labor, capital and other intermediate inputs. Firm input decisions are modeled using a multi-tiered production system of equations that allow for smooth substitution between some inputs, while requiring fixed proportions of others. Cost minimization yields capital demand, high-skilled labor demand and low-skilled labor demand in equations 1.1, 1.3, and 1.5 respectively. The zero profit equation is used to close the production system and ensure that cost minimization occurs. It also yields the intermediate inputs required by each firm (equation 1.6).

Foreign Sector

The Oklahoma economy is modeled using a "small country" assumption. Simply put, this means that sectoral output from within the state of Oklahoma is minimal when compared to aggregate world output for each sector. This assumption implies that changes to Oklahoma output do not appreciably affect world prices for comparable goods. The prices that are affected by changes to the model include local Oklahoma producer and consumer prices. These prices impact cost of living conditions within the state relative to other states and other countries. The cost of living is modeled using the Price Deflator equation 1.15. Local cost of living conditions affect labor supply migration decisions and thus in and out-migration.

Many international models employ Constant Elasticity of Transformation (CET) functions that allow for smooth transition between production for domestic and export markets. Often these functions are used when a different "quality" of product is shipped to foreign markets. The CET elasticity represents the ease with which production can be changed from domestic to export. The OIM does not employ a CET function due to the fact that most export markets are located in other states. The OIM employs a simple aggregator function to sum foreign and domestic production (equation 1.7).

Export demand is determined by the ratio of domestic and foreign prices. Production conditions allow domestic prices to change while world prices remain constant. Demand for Oklahoma goods in world markets changes as Oklahoma prices change relative to world prices as represented in equation 1.8.

Imports are determined using a Constant Elasticity of Substitution (CES) function to allow for imperfect competition between foreign and domestically produced goods for domestic use. Oklahoma consumers and producers are afforded a wide variety of goods both foreign and domestic. While they are often similar, they aren't always perfect substitutes. This CES function allows Oklahomans to choose between local and imported goods based on variety as well as price. Equations 1.9 and 1.10 are used to model this imperfect competition.

Households

The Oklahoma consumer is modeled using an aggregate household that chooses output from the various sectors using another CES function. Household demand for goods and services is given by equation 1.12 based on disposable income given in equation 1.14.

Labor supply decisions are based on local real wages. Aggregate labor supply by skill is the summation of formal and informal workers (equations 1.22 and 1.25). Informal supplies are intended to include undocumented and documented workers with ties to undocumented workers. This assumption gives flexibility to include documented workers who leave Oklahoma based on their relationships with undocumented workers, as anecdotal evidence seems to support.

Equations 1.23 and 1.26 model formal labor supply decisions based on changes to Oklahoma real wages. Equations 1.24 and 1.27 model informal labor supply decisions. Their decisions are responsive to Oklahoma real wages inclusive of a perceived cost-of-living penalty resulting from the implementation of the Oklahoma immigration reform legislation.

Market Clearing

Market clearing equations are used to ensure that the quantities of factors and goods demanded are exactly equal to the quantities supplied. These are modeled in equations 1.16 – 1.19.

Investment

Investment is given by equations 1.20 and 1.21. Equation 1.16 indicates that in the long run, capital is perfectly mobile and thus not dependent on local saving decisions. It implies that capital migrates to ensure long-run returns to capital are consistent with returns in world markets. Equation 1.21 ensures a proportional amount of capital demand is fulfilled locally.

State and Local Government

Government production is modeled as an independent production sector given by NAICS code 92. Government expenditure is assumed proportional to gross state product. This expenditure is modeled in equation 1.28.

Other Equations

All other model equations not specifically mentioned in this section are used for closure purposes to ensure the consistency of the model.

Table A-1: CGE Model Equations

Firms

Capital Demand:

$$(1.1) \qquad KDEM_i = \gamma_i^{\sigma va_i} \cdot PK^{-\sigma va_i} \cdot \left(\gamma_i^{\sigma va_i} \cdot PK^{(1-\sigma va_i)} + (1-\gamma_i)^{\sigma va_i} \cdot PL^{(1-\sigma va_i)} \right)^{\sigma va_i / (1-\sigma va_i)} \cdot \left(\frac{QOUT_i}{a_i} \right)$$

Aggregate Labor Demand:

$$(1.2) \qquad LDEM_i = (1-\gamma_i)^{\sigma va_i} \cdot PL^{-\sigma va_i} \cdot \left(\gamma_i^{\sigma va_i} \cdot PK^{(1-\sigma va_i)} + (1-\gamma_i)^{\sigma va_i} \cdot PL^{(1-\sigma va_i)} \right)^{\sigma va_i / (1-\sigma va_i)} \cdot \left(\frac{QOUT_i}{a_i} \right)$$

