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Economic Growth in Washington: An Examination of Labor Market and Fiscal Response

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Abstract. This study develops a regional econometric model to extend and complement standard local economic impact analysis for Washington counties. Based on a static macroeconomic model, we derive labor supply equations and fiscal equations. The resulting empirical model is based on a cross- sectional econometric analysis of all Washington counties. The use of the estimated econometric model is illustrated with 5 percent job growth scenario that is simulated for each Washington county. For some counties, growth scenario actually results in an increase in the number of unemployed. This occurs because most of the new jobs are taken by either in-commuters or new residents who bring with them additional entrants into the local labor market some of whom become unemployed.

1. Introduction

The trend of transferring some of the responsibilities of the Federal government to local government implies that local government decision makers will need more accurate information about their own regional economic systems. It is well understood that new businesses bring changes in population and migration of new residents that will induce changes in local government revenues and expenditures, but estimates of the numerical relationship are often missing. As the need for timely information about the local economic system increases, the development of a well-defined community impact model is crucial.

Since labor markets are highly interrelated between local communities, it is necessary to include the role of commuting in a regional economic impact model. In response to an increase in labor demand, people commute or relocate to seek new jobs or better salaries. If a private company invests their

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capital in a certain county and produces new jobs, the environment of the county labor market will improve relative to contiguous counties. Those new jobs may be captured by the formerly underemployed or unemployed people of the county. Also, people who live in the contiguous counties may try to commute from their own counties to the better labor market. Moreover, some people may immigrate into the county in response to the job growth in hope of getting a better job. The nature of the labor market response has important implications in terms of expected population change and public services pressures.

In the U.S., regional economic impact analysis is commonly conducted with the use of input-output (I-O) models constructed with IMPLAN[1]. These economic models can be used to predict economy-wide changes in employment and income in response to shocks to the regional economy. The weakness of such analysis is that it says nothing about how the predicted employment change will impact commuting behavior, unemployment, in-migration of new residents, total population change, and the local government response in terms of expected changes in revenues and expenditures. The econometric model developed in this paper is intended to fill those information needs and to complement regional input-output analysis. In this study, we will develop a regional econometric model of Washington at the county level and show how the model works in simulating the impact of regional employment changes on county labor markets and county fiscal behavior.

In particular we will use the model to test two of what Fodor (1999) calls the twelve myths of economic growth as follows: "Myth 1: Growth provides needed tax revenues." If we check out the tax rates of cities larger than ours, there are a few exceptions but the general rule is: the larger the city, the higher the taxes. That's because development requires water, sewage treatment, road maintenance, police and fire protection, garbage pickup - a host of public services. Almost never do the new taxes cover the new costs. Fodor says, "the bottom line on urban growth is that it rarely pays its own way." "Myth 2: We have to grow to provide jobs. But there's no guarantee that new jobs will go to local folks." In fact they rarely do. If you compare the 25 fastest growing cities in the U.S. to the 25 slowest growing, you find no significant difference in unemployment rates. Says Fodor: "Creating more local jobs ends up attracting more people, who require more jobs."

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[1] IMPLAN (IMpact analysis for PLANning) from the Minnesota IMPLAN Group Inc. IMPLAN Professional, Version 2.0 Social Accounting and Impact Analysis Software, 1999.

2. Conceptual Model

Conjoined I-O and Econometric Model

Glickman (1977) suggested integrating regional I-O tables with econometric models. He expressed the integrated I-O and econometric model as combining the good qualities of both devices. The Nobel Laureate, L. R. Klein also suggested that integrated I-O and econometric model might become "a new basic model" to "guide our thinking about [the] performance of the economy as a whole" in his 1977 presidential address to the American Economic Association. For Washington state, Bourque et al (1977) built in the Washington Projection and Simulation Model (WPSM) which is a regional interindustry econometric model designed for forecasting and impact analysis. Conway (1990) improved the WPSM, analyzed the accuracy of the long-range forecasts prepared with the original WPSM, and evaluated the model's simulation properties. WPSM includes consumption, investment, state and local government expenditures, and exports, and each of these variables is estimated stochastically.

In a very through review, Rey (2000) classifies integrated econometric+input-output models as having the following three types of integrating strategies: linking, embedding, and coupling. In the coupling approach, Conway (1990) there is full two-way feedback between econometric (EC) and input-output (IO) components. In the linking approach Swenson (1995) and this paper, the linkage runs only one way. The IO model serves as a "front end" and the results from the IO component feed into the EC model. In the embedding approach, Rey and Jackson (1999) the interaction between EC and IO components is simultaneous but with fewer channels of integration than is the case in the coupling strategy.

The Virginia Impact Projection (VIP) model and the Show Me model in Missouri State were developed by Thomas Johnson and provided much of the initiative for recent rural policy impact analysis. In particular, the VIP model offered a basic framework for fiscal impact modeling but did not contain a formal analysis of regional labor markets. Johnson introduced the theoretical basis for fiscal impact analysis, and suggested a system of equations and also some relevant exogenous variables for fiscal equations, but initially did not give much attention to the labor force behavior. The Show Me model is a county government model, and it is used primarily to test policy change and economic growth scenarios for counties. A good introduction to Johnson's approach to fiscal and labor market modeling is "Econometric Impact Models for Communities: A Theoretical Framework and Research Agenda" (Johnson et al, 1996).

Similar to the VIP model, "The Iowa Economic/Fiscal Impact Modeling System" (Swenson 1995) and "A Manual for Community and Fiscal Impact Modeling Systems" (Swenson and Eathington 1998) was developed for impact analysis in Iowa. Swenson presented a detailed description of how to develop and combine the labor force and fiscal models. He emphasized the choice of available and appropriate variables in an empirical econometric model. Martin Shields (1998) in his Ph.D. dissertation research, developed a Wisconsin regional model for the purpose of enhancing theoretical understanding of rural economic structure and improving the information set for local policy makers and residents. The model was developed on the basis of six components of a local economy: production, labor markets, demographics, housing markets, retail and government. He also accounts for regional differences by using dummy variables for four groups of similar counties. Using the estimated model, he simulated two different economic impact scenarios.

Currently in the U.S.A., about 14 states, including Washington, are developing their own community policy economic model. All states are cooperating under the Community Policy Analysis Network (CPAN)[2] under the leadership of the Rural Policy Research Institute (RUPRI).

Theoretical Framework

Building on previous work in this field, a static Washington labor and fiscal impact model is developed. The analytical framework is comparative statics. We assume that the time frame of analysis is sufficiently long so that the labor market can adjust to changes in regional capital stock. New investment or new exogenous demand is assumed to drive employment growth. This may result from new private investment, new public investment or an increase in demand for the products of the region. Based on optimizing firm behavior, labor demand is represented by:

$$l^d = l^d(w), \qquad \frac{\partial l^d}{\partial w} < 0$$

where w denotes the real wage rate. And the labor supply function is also a function of the real wage.

$$l^s = l^s(w), \qquad \frac{\partial l^s}{\partial w} > 0$$

If we denote the equilibrium level of employment and real wage rate as l^* and w^*, the labor market equilibrium is attained at the equilibrium values l^* and w^*, $l^d(w^*) = l^s(w^*)$. The equilibrium level of employment l^* is composed of the locally employed residents and locally employed non-residents. The locally employed residents are derived from the relationship: locally employed residents = resident labor force - unemployed residents - outcom-

[2] Since 1995 the Rural Policy Research Institute (RUPRI) has promoted the idea of a multi-state, interdisciplinary research and outreach network, called the Community Policy Analysis Network (CPAN). The network's goals are to improve policy outcomes, and the governance of communities, especially rural communities. More information on RUPRI and CPAN can be found at http://www.rupri.org.

muters[3]. Therefore, the equilibrium employment level (place of work employment) is defined as $l^s =$ local resident labor force + incommuters - outcommuters - unemployed residents. Incommuters are defined as people who do not live in a certain county but work in the county. Outcommuters are the people who live in the county but work outside the county. We assume that the real wage rate adjusts to equate the labor supply and labor demand at the equilibrium real wage rate and the local labor market is in equilibrium. We obtain a relationship, $l^* = l^d(w^*) = l^s(w^*)$, at the labor market equilibrium. The equilibrium employment level, $l^* = l^s(w^*) =$ local resident labor force + incommu ters - outcommuters - unemployed residents. We now can derive the local labor force identity equation as local resident labor force = place of work employment - incommuters + outcommuters + unemployed[4].