Skilled Labor Demand:

$$(1.3) \qquad LSDEM_i = \gamma l_i^{\sigma l_i} \cdot PLS^{-\sigma l_i} \cdot \left(\gamma l_i^{\sigma l_i} \cdot PLS^{(1-\sigma l_i)} + (1-\gamma l_i)^{\sigma l_i} \cdot PLU^{(1-\sigma l_i)} \right)^{\sigma l_i / (1-\sigma l_i)} \cdot \left(\frac{LDEM_i}{al_i} \right)$$

Aggregate Labor Demand Zero Profit:

$$(1.4) \qquad PL_i \cdot LDEM_i = PLS \cdot LSDEM_i + PLU \cdot LUDEM_i$$

Unskilled Labor Demand:

$$(1.5) \qquad LUDEM_i = (1-\gamma l_i)^{\sigma l_i} \cdot PLU^{-\sigma l_i} \cdot \left(\gamma l_i^{\sigma l_i} \cdot PLS^{(1-\sigma l_i)} + (1-\gamma l_i)^{\sigma l_i} \cdot PLU^{(1-\sigma l_i)} \right)^{\sigma l_i / (1-\sigma l_i)} \cdot \left(\frac{LDEM_i}{al_i} \right)$$

Zero Profit:

$$(1.6) \quad PX_i \cdot QOUT_i = PK \cdot KDEM_i + PLS \cdot LSDEM_i + PLU \cdot LUDEM_i + \sum_j io0_{j,i} \cdot QOUT_i \cdot PXCOMP_i + qmiscsec0_i$$

Foreign Sector

Export Production:

$$(1.7) \qquad QEXP_i = QOUT_i - QDOM_i$$

Export Demand:

(1.8) $$QEXP_i = qexp0_i \cdot \left(\frac{PXEXP_i}{PX_i} \right)^{\sigma exp_i}$$

Armington Domestic Demand:

(1.9) $$QDOM_i = (1-\gamma a_i)^{\sigma a_i} \cdot PXDOM_i^{-\sigma a_i} \cdot \left(\gamma a_i^{\sigma a_i} \cdot PXIMP_i^{(1-\sigma a_i)} + (1-\gamma a_i)^{\sigma a_i} \cdot PX_i^{(1-\sigma a_i)} \right)^{\sigma a_i/(1-\sigma a_i)} \cdot \left(\frac{QCOMP_i}{aa_i} \right)$$

Armington Import Demand:

(1.10) $$QIMP_i = \gamma a_i^{\sigma a_i} \cdot PXIMP_i^{-\sigma a_i} \cdot \left(\gamma a_i^{\sigma a_i} \cdot PXIMP_i^{(1-\sigma a_i)} + (1-\gamma a_i)^{\sigma a_i} \cdot PX_i^{(1-\sigma a_i)} \right)^{\sigma a_i/(1-\sigma a_i)} \cdot \left(\frac{QCOMP_i}{aa_i} \right)$$

Armington Zero Profit:

(1.11) $$PXCOMP_i \cdot QCOMP_i = PXIMP_i \cdot QIMP_i + PX_i \cdot QDOM_i$$

<u>Households</u>

Consumption (CES):

(1.12) $$QCONS_i = \frac{\alpha_i^{\sigma c}}{PXCOMP_i^{\sigma c} \cdot \sum \alpha_j \cdot PXCOMP_j^{(1-\sigma c)}} \cdot CBUD$$

Income:

(1.13) $$Y = PK \cdot KSUP + PUL \cdot LUSUP + PSL \cdot LSSUP$$

(1.14) $$CBUD = (1-mps) \cdot Y$$

Price Deflator:

(1.15) $$CPI = \frac{\sum_i PXCOMP_i \cdot qcons0_i}{\sum_i pxcomp0_i \cdot qcons0_i}$$

Market Clearing

Capital Market (Perfectly Elastic Capital Supply):

(1.16) $$\sum_i KDEM_i = KSUP$$

Low skilled Labor Market:

(1.17) $$\sum_i LUDEM_i = LUSUP$$

Skilled Labor Market:

(1.18) $$\sum_i LSDEM_i = LSSUP$$

Goods Market:

(1.19) $$QCOMP_i = \sum_j \left(io_{ij} \cdot QOUT_j \right) + QSGOV_i + qfgov0_i + QCONS_i + QINV_i$$

Investment

(1.20) $$INVEST = invest0 \cdot \frac{\sum_i KDEM_i}{\sum_i kdem0_i}$$

(1.21) $$QINV_i = qinv0_i \cdot \frac{INVEST}{invest0}$$

Labor Supplies

High-skilled Labor Supply:

(1.22) $$LSSUP = LSFORMAL + LSINFORMAL$$

(1.23) $$LSFORMAL = lsformal0 \cdot \left(\frac{PLS}{CPI} \right)^{\sigma lsf}$$

(1.24) $$LSINFORMAL = lsinformal0 \cdot \left(\frac{PLS}{CPI \cdot (1 + penalty)} \right)^{\sigma lsi}$$

Low-skilled Labor Supply:

(1.25) $$LUSUP = LUFORMAL + LUINFORMAL$$

(1.26) $$LUFORMAL = luformal0 \cdot \left(\frac{PLU}{CPI} \right)^{\sigma luf}$$

(1.27) $$LUINFORMAL = luinformal0 \cdot \left(\frac{PLU}{CPI \cdot (1 + penalty)} \right)^{\sigma lui}$$

Proportional State and Local Government Spending

(1.28) $$QSGOV_i = qsgov0_i \cdot \left(\frac{\sum_j QOUT_j}{\sum_j qout0_j} \right)$$

Table A-2: CGE Model Variables

Variable	*Benchmark*	*Description*
CBUD	cbud0	Regional Consumption Budget
CPI	cpi0	Regional Price Deflator
INVEST	invest0	New Regional Investment
KDEM	kdem0	Sectoral Capital Demand
KSUP	ksup0	Regional Capital Supply
LDEM	ldem0	Sectoral Aggregate Labor Demand
LSDEM	lsdem0	Sectoral High-Skilled Labor Demand
LSSUP	lssup0	Regional High-Skilled Labor Supply
LSFORMAL	lsformal0	Regional High-Skilled Formal Labor Supply
LSINFORMAL	lsinformal0	Regional High-Skilled Informal Labor Supply
LUDEM	ludem0	Sectoral Low-Skilled Labor Demand
LUSUP	lusup0	Regional Low-Skilled Labor Supply
LUFORMAL	luformal0	Regional Low-Skilled Formal Labor Supply
LUINFORMAL	luinformal0	Regional Low-Skilled Informal Labor Supply
PK	pk0 (Numeraire)	Regional Returns to Capital
PL	pl0	Sectoral Aggregate Labor Price
PLS	pls0	Regional High-Skilled Labor Price
PLU	plu0	Regional Low-Skilled Labor Price
PX	px0	Sectoral Domestic (Producer) Price
PXCOMP	pxcomp0	Composite Good Price
PXEXP	pxexp0	Fixed World Export Price
PXIMP	pximp0	Fixed World Import Price
QCOMP	qcomp0	Regional Composite Good Quantity
QCONS	qcons0	Regional Consumption
QDOM	qdom0	Regional Consumption of Regional Output
QEXP	qexp0	Exports
QIMP	qimp0	Imports
QINV	qinv0	Investment Demand
QOUT	qout0	Total Sectoral Production
QSGOV	qsgov0	State & Local Gov’t Demand
Y	y0	Total Regional Income

Table A-3: CGE Model Sectors

NAICS Code	Sector Description
11	Ag, Forestry, Fish & Hunting
21	Mining
22	Utilities
23	Construction
31-33	Manufacturing
42	Wholesale Trade
48-49	Transportation & Warehousing
44-45	Retail Trade
51	Information
52	Finance & Insurance
53	Real Estate & Rental
54	Professional – Scientific & Tech Services
55	Management of Companies
56	Administrative & Waste Services
61	Educational Services
62	Health & Social Services
71	Arts, Entertainment, & Recreation
72	Accommodation & Food Services
81	Other Services
92	Government & non-NAICS

Model Parameterization

The choice of elasticity certainly influences the results of any model. The variety of estimates for all elasticities is vast. The elasticity estimates for each required function are listed in the following tables.

Trade

Trade incorporates domestic and export production as well as domestic and import consumption. Many trade elasticity estimates are given for exports as well as imports in the international trade literature. As Berck et al. (1997) point out, regional economies are much more open to trade than national economies and thus higher trade elasticities are appropriate for use. Most studies estimate elasticity ranges between low, medium and high values. The "high" values are typically used in this model to reflect the openness of the regional economy. Table A-4 gives the elasticity of substitution between imported and domestically produced goods and services. Estimates are largely taken from Rickman and Snead (2007).