If we represent the labor demand function as an inverse labor demand function, $w = f(l^d)$, at the equilibrium real wage rate, the labor demand is determined at l^*, $w^* = f(l^*)$. Therefore, at the equilibrium, we can specify each labor supply component as a function of the employment level, $l^s_{LF} = g_{LF}(w^*, Z_{LF}) = g_{LF}(f(l^*), Z_{LF})$, $l^s_{IN} = g_{IN}(w^*, Z_{IN}) = g_{IN}(f(l^*), Z_{IN})$, $l^s_{OUT} = g_{OUT}(w^*, Z_{OUT}) = g_{OUT}(f(l^*), Z_{OUT})$ where l^s_{LF} is the resident labor supply function, l^s_{IN} is the labor supply function for incommuters, l^s_{OUT} is the labor supply function for outcommuters, z_{LF} are labor supply shift variables for the resident labor supply function, Z_{IN} are the supply shift variables for the incommuters function and z_{OUT} are the supply shift variables for the outcommuters function. Given the local employment by place of work l^*, we can determine the resident labor supply, incommuters and outcommuters. Once the endogenous variables are estimated, the unemployment variable can be estimated as a residual in the local labor force identity above.

Application to Washington Labor Market and Fiscal Behavior

The Washington economic impact model starts from the estimation of the labor supply functions at the county level. Based on the estimated model, we simulate the impact of an exogenous local employment shock on

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[3] Based on the Keynesian macroeconomic foundation, the econometric model allows for unemployment in local labor market, whereas I-O and Computable General Equilibrium (CGE) models adopt the full employment assumption.

[4] It is common to define labor force by place of residence as the sum of the number of employed plus unemployed, where both the number of employed and unemployed are defined by place of residence. It can be shown that employment by place of residence is equal to employment by place of work plus outcommuters less incommuters. Let EPOR = Employment by place of residence, EPOW = Employment by place of work, OUT = Outcommuters and IN = Incommuters. Then EPOW - IN = Residents who work in region, OUT = Residents who work out of region, and EPOW - IN + OUT = Employment by place of residence.

the local labor force, population, commuting patterns, and the local government revenues and expenditures. The additional demand for labor attracts new participants in the potential employment pool who consist of former unemployed residents, new incommuters, former outcommuters and new inmigrants. That is, local labor force, unemployed residents, incommuters and outcommuters are determined endogenously as a function of employment. Based on these variables, we can deduce that the greater the proportion of new residents, the greater the increase of population and total personal income. The endogenously determined population variable along with personal income influences total county government revenues and expenditures. Since total government revenues and expenditures are a function of population, these are also determined endogenously. Total government revenues, expenditures and personal income variables allow us to test Fodor's Myth 1 by comparing the impact influences on those variables. The functional relationships among the variables are: $Y_1 = f_1(Y_2, X_4)$, $Y_2 = f_2(Y_3, Y_4, X_1)$, $Y_3 = f_3(X_1, X_2, X_5)$, $Y_4 = f_4(Y_2, X_1, X_3)$, $Y_5 = f_5(Y_1, X_6, X_7)$, $Y_6 = f_6(Y_1, X_6, X_7)$, and the labor force identity equation is $Y_7 = Y_2 + Y_3 - Y_4 - X_1$ where Y_1 = POP (Population), Y_2 = LF (Labor force), Y_3 = INCOMM (Incommuters), Y_4 = OUTCOM (Outcommuters), Y_5 = TRPC (Per capita general government revenue), Y_6 = TEPC (Per capita general government expenditure), Y_7 = UNEMP (The number of unemployed persons), X_1 = POWEMP (Place of work employment), X_2 = XLF (External labor force), X_3 = XEMP (External employment), X_4 = PAR (Local labor force participation rate), X_5 = POPDEN (Population density), X_6 = TPI (Total personal income), X_7 = WAGE (Average wage and salary earnings per job).

As shown in the above relationships, some endogenous variables stand on the right-hand side of other equations. This means a violation of non-randomness assumption in the multiple linear regression model. We will discuss the statistical properties and estimation method of simultaneous equation model in the next section.

3. Econometric Impact Model for Washington Counties

Based on the theoretical development of the preceding section the Washington econometric impact model at county level is constructed. To find the most suitable econometric model we tried many variables suggested to be theoretically important according to mainstream economic theory. In real data analysis, however, since some explanatory variables are highly correlated each other, and some are statistically insignificant, we have dropped problematic variables and replaced them with other meaningful variables. By checking plots and the correlation matrix among the explanatory variables, we found some problematic variables that would possibly cause a multicollinearity problem. As a remedy of the multicollinearity, we drop the variables that are less meaningful economically and less significant statistically. Based on the plots and correlation matrix between endogenous variables and exogenous variables, we examined a number of different model specifications some of which were linear in variables and parameters, non-linear in variables and parameters, and we tried dummy variable techniques for both linear and non-linear models. When we fitted a system of simultaneous equations by assuming a linear functional form and unobserved residual for each equation, the variances of estimated parameters and the estimate of constant term were enormous in each equation. To account for different behavior between urban and rural areas, or between the western side and eastern side of the Cascade Mountain Range, we used dummy variables in the equations. In accordance with anticipation, every coefficient of the dummy variables was significantly different from zero. However, the variances of estimated parameters were still huge. When we checked the plots of log-transformed data, the scales and distance among observations were significantly reduced, and the shapes of plots seemed reasonable to explain the endogenous variables. Dummy variables were no longer significant when we fitted the model by means of log-transformed variables. Our final result was a model that is linear in log-transformed variables.

Data and Variable Descriptions

Cross-sectional data for all 39 Washington counties are involved in the model. Most of the variables used in this model are collected or calculated on the basis of 1990 U.S. Census.

A summary of variable descriptions and sources is shown in Table 1. Most of variables are easily obtained in appropriate web sites or periodical publications, but some variables like POWEMP, XLF, XEMP, INCOMM, and OUTCOM are derived according to definitions in Table 1. The collected variables have very different sizes on their economic units and some observations like King, Pierce, Snohomish, and Spokane have extraordinary large sizes relative to the smaller counties.

Empirical Model

Although no theoretical functional form exists in this field most previous studies have used a linear specification (Johnson, Scott and Ma 1996; Swenson and Ecthington 1995; and Shields 1998). As mentioned before, log-transformed variables are more reasonable if we want to take account of the large variability in raw data. In the empirical framework, a log transformation is performed on each variable and the resulting specification is linear in logs. The empirical structural model consists of 7 equations, 7 endogenous variables, and 7 exogenous variables to represent the interrelationships among the variables. First, the population equation is specified as a log linear functional form and unobserved random error.

Table 1. Descriptions and Sources of the Variables

VARIABLE	SCALE	DESCRIPTION	SOURCE
POP	Number of persons	Population, 1990	U.S. Census of Population and Housing, 1990
LF	Number of persons	Total county labor force, 1990	Derived from BEA Journey to Work data and U.S. 1990 Census data
POWEMP	Number of persons	Place of Work Employment, 1990	BEA REIS CD-ROM 1969-1994: Journey to Work database
UNEMP	Number of persons	Number of unemployed persons, 1990	U.S. Census of Population and Housing, 1990
INCOMM	Number of persons	Number of incommuters, 1990	BEA REIS CD-ROM 1969-1994: Journey to Work database
OUTCOM	Number of persons	Number of outcommuters, 1990	BEA REIS CD-ROM 1969-1994: Journey to Work database
XLF	$\sum_i$ [Contiguous labor force / $\text{Distance}^2{}_i$]	External labor force	Derived from the formula, $\sum_i$ [Contiguous labor force / $\text{Distance}^2{}_i$]
XEMP	$\sum_i$ [Contiguous labor force / $\text{Distance}^2{}_i$]	External employment	Derived from the formula, $\sum_i$ [Contiguous employment / $\text{Distance}^2{}_i$]
CONLF	Number of persons	Contiguous labor force	Derived from Compiling contiguous labor force counts
CONEMP	Number of persons	Contiguous employment	Derived from Compiling contiguous employment counts
DISTANCE	Miles	Distance between counties	Derived from the U.S. Gazetteer Data Set
PAR	Percentage	Total Participation Rate, 1990	U.S. Census of Population and Housing, 1990
TPI	Thousands of dollars	Total Personal Income, 1990	BEA REIS database 1969-1996
WAGE	Dollars	Wage & Salary earnings per job, 1990	BEA REIS database 1969-1996
AREAPC	Square Miles / Population	Per capita County area in Square Miles	Derived from ESRI ArcView USA Counties coverage and U.S. Census of Population and Housing, 1990
POPDEN	Number of persons	Number of persons per square miles, 1990	ESRI ArcView USA Counties coverage
TRPC	Dollars	Per capita total county government general revenues	U.S. Census of Governments, 1992
TEPC	Dollars	Per capita total county government general expenditures	U.S. Census of Governments, 1992

$$Y_{1j}^{*} = c_1^{*} + g_{21} Y_{2j}^{*} + b_{41} x_{4j}^{*} + e_{1j} \tag{1}$$

where $Y_{1j}^{*} = \ln Y_{1j}$, $x_{4j}^{*} = \ln x_{4j}$, $c_1^{*} = \ln c_1$ and subscript, *j*, represents *j*th observation. And c_1^{*} is a constant term, g_{21} is a coefficient of labor force (LF), and b_{41} is a coefficient of labor force participation rate (PAR) and e_{1j} is an unobserved random error in the population equation. In equation (1), g_{21} is the labor force elasticity and b_{41} is the labor force participation rate elasticity. Here, we expect that the labor force elasticity will be positive, while the labor force participation rate elasticity will be negative. Counties with higher proportion of their population in the labor force have smaller population for a given level of labor force.

The labor force, incommuters, outcommuters, per capita total government revenues and per capita total government expenditures equations take the following forms, respectively:

$$Y_{2j}^{*} = c_2^{*} + g_{32} Y_{3j}^{*} + g_{42} Y_{4j}^{*} + b_{12} x_{1j}^{*} + e_{2j} \tag{2}$$

$$Y_{3j}^{*} = c_3^{*} + b_{13} x_{1j}^{*} + b_{23} x_{2j}^{*} + b_{53} x_{5j}^{*} + e_{3j} \tag{3}$$

$$Y_{4j}^{*} = c_4^{*} + g_{24} Y_{2j}^{*} + b_{14} x_{1j}^{*} + b_{34} x_{3j}^{*} + e_{4j} \tag{4}$$

$$Y_{5j}^{*} = c_5^{*} + g_{15} Y_{1j}^{*} + b_{65} x_{6j}^{*} + b_{75} x_{7j}^{*} + e_{5j} \tag{5}$$

$$Y_{6j}^{*} = c_6^{*} + g_{16} Y_{1j}^{*} + b_{66} x_{6j}^{*} + b_{76} x_{7j}^{*} + e_{6j} \tag{6}$$

$$Y_{7j}^{*} = \ln (Y_{2j} + Y_{3j} - Y_{4j} - x_{1j}) \tag{7}$$

where $Y_{lj}^{*} = \ln Y_{lj}$, $x_{kj}^{*} = \ln x_{kj}$ and $c_i^{*} = \ln c_i$; *j* = 1, 2, ..., 39, *j*th county (number of observations); c_i^{*} = Constant tem of *i*th equation, *i* = 1, 2, ... , 7, note that $c_7^{*} = 0$; g_{li} = Coefficient of *l*th endogenous variable in *i*th equation, *l* = 1, 2, ... , 7; b_{ki} = Coefficient of *k*th exogenous variable in *i*th equation, *k* = 1, 2, ... , 7; e_{ij} = Random error of *i*th equation.

Equation (2) is the local labor force equation. Here, we expect the sign of place of work employment elasticity and outcommuters elasticity to be positive, while the sign of incommuters elasticity is expected to be negative. This logic goes back to the labor force identity. Equation (3) is the incommuters equation. We expect that place of work employment elasticity and external labor force elasticity will be positive, while population density elasticity will be negative. Place of work employment represents demand for labor while external labor force represents the supply of labor from the outside. Low density counties tend to be more rural with a reduced tendency to attract incommuters. In the outcommuters equation (4), the sign of the labor force elasticity and external employment elasticity is expected to be positive while the sign of place of work employment elasticity is expected to be negative. Equation (5) is per capita total government revenues equation and Equation (6) is per capita total government expenditures equation. We expect that total personal income elasticity and wage elasticity will be positive in both equations. In Washington, county general revenues are related to property taxes. We use the broader personal income measure partially as a proxy for property taxes, but also because personal income is a more comprehensive measure of ability to pay for services. On the contrary, population elasticity is expected to be negative in both equations reflecting the likely existence economies of scale in the provision of county provided public services. Figure 1 diagrams the behavior of the simultaneous equations system.

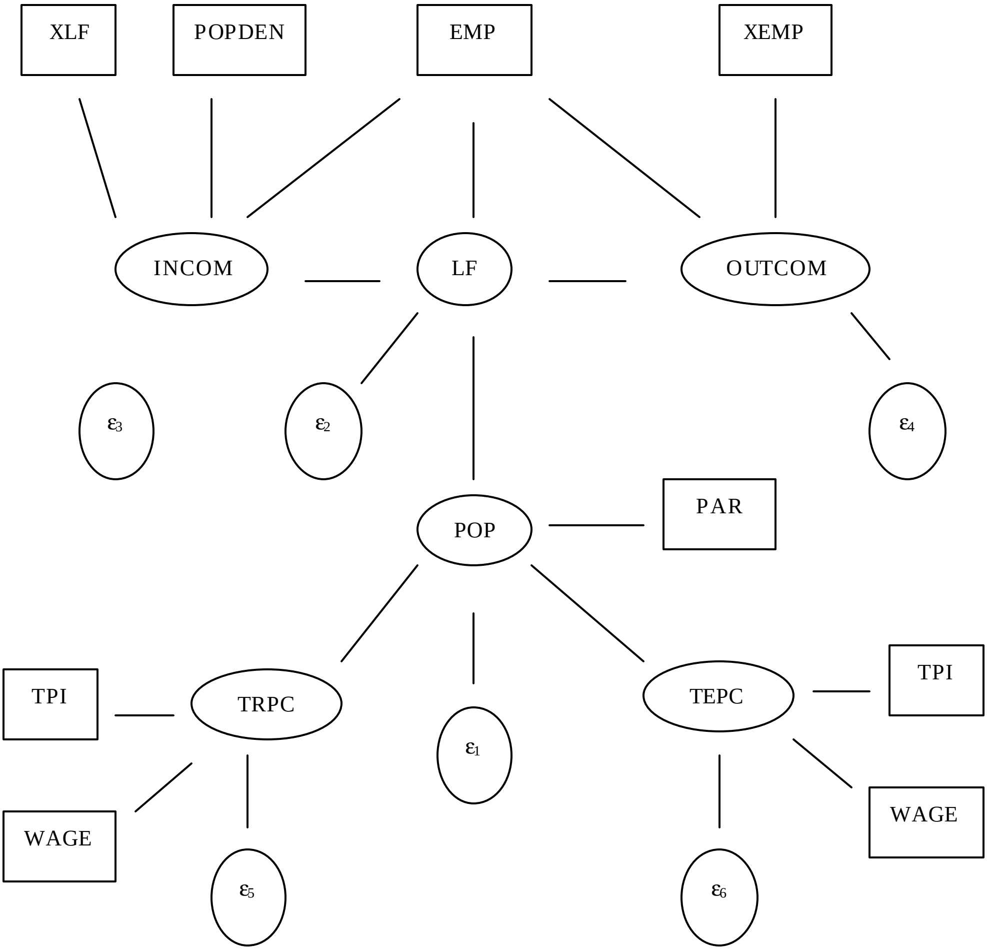
The Method of Estimation

In this structure, the right-hand sides of the equations involve two kinds of random variables, endogenous variables and error terms. This implies that the endogenous variables, Y_{ij}^{*} s and the error terms, e_{ij} s are possibly correlated. Thus, each multiple linear regression model violates the classical GLM assumptions. If we were to use the OLS (Ordinary Least Squares) estimation method separately for these statistical models, the OLS estimators of the parameter vector would be biased and inconsistent.