Production

Production elasticities involve substitution between value added factors labor and capital and at a lower level high and low skilled labor. Capital and Labor substitutability taken from de Melo and Tarr (1992) is mostly consistent with Rickman and Snead (2007) who vacillate between 0.8 and 0.9. Specific capital and labor substitution elasticities are given in Table A-5.

Table A-4 – Elasticity of Substitution: Armington Domestic/Import

Sector	Elasticity	Source
Agriculture	1.5	Berck, Golan and Smith 1997
Mining	1.062	Berck, Golan and Smith 1997
Utilities	1.5	Berck, Golan and Smith 1997
Construction	1.5	Berck, Golan and Smith 1997
Manufacturing	0.55	Berck, Golan and Smith 1997
Wholesale Trade	0.5	Rickman and Snead, 2007
Transportation	1.5	Berck, Golan and Smith 1997
Retail Trade	0.5	Rickman and Snead, 2007
Information	1.5	Rickman and Snead, 2007
Finance and Insurance	1.5	Berck, Golan and Smith 1997
Real Estate	1.5	Rickman and Snead, 2007
Professional Services	1.5	Oregon Tax Incidence Model, 2001[26]
Management of Companies	0.5	Oregon Tax Incidence Model, 2001
Administrative Services	1.5	Berck, Golan and Smith 1997
Education Services	0.5	Rickman and Snead, 2007
Health Services	0.5	Oregon Tax Incidence Model, 2001
Arts & Entertainment	0.5	Oregon Tax Incidence Model, 2001
Accommodation Services	0.5	Rickman and Snead, 2007
Other Services	1.5	Berck, Golan and Smith 1997
Govt& Non-NAICs	0.5	Rickman and Snead, 2007

[26] The Oregon Tax Incidence Model (OTIM), 2001, Legislative Revenue Office Research Report, www.leg.state.or.us/comm/lro/home.htm.

Table A-5 – Capital-Labor Substitution Elasticities

Sector	Elasticity	Source
Agriculture	0.8	Berck, Golan and Smith 1997[27]
Mining	0.8	Berck, Golan and Smith 1997
Utilities	0.8	Berck, Golan and Smith 1997
Construction	0.8	Berck, Golan and Smith 1997
Manufacturing	0.8	Berck, Golan and Smith 1997
Wholesale Trade	0.8	Berck, Golan and Smith 1997
Transportation	0.8	Berck, Golan and Smith 1997
Retail Trade	0.8	Berck, Golan and Smith 1997
Information	0.8	Berck, Golan and Smith 1997
Finance and Insurance	0.8	Berck, Golan and Smith 1997
Real Estate	0.8	Berck, Golan and Smith 1997
Professional Services	0.8	Berck, Golan and Smith 1997
Management of Companies	0.8	Berck, Golan and Smith 1997
Administrative Services	0.8	Berck, Golan and Smith 1997
Education Services	0.8	Berck, Golan and Smith 1997
Health Services	0.8	Berck, Golan and Smith 1997
Arts & Entertainment	0.8	Berck, Golan and Smith 1997
Accommodation Services	0.8	Berck, Golan and Smith 1997
Other Services	0.8	Berck, Golan and Smith 1997
Govt& Non-NAICs	0.8	Berck, Golan and Smith 1997

As Rickman and Snead point out, labor skills tend to be relatively inelastic in substitution. The authors chose an elasticity of 0.15 for this project (Table A-6).

[27] Elasticities chosen just below 1.0 as in Berck, Golan and Smith. These elasticities are consistent with those in de Melo and Tarr (1992) as well.

Table A-6 – Labor Skill Substitution Elasticities

Sector	Elasticity	Source
All	0.15	Author Interpolation

Migration elasticities are extremely important to the outcome of the analysis. The model includes domestic and foreign-born suppliers of high and low skilled labor. Domestic elasticities are taken from Berck et al. (1997). Based on the distance of initial migration to the region, it is estimated that foreign-born migrants have at least twice the migration elasticity of their domestic counterparts. Thus, each foreign-born elasticity is twice that of the domestic elasticity. See Table A-7 for the migration elasticities.

Table A-7 – Labor Migration Elasticities

Labor Skill	Elasticity	Source
High-Skilled Domestic	2.3	Berck, Golan, and Smith, 1997
Low-Skilled Domestic	1.3	Berck, Golan, and Smith, 1997
High-Skilled Foreign-Born	4.6	Authors' Interpolation
Low-Skilled Foreign-Born	2.6	Authors' Interpolation

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