Many estimation methods have been developed to correct this problem. Among them, Two Stage Least Squares (2SLS) and 3 Stage Least Squares (3SLS) methods are used frequently because they can be applied to an over-identified structural model that is a general case of a real data analysis. Since the 2SLS method estimates each single equation, sometimes, it is called a limited information method. On the other hand, the 3SLS method estimates the equations jointly and uses the full information in the structural model. The statistical properties of estimates in both methods are asymptotically unbiased and consistent for the parameters, but 3SLS estimates are more efficient (Judge et. al, 1988).

As mentioned previously, 3SLS estimates the equations jointly. If we do a GLS estimation using the information of variance-covariance of residuals in 2SLS, then we get the 3SLS estimates for which the statistical properties are unbiased and consistent. The 3SLS procedure yields more efficient parameter estimates than 2SLS because it considers cross-equation correlation. Based on these properties, 3SLS was chosen to estimate our structural model.

Before the application of 3SLS, any under-identified equations and identity equations should be removed, especially, for the identity equation, since the error term is zero, the variance and covariance matrix could be a singular matrix. So, the identity equation (7) is removed from the system of equations.



Variables in circles are stochastic.
Variables in rectangular are non -stochastic.

Figure 1. Labor Supply-Demand Influence Diagram

After estimating Y_2, Y_3 and Y_4, we can estimate Y_7 as a residual by the identity equation (7). From equation (1) through (6) all the equations are overidentified. Therefore, we can estimate them with 3SLS method.

Note that Washington State is composed of 39 counties, and all of these counties are used for the model. This means that we are using population data rather than sampling data for Washington economic impact analysis at the county level. The normality test of the error terms in our model is necessary because we use all elements of the population for the estimation and cannot use the normality assumption of the sample mean. And also if the normality of error terms is not attained, we should perform the Wald test to check the statistical significance of each of the parameters in the linear semi-parametric regression model instead of the t-test. The results of the normality test of error terms are shown in Appendix 1.

Estimated Model

The equations estimated by 3SLS method are shown below. Because this is a log linear model, each coefficient represents the percentage change in the dependent variable due to a percentage change in the independent variable. Each model is considered as a multivariate normal linear regression model because the noise components in the structural equations are normally distributed. Now, we can perform a t-test to check the statistical significance of each of the parameters in the multivariate normal linear regression model. Based on the t-statistic, all of the estimates are significantly different from zero except for the constant terms of TRPC and TEPC equations.

$$\ln POP = \underset{(0.267)}{4.128} + \underset{(0.005)}{0.994} \ln LF - \underset{(0.070)}{0.796} \ln PAR \tag{8}$$

$$\ln LF = \underset{(0.105)}{0.193} + \underset{(0.028)}{0.943} \ln POWEMP - \underset{(0.040)}{0.193} \ln INCOMM + \underset{(0.027)}{0.249} \ln OUTCOM \tag{9}$$

$$\ln INCOMM = \underset{(0.589)}{-2.541} + \underset{(0.071)}{0.929} \ln POWEMP + \underset{(0.064)}{0.322} \ln XLF - \underset{(0.064)}{0.133} \ln POPDEN \tag{10}$$

$$\ln OUTCOM = \underset{(0.410)}{-1.835} + \underset{(0.398)}{3.050} \ln LF - \underset{(0.377)}{2.230} \ln POWEMP + \underset{(0.044)}{0.282} \ln XEMP \tag{11}$$

$$\ln TRPC = \underset{(3.664)}{-2.180} - \underset{(0.482)}{1.590} \ln POP + \underset{(0.456)}{1.227} \ln TPI + \underset{(0.371)}{0.887} \ln WAGE \tag{12}$$

$$\ln TEPC = \underset{(3.865)}{-1.559} - \underset{(0.509)}{1.575} \ln POP + \underset{(0.482)}{1.222} \ln TPI + \underset{(0.391)}{0.826} \ln WAGE \tag{13}$$

The numbers in parentheses below the coefficient estimates are the corresponding standard errors.

The signs of all the coefficients are in accordance with our expectations. Population is almost unitary elastic with changes in labor force (equation 8). The labor force participation rate elasticity in the population equation is negative and inelastic. The labor force equation (9) is characterized by inelastic values for POWEMP, INCOMM, and OUTCOM variables with the expected sign on all variables. The incommuters equation (10) is inelastic also in its explanatory variables. The OUTCOM equation (11) is elastic for LF and POWEMP, inelastic for external employment. TRPC (12) and TEPC (13) equations are elastic for population and total personal income, and inelastic for the WAGE variable. The population elasticity for TRPC and TEPC equations is negative, and roughly of the same magnitude as the positive total personal income elasticity. If population and personal income were to increase by the same percentage, we would expect a slight decrease in per capita county revenue and per capita county expenditure.

4. Policy Simulation and Results

To assess the impact of economic growth on county labor market adjustments and county government fiscal response, a simulation experiment was carried out. As indicated in section II, the employment level was substituted for the real wage level through the supply function, and we assumed that the economic growth of a region was manifested by an exogenous increase in employment demand. Therefore, the simulation experiment involves increasing the number of jobs as a result of an assumed increase in labor demand by 5 percent for each of the counties. The simulation is conducted for each county independently assuming no changes in the other counties.

To account for multiple job holding, the job change in terms of full time and part time jobs is translated into employment by place of work persons. In the baseline data for Adams County, for example, 8,130 full time and part time jobs were held by 5,634 people as shown in Table 2, indicating multiple job holding. Our first step is to convert the assumed change in the number of jobs into the associated change in people with jobs. Table 2 presents an example of the assumed employment impact and calculated total personal income impact for Adams County. Using a simple ratio between total jobs and POW employment, the level of impact on POW employment is calculated by 406.5*(5634/8130) = 281.7. The Table shows that 8,130 jobs were actually held by 5,634 persons so that the assumed increase of 406 jobs actually translates into 282 increased employment (persons employed).

Table 2. Summary of Assumed Growth for Adams County

Variable	Baseline Values	Impact Scenario	Level of Impact
Total Jobs	8130	0.05*8130	406.5
Total POW Employment	5634	0.05*5634	281.7
Personal Income	230,224	(1.929+5.1)*230,224	16,182.645

Along with the increase of the number of jobs in a county, the total personal income also increases. Historically, the percentage change of the total personal income in Washington has been greater than that of the number of jobs. However we did not know the historical relationship between the two variables, and did not have any functional expression to calculate the expected percentage change of the total personal income caused by a 5% change of employment. To find the expected percentage change of the total personal income it was necessary to estimate the functional relationship between two variables. A transfer function model is often considered where an output series is related to an input series. Considering real personal income for Washington as output series and employment as input series, a transfer function analysis was completed. Analysis procedures and results are represented in Appendix 2.

Exogenous Regional Impact Scenario

To calculate simulated percentage change of the real personal income caused by a 5% change of employment in 1990, we imposed a 5% impact of employment on the estimated transfer function model in each quarter of 1990. For example, the estimates of the real personal income in the forth quarter of 1990 according to a 5% impact of employment is calculated by the formula,

$$E(Y_{1990:4}) = (d_1 + f_1 + 1)Y_{1990:3} - (d_1 + f_1 + d_1 f_1)Y_{1990:2} + d_1 f Y_{1990:1} + w_0(X_{1990:4} + 0.05X_{1990:4})$$
$$- (w_0 + w_1 + w_0 f_1)X_{1990:3} + (w_1 + w_0 f_1 + w_1 f_1)X_{1990:2} - w_1 f_1 X_{1990:1} + m - (d_1 + f_1)m + d_1 f_1 m \,.$$

We then can calculate the average of four percentage changes on the real personal income. The summary of simulated percentage change of real personal income through the estimated transfer function is shown in Table 3. Since we used the nominal personal income values in our system of equations, we need to add an inflation rate to the estimated percentage change of the real personal income in 1990. For 1990 the inflation rate was 7.3% for the seven big western counties - King, Pierce, Thurston, Snohomish, Kitsap, Whatcom and Clark - which are Combined Metropolitan Statistical Area (CMSA), and 5.1% for all the other counties in Washington[5]. Table 3 shows the estimated impact regarding changes in real personal income for the state

[5] Selected Inflation Indicators
(Deflator 1992=1.0; Consumer Price Index (CPI) 1982-1984=1.0)

	Price Deflator*		Seattle CPI+	
	Index	Percent Change	Index	Percent Change
1990	0.929	5.1	1.268	7.3

* Chain-Weight Implicit Price Deflator for Personal Consumption Expenditures
\+ Consumer Price Index for the Seattle-Tacoma Combined Metropolitan Statistical Area (CMSA)
Source: Washington Economic and Revenue Forecast prepared by the Office of the Forecast Council in Washington state, Volume 22, No. 4, November 1999.

of Washington. The simulated percentage change in real personal income is added to the inflation rate to obtain the expected change in personal income.

Simulation Method

If we impose the exogenous policy impacts on the estimated structural model, a unique solution for each equation does not exist. To deal with this problem we transform the estimated structural model into reduced form. Since each reduced form equation is a function of exogenous variables only, we can calculate the impacts of POW employment and total personal income changes on each variable of interest.

Table 3. Simulated Percentage Change of Real Personal Income (PI)

	Baseline Values	5% Job Increase	Estimated Value of Real PI	Change of Real PI	% Change of Real PI
5% job increase in 1990:1	2410.115	120.506	103707.874	1996.899	1.963 %
5% job increase in 1990:2	2421.599	121.080	105451.112	2006.415	1.940 %
5% job increase in 1990:3	2421.134	121.057	106793.416	2006.029	1.914 %
5% job increase in 1990:4	2398.792	119.940	106645.552	1987.518	1.899 %
Average					1.929 %
Inflation Indicator for the Seattle-Tacoma CMSA					7.3 %
Inflation Indicator for the other counties					5.1 %

The simulation results for population, labor force, incommuters, outcommuters, and per capita government revenue and expenditure variables are driven by the assumed changes in exogenous variables as in Table 2. To get the predicted values of endogenous variables except for unemployment, we take the expectation on those variables. Since the functional form of the reduced form equations is log linear, that means $\ln Y_i \sim N(0, s_i^2)$ where Y_i has a multivariate log normal distribution. Thus we can calculate the expected value of Y_i by the formula, $E(Y_l) = \exp(\ln a_l + \sum_{k=1}^{7} a_{kl} \ln x_k + \frac{1}{2} s_l^2)$, or

$E(Y_l) = a_l \prod_{k=1}^{7} x_k^{a_{kl}} \exp(\frac{1}{2} s_l^2)$, and $E(e^{u_l}) = \exp(\frac{1}{2} s_l^2)$ where a_l, a_{kl} and s_l^2 are the estimated parameters in Y_l equation, and u_l is an error term in Y_l equation.

Results

Table 4 shows the exogenous impact level of changes in Place of Work (POW) employment and the corresponding predicted changes on the number of unemployed people. The Table includes the Beale code[6] that ranges from 0 to 9 and represents the degree of rurality. A bigger number means a more rural area. From the Beale code, we can see that the 20 counties on the eastern side of the Cascade Range are more rural; the average Beale level of the 20 eastern counties is 5.95 and that of the 19 western counties is 4.21.

According to the impact analysis, the growth scenario results in a reduction of the number of unemployed people in 14 of the 39 counties as shown in Figure 2 and Table 4. For example, the number of unemployed people in King County, the largest county in Washington State, is predicted to decrease by 10.23 percent. In other words, among the 45,515 newly created employed persons, 3,619 persons are from the formerly unemployed. Examining the percentage of high school graduates or higher, and the percent of bachelor's degree or higher we find the values for King County are 88.2 percent and 32.8 percent, respectively, whereas those percentages for Washington State are 83.8 percent and 22.9 percent. This indicates that formal education is relatively high among the population in King County and that the pool of unemployed people in King County may have the education and experience to compete with the incommuting workers and inmigrants from other counties or states for getting jobs.

Kitsap County borders on King County to the west, and Kitsap is the 6th most populated county in Washington State. In contrast to King County, although the number of jobs increases, the number of unemployed people in Kitsap is actually predicted to increase by 14.89 percent. This means that most of the newly created jobs in Kitsap are captured by people who live in contiguous counties like King and who commute into Kitsap, or are captured by the new inmigrants. The large percentage increase in labor force and incommuters in Kitsap causes a large percentage increase in the number of unemployed people. Tables 6 and 7 show that the percent changes of incommuters, labor force and population of Kitsap are 7.94%, 5.59% and 5.55%, whereas the state average is 3.71%, 4.39% and 4.42% respectively. We can represent this labor market behavior of Kitsap from the labor force identity equation as:

UNEMP (810) = LF (5232) + INCOMM (711) - POWEMP (4164) - OUTCOM (969).

The other contiguous counties to King County also suffer an increase in the unemployed people in response to local job growth. Even though the number of jobs increased in their own counties, the percent changes of unemployed people in Mason, Snohomish, and Pierce counties are 7.41 percent,

[6] Each county within the United States is categorized as "urban" or "rural". A county is urban if, at the time of determination, it has a Department of Agriculture rural-urban continuum code ("Beale Code") of 0 through 3. A county is rural if, at the time of determination, it has a Beale Code of 4 through 9.
Source: The website of North American Development Bank (NADBank), http://www.nadbank-caip.org/caipguide/uscaipb.html

7.71 percent and 4.9 percent, respectively. For 19 western side counties with the 5 percent job growth scenario, the number of unemployed people decreases in only four counties -Clallam, Cowlitz, Grays Harbor, and Whatcom – in addition to King. In Figure 2, we can see a common feature of these four counties is their distant location from King County.

The labor market response in San Juan County is the most sensitive to the assumed job increase. The percentage changes of the number of unemployed people, outcommuters, labor force, population, and unemployment rate are largest among all the counties. San Juan County, located on the western coast of Washington, is one of the most attractive counties because of its beautiful environment and amenities. Apparently, people who live in the other areas want to relocate to San Juan County, so when new jobs are created in the county, there is a response in the form of a large percentage increase rate of labor force and population resulting from migration. The large percentage changes of the unemployed and outcommuters are caused by the new incommuters and inmigrants who capture the newly created jobs in San Juan. San Juan is an example of a county where job growth appears to attract many new people who require more jobs as predicted by Fodor in Myth 2. However, this is certainly not the case in King County or in Spokane County, the largest county in eastern Washington.

Table 10 presents the change in unemployment rates that corresponds to the predicted change in number of unemployed from Table 4. The unemployment rate may decrease even though the number of unemployed increases depending the size of change in the labor force. For example, in Skagit County the number of unemployed people goes up but the unemployment rate goes down due to the relative increase in the labor force. The unemployment rate is shown to decrease in 22 of the 39 counties, and the western, eastern, and overall average unemployment rates decrease also as shown in Table 10. On average in Washington, the 5 percent change in POW employment results in just a -0.28 percent change in unemployment rate (Table 10). We can find the reason for this by examining the labor force identity equation. On average, the change of POW employment is 2,900, and that of labor force, incommuters, outcommuters and unemployed people is 2,748, 313, 188, and –27, respectively. Expressed in the labor force identity equation, the relationship is as follows: 2748 = 2900 - 313 +188 -27. New labor force participants occupy most of the new POW employment. As a result, the role of the other components of labor market adjustment is modest, especially changes in the number of unemployed. In our model, we cannot estimate what proportion of new labor force participants comes from within the county and what proportion comes from outside of the county. We believe, however that a high proportion of them come from outside of the county because the percent increase in population and labor force is very close. Even so, the effect of employment growth in most counties was to reduce the rate of unemployment in contrast to the implications of Myth 2.

As a general rule the simulation results indicate that the urban centers had the strongest reduction in number of unemployed. For example, King county is the major urban county in western Washington while Spokane and Yakima are the major urban counties in eastern Washington (Figure 2). All of these counties experienced decreased unemployment as well as decreased unemployment rates. Counties that are adjacent to very large counties or counties that are very high in natural amenities have just the opposite experience in terms of unemployment change. Kitsap, Snohomish and Pierce which are all adjacent to King experienced increased unemployment. Likewise, Clark County is adjacent to Portland and exhibits the same unemployment behavior and likewise Asotin County in eastern Washington, adjacent to Lewiston in Idaho.

Counties that are more remote (not adjacent to urban centers) tended to experience reduced unemployment unless they were high amenity counties. Examples of counties showing increases in number of unemployed that are high in amenities are San Juan on the west side and Pend Oreille in the east. It is interesting to note that the average percent decline in unemployment rate is larger in eastern Washington than western Washington. The implication is that a given percent increase in jobs would be more effective in reducing unemployment in eastern Washington than it would be in western Washington. The response of labor force increase and incommuting increase is not as large in eastern Washington as in western Washington. Of course this says nothing about the profitability of investment in eastern versus western Washington. This would have to be factored in with the labor market response in thinking about rural development policy.

The simulation results from the fiscal model are shown in Tables 9, 10 and 11. On average, the percentage changes in total personal income, total government revenues and total government expenditures increased by 8.64, 7.19 and 7.21 percent respectively. In per capita measures, the average percentage changes of those variables increased by 2.95, 1.86 and 1.89 percent. The results regarding per capita revenues and expenditures seem to support Myth 1. That is the economic increase led to increased tax revenues and expenditures per capita. The size of the increase in per capita measures is relatively small because the population effect is more elastic than total personal income effect and the population elasticity is negative (see the estimated revenue and expenditure equations in the model). Only for San Juan County, where per capita income is decreased by 0.15%, is the per capita income change negative.

Table 4. Exogenous Impact of Place of Work Employment and Corresponding Changes on the Unemployed

		Employment				Unemployment			
COUNTY NAME	BEALE	Baseline Value	Simulated Value	Net Impact	Percent Change	Baseline Value	Simulated Value	Net Impact	Percent Change
Clallam	5	20,361.00	21,379.05	1,018.05	5.00	1,817.00	1,718.07	-98.93	-5.44
Clark	1	81,194.00	85,253.70	4,059.70	5.00	6,898.00	7,710.53	812.53	11.78
Cowlitz	4	34,264.00	35,977.20	1,713.20	5.00	2,681.00	2,678.93	-2.07	-0.08
Grays Harbor	4	23,485.00	24,659.25	1,174.25	5.00	2,513.00	2,484.74	-28.26	-1.12
Island	1	22,337.00	23,453.85	1,116.85	5.00	1,336.00	1,534.31	198.31	14.84
Jefferson	6	7,188.00	7,547.40	359.40	5.00	595.00	624.10	29.10	4.89
King	0	910,305.00	955,820.25	45,515.25	5.00	35,391.00	31,771.61	-3,619.39	-10.23
Kitsap	3	83,277.00	87,440.85	4,163.85	5.00	5,439.00	6,249.02	810.02	14.89
Lewis	6	23,321.00	24,487.05	1,166.05	5.00	2,050.00	2,069.64	19.64	0.96
Mason	6	11,139.00	11,695.95	556.95	5.00	1,067.00	1,146.09	79.09	7.41
Pacific	7	6,388.00	6,707.40	319.40	5.00	504.00	529.18	25.18	5.00
Pierce	2	232,150.00	243,757.50	11,607.50	5.00	17,323.00	18,172.09	849.09	4.90
San Juan	8	4,232.00	4,443.60	211.60	5.00	180.00	241.61	61.61	34.23
Skagit	4	32,607.00	34,237.35	1,630.35	5.00	2,099.00	2,124.65	25.65	1.22
Skamania	8	2,256.00	2,368.80	112.80	5.00	397.00	418.58	21.58	5.44
Snohomish	0	179,402.00	188,372.10	8,970.10	5.00	10,203.00	10,989.49	786.49	7.71
Thurston	3	68,750.00	72,187.50	3,437.50	5.00	5,524.00	5,777.87	253.87	4.60
Wahkiakum	9	1,035.00	1,086.75	51.75	5.00	111.00	122.53	11.53	10.38
Whatcom	3	59,326.00	62,292.30	2,966.30	5.00	3,116.00	2,892.19	-223.81	-7.18
Western Avg.	4.21	94,895.63	99,640.41	4,744.78	5.00	5,223.37	5,223.96	0.59	0.01
Adams	6	5,634.00	5,915.70	281.70	5.00	385.00	381.22	-3.78	-0.98
Asotin	7	4,299.00	4,513.95	214.95	5.00	650.00	692.79	42.79	6.58
Benton	3	50,782.00	53,321.10	2,539.10	5.00	3,402.00	3,432.91	30.91	0.91
Chelan	5	25,787.00	27,076.35	1,289.35	5.00	1,969.00	1,944.97	-24.03	-1.22
Columbia	9	1,649.00	1,731.45	82.45	5.00	259.00	268.59	9.59	3.70
Douglas	7	7,106.00	7,461.30	355.30	5.00	1,050.00	1,100.79	50.79	4.84
Ferry	9	2,170.00	2,278.50	108.50	5.00	464.00	459.30	-4.70	-1.01
Franklin	3	17,409.00	18,279.45	870.45	5.00	1,404.00	1,481.02	77.02	5.49
Garfield	9	924.00	970.20	46.20	5.00	25.00	29.04	4.04	16.18
Grant	5	22,362.00	23,480.10	1,118.10	5.00	1,886.00	1,807.04	-78.96	-4.19
Kittitas	6	10,790.00	11,329.50	539.50	5.00	906.00	934.50	28.50	3.15
Klickitat	7	5,956.00	6,253.80	297.80	5.00	792.00	798.52	6.52	0.82
Lincoln	8	3,295.00	3,459.75	164.75	5.00	158.00	167.82	9.82	6.22
Okanogan	7	13,405.00	14,075.25	670.25	5.00	1,549.00	1,453.40	-95.60	-6.17
Pend Oreille	8	2,447.00	2,569.35	122.35	5.00	501.00	515.15	14.15	2.82
Spokane	2	161,867.00	169,960.35	8,093.35	5.00	12,328.00	11,500.77	-827.23	-6.71
Stevens	6	9,418.00	9,888.90	470.90	5.00	1,388.00	1,388.08	0.08	0.01
Walla Walla	4	21,777.00	22,865.85	1,088.85	5.00	1,650.00	1,647.38	-2.62	-0.16
Whitman	5	17,571.00	18,449.55	878.55	5.00	790.00	787.32	-2.68	-0.34
Yakima	3	74,113.00	77,818.65	3,705.65	5.00	8,416.00	8,095.62	-320.38	-3.81
Eastern Avg.	5.95	22,938.05	24,084.95	1,146.90	5.00	1,998.60	1,944.31	-54.29	-2.72
Average	5.10	57,994.31	60,894.02	2,899.72	5.00	3,569.64	3,542.09	-27.55	-0.77
Max	9.00	910,305.00	955,820.25	45,515.25	5.00	35,391.00	31,771.61	849.09	34.23
Min	0	924.00	970.20	46.20	5.00	25.00	29.04	-3,619.39	-10.23

Table 5. Simulation Results of Incommuter and Outcommuter Variables

	Incommuter				**Outcommuter**			
COUNTY NAME	Baseline Value	Simulated Value	Net Impact	Percent Change	Baseline Value	Simulated Value	Net Impact	Percent Change
Clallam	763.00	800.98	37.98	4.98	1,056.00	1,073.64	17.64	1.67
Clark	11,339.00	12,073.49	734.49	6.48	39,090.00	40,181.77	1,091.77	2.79
Cowlitz	4,510.00	4,669.42	159.42	3.53	3,730.00	3,812.26	82.26	2.21
Grays Harbor	2,038.00	2,135.31	97.31	4.77	2,468.00	2,515.21	47.21	1.91
Island	1,202.00	1,314.85	112.85	9.39	6,753.00	6,900.90	147.90	2.19
Jefferson	916.00	971.28	55.28	6.03	1,260.00	1,293.18	33.18	2.63
King	159,335.00	163,835.34	4,500.34	2.82	54,812.00	56,292.73	1,480.73	2.70
Kitsap	8,954.00	9,664.75	710.75	7.94	13,821.00	14,789.76	968.76	7.01
Lewis	3,686.00	3,843.94	157.94	4.28	3,536.00	3,607.39	71.39	2.02
Mason	2,139.00	2,228.00	89.00	4.16	5,137.00	5,214.87	77.87	1.52
Pacific	588.00	616.75	28.75	4.89	954.00	976.77	22.77	2.39
Pierce	28,524.00	29,960.59	1,436.59	5.04	66,963.00	67,919.75	956.75	1.43
San Juan	228.00	246.55	18.55	8.13	361.00	412.34	51.34	14.22
Skagit	4,668.00	4,867.94	199.94	4.28	5,713.00	5,809.29	96.29	1.69
Skamania	503.00	532.38	29.38	5.84	1,509.00	1,537.07	28.07	1.86
Snohomish	37,600.00	38,943.92	1,343.92	3.57	90,165.00	91,030.28	865.28	0.96
Thurston	9,681.00	10,043.23	362.23	3.74	16,295.00	16,557.42	262.42	1.61
Wahkiakum	97.00	103.67	6.67	6.87	524.00	535.70	11.70	2.23
Whatcom	2,814.00	3,007.48	193.48	6.88	3,927.00	4,007.76	80.76	2.06
Western Avg.	14,715.00	15,255.78	540.78	3.68	16,740.74	17,077.27	336.53	2.01
Adams	823.00	844.66	21.66	2.63	961.00	972.47	11.47	1.19
Asotin	994.00	1,038.94	44.94	4.52	3,711.00	3,783.42	72.42	1.95
Benton	8,113.00	8,350.55	237.55	2.93	9,172.00	9,303.30	131.30	1.43
Chelan	6,031.00	6,220.47	189.47	3.14	2,644.00	2,709.31	65.31	2.47
Columbia	353.00	362.46	9.46	2.68	244.00	252.26	8.26	3.39
Douglas	2,186.00	2,245.33	59.33	2.71	6,530.00	6,580.78	50.78	0.78
Ferry	264.00	272.51	8.51	3.22	357.00	360.82	3.82	1.07
Franklin	7,919.00	8,047.65	128.65	1.62	5,948.00	6,031.42	83.42	1.40
Garfield	83.00	87.70	4.70	5.67	115.00	118.68	3.68	3.20
Grant	1,927.00	2,013.10	86.10	4.47	1,474.00	1,507.96	33.96	2.30
Kittitas	408.00	483.89	75.89	18.60	1,259.00	1,300.06	41.06	3.26
Klickitat	956.00	986.74	30.74	3.22	1,285.00	1,301.90	16.90	1.32
Lincoln	360.00	383.15	23.15	6.43	641.00	654.00	13.00	2.03
Okanogan	1,002.00	1,045.80	43.80	4.37	940.00	952.75	12.75	1.36
Pend Oreille	547.00	564.06	17.06	3.12	873.00	886.49	13.49	1.54
Spokane	8,897.00	9,339.58	442.58	4.97	5,233.00	5,407.18	174.18	3.33
Stevens	698.00	740.12	42.12	6.04	2,558.00	2,580.27	22.27	0.87
Walla Walla	3,584.00	3,663.91	79.91	2.23	2,535.00	2,580.80	45.80	1.81
Whitman	2,226.00	2,322.21	96.21	4.32	1,465.00	1,509.78	44.78	3.06
Yakima	1,865.00	2,155.84	290.84	15.59	3,690.00	3,794.71	104.71	2.84
Eastern Avg.	2,461.80	2,558.43	96.63	3.93	2,581.75	2,629.42	47.67	1.85
Average	8,431.31	8,744.32	313.01	3.71	9,479.72	9,668.11	188.40	1.99
Max	159,335.00	163,835.34	4,500.34	18.60	90,165.00	91,030.28	1,480.73	14.22
Min	83.00	87.70	4.70	1.62	115.00	118.68	3.68	0.78

As shown in Table 7, 8, 9, the simulation results strongly indicate that the simulated economic expansion tends to result in a bigger county government than before the simulated expansion on both a total and a per capita basis. The simulated average percentage increase in total county government revenues (7.19%) is almost identical to the increase in simulated total county government expenditures (7.21%). On average, the percentage increase in total and per capita personal income is larger than the percent increase in total and per capita government revenues and expenditures. So it does seem true that employment growth causes tax revenue increases even on a per capita basis (Myth 1). However, the increase and percent increase in per capita tax revenue is less than the increase and percent increase in per capita income. If the change in personal income is taken as reflection of ability to pay, the tax increase is less than the increase in ability to pay for both urban counties and rural counties.

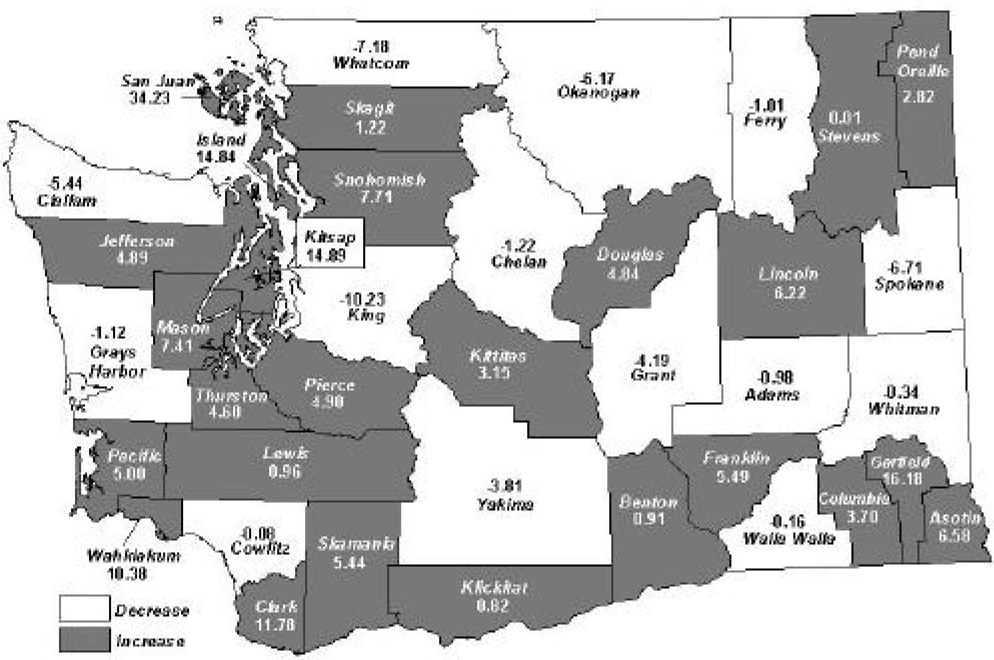


Figure 2. Percent Change in Number of Unemployment in Response to a Five Percent Growth in County Employment

Table 6. Simulation Results of Labor Force and Population Variables

	Labor Force				Popu;ation			
COUNTY NAME	Baseline Value	Simulated Value	Net Impact	Percent Change	Baseline Value	Simulated Value	Net Impact	Percent Change
Clallam	22,471.00	23,369.78	898.78	4.00	56,464.00	58,703.53	2,239.53	3.97
Clark	115,843.00	121,072.52	5,229.52	4.51	238,053.00	248,616.42	10,563.42	4.44
Cowlitz	36,165.00	37,798.97	1,633.97	4.52	82,119.00	85,747.01	3,628.01	4.42
Grays Harbor	26,428.00	27,523.88	1,095.88	4.15	64,175.00	66,760.40	2,585.40	4.03
Island	29,224.00	30,574.20	1,350.20	4.62	60,195.00	63,017.45	2,822.45	4.69
Jefferson	8,127.00	8,493.40	366.40	4.51	20,146.00	21,068.55	922.55	4.58
King	841,173.00	880,049.25	38,876.25	4.62	1,507,319.00	1,580,656.59	73,337.59	4.87
Kitsap	93,583.00	98,814.88	5,231.88	5.59	189,731.00	200,261.43	10,530.43	5.55
Lewis	25,221.00	26,320.14	1,099.14	4.36	59,358.00	61,878.99	2,520.99	4.25
Mason	15,204.00	15,828.90	624.90	4.11	38,341.00	39,904.18	1,563.18	4.08
Pacific	7,258.00	7,596.60	338.60	4.67	18,882.00	19,755.26	873.26	4.62
Pierce	287,912.00	299,888.75	11,976.75	4.16	586,203.00	610,323.73	24,120.73	4.11
San Juan	4,545.00	4,851.01	306.01	6.73	10,035.00	10,756.72	721.72	7.19
Skagit	35,751.00	37,303.36	1,552.36	4.34	79,555.00	82,993.77	3,438.77	4.32
Skamania	3,659.00	3,792.07	133.07	3.64	8,289.00	8,582.65	293.65	3.54
Snohomish	242,170.00	251,447.94	9,277.94	3.83	465,642.00	483,426.48	17,784.48	3.82
Thurston	80,888.00	84,479.56	3,591.56	4.44	161,238.00	168,467.32	7,229.32	4.48
Wahkiakum	1,573.00	1,641.31	68.31	4.34	3,327.00	3,478.40	151.40	4.55
Whatcom	63,555.00	66,184.76	2,629.76	4.14	127,780.00	133,193.50	5,413.50	4.24
Western Avg.	102,144.74	106,685.86	4,541.12	4.45	198,781.68	207,768.02	8,986.33	4.52
Adams	6,157.00	6,424.72	267.72	4.35	13,603.00	14,156.95	553.95	4.07
Asotin	7,666.00	7,951.22	285.22	3.72	17,605.00	18,255.05	650.05	3.69
Benton	55,243.00	57,706.76	2,463.76	4.46	112,560.00	117,484.64	4,924.64	4.38
Chelan	24,369.00	25,510.17	1,141.17	4.68	52,250.00	54,674.05	2,424.05	4.64
Columbia	1,799.00	1,889.84	90.84	5.05	4,024.00	4,234.86	210.86	5.24
Douglas	12,500.00	12,897.54	397.54	3.18	26,205.00	27,033.44	828.44	3.16
Ferry	2,727.00	2,826.10	99.10	3.63	6,295.00	6,517.30	222.30	3.53
Franklin	16,842.00	17,744.23	902.23	5.36	37,473.00	39,325.20	1,852.20	4.94
Garfield	981.00	1,030.22	49.22	5.02	2,248.00	2,363.03	115.03	5.12
Grant	23,795.00	24,782.01	987.01	4.15	54,758.00	56,902.52	2,144.52	3.92
Kittitas	12,547.00	13,080.17	533.17	4.25	26,725.00	27,925.46	1,200.46	4.49
Klickitat	7,077.00	7,367.47	290.47	4.10	16,616.00	17,273.47	657.47	3.96
Lincoln	3,734.00	3,898.43	164.43	4.40	8,864.00	9,255.60	391.60	4.42
Okanogan	14,892.00	15,435.61	543.61	3.65	33,350.00	34,538.77	1,188.77	3.56
Pend Oreille	3,274.00	3,406.93	132.93	4.06	8,915.00	9,255.59	340.59	3.82
Spokane	170,531.00	177,528.73	6,997.73	4.10	361,364.00	376,129.18	14,765.18	4.09
Stevens	12,666.00	13,117.13	451.13	3.56	30,948.00	31,973.11	1,025.11	3.31
Walla Walla	22,378.00	23,430.11	1,052.11	4.70	48,439.00	50,757.04	2,318.04	4.79
Whitman	17,600.00	18,424.44	824.44	4.68	38,775.00	40,729.22	1,954.22	5.04
Yakima	84,354.00	87,553.14	3,199.14	3.79	188,823.00	195,642.02	6,819.02	3.61
Eastern Avg.	25,056.60	26,100.25	1,043.65	4.17	54,492.00	56,721.33	2,229.33	4.09
Average	62,612.36	65,359.90	2,747.55	4.39	124,786.97	130,308.18	5,521.20	4.42
Max	841,173.00	880,049.25	38,876.25	6.73	1,507,319.00	1,580,656.59	73,337.59	7.19
Min	981.00	1,030.22	49.22	3.18	2,248.00	2,363.03	115.03	3.16

Table 7. Simulation Results of Total Personal Income and Per Capita Income Variables

	Total Personal Income				Per Capita Income			
COUNTY NAME	Baseline Value	Simulated Value	Net Impact	Percent Change	Baseline Value	Simulated Value	Net Impact	Percent Change
Clallam	1,024,182,000	1,096,172,645	71,990,645	7.03	18,138.67	18,673.03	534.36	2.95
Clark	4,493,124,000	4,907,798,327	414,674,327	9.23	18,874.47	19,740.44	865.97	4.59
Cowlitz	1,384,273,000	1,481,574,755	97,301,755	7.03	16,856.91	17,278.44	421.53	2.50
Grays Harbor	1,005,440,000	1,076,113,253	70,673,253	7.03	15,667.16	16,119.04	451.88	2.88
Island	996,608,000	1,066,660,444	70,052,444	7.03	16,556.33	16,926.43	370.10	2.24
Jefferson	369,348,000	395,309,793	25,961,793	7.03	18,333.56	18,763.03	429.47	2.34
King	38,163,540,000	41,685,686,347	3,522,146,347	9.23	25,318.82	26,372.39	1,053.57	4.16
Kitsap	3,379,540,000	3,691,440,690	311,900,690	9.23	17,812.27	18,433.11	620.84	3.49
Lewis	906,246,000	969,946,821	63,700,821	7.03	15,267.46	15,674.90	407.44	2.67
Mason	571,182,000	611,330,880	40,148,880	7.03	14,897.42	15,319.97	422.55	2.84
Pacific	281,099,000	300,857,694	19,758,694	7.03	14,887.14	15,229.24	342.10	2.30
Pierce	10,261,506,000	11,208,549,326	947,043,326	9.23	17,505.04	18,364.92	859.89	4.91
San Juan	255,673,000	273,644,478	17,971,478	7.03	25,478.13	25,439.40	-38.73	-0.15
Skagit	1,446,575,000	1,548,256,017	101,681,017	7.03	18,183.33	18,655.09	471.76	2.59
Skamania	127,076,000	136,008,283	8,932,283	7.03	15,330.68	15,846.88	516.20	3.37
Snohomish	8,936,907,000	9,761,701,931	824,794,931	9.23	19,192.66	20,192.73	1,000.08	5.21
Thurston	3,007,557,000	3,285,127,055	277,570,055	9.23	18,652.90	19,500.09	847.18	4.54
Wahkiakum	54,461,000	58,289,111	3,828,111	7.03	16,369.40	16,757.46	388.06	2.37
Whatcom	2,228,105,000	2,433,738,751	205,633,751	9.23	17,437.04	18,272.20	835.16	4.79
Western Avg.	4,152,233,789	4,525,695,084	373,461,295	8.99	17,934.71	18,503.09	568.39	3.17
Adams	230,224,000	246,406,645	16,182,645	7.03	16,924.50	17,405.35	480.84	2.84
Asotin	263,928,000	282,479,729	18,551,729	7.03	14,991.65	15,474.06	482.41	3.22
Benton	2,012,381,000	2,153,833,013	141,452,013	7.03	17,878.30	18,332.89	454.59	2.54
Chelan	906,139,000	969,832,300	63,693,300	7.03	17,342.37	17,738.44	396.07	2.28
Columbia	64,212,000	68,725,517	4,513,517	7.03	15,957.26	16,228.52	271.26	1.70
Douglas	391,646,000	419,175,138	27,529,138	7.03	14,945.47	15,505.80	560.33	3.75
Ferry	77,360,000	82,797,702	5,437,702	7.03	12,289.12	12,704.29	415.17	3.38
Franklin	535,765,000	573,424,388	37,659,388	7.03	14,297.36	14,581.60	284.24	1.99
Garfield	39,626,000	42,411,346	2,785,346	7.03	17,627.22	17,947.84	320.61	1.82
Grant	778,471,000	833,190,405	54,719,405	7.03	14,216.57	14,642.42	425.84	3.00
Kittitas	405,004,000	433,472,084	28,468,084	7.03	15,154.50	15,522.47	367.97	2.43
Klickitat	246,181,000	263,485,277	17,304,277	7.03	14,815.90	15,253.75	437.85	2.96
Lincoln	160,152,000	171,409,224	11,257,224	7.03	18,067.69	18,519.53	451.84	2.50
Okanogan	474,111,000	507,436,675	33,325,675	7.03	14,216.22	14,691.80	475.58	3.35
Pend Oreille	116,253,000	124,424,525	8,171,525	7.03	13,040.16	13,443.18	403.02	3.09
Spoka ne	6,044,598,000	6,469,478,058	424,880,058	7.03	16,727.17	17,200.15	472.98	2.83
Stevens	402,143,000	430,409,982	28,266,982	7.03	12,994.15	13,461.62	467.47	3.60
Walla Walla	735,622,000	787,329,511	51,707,511	7.03	15,186.56	15,511.73	325.16	2.14
Whitman	520,270,000	556,840,231	36,570,231	7.03	13,417.67	13,671.76	254.10	1.89
Yakima	2,945,445,000	3,152,482,894	207,037,894	7.03	15,598.97	16,113.53	514.55	3.30
Eastern Avg.	867,476,550	928,452,232	60,975,682	7.03	15,284.44	15,697.54	413.09	2.70
Average	2,467,742,897	2,680,955,160	213,212,263	8.64	16,575.60	17,064.35	488.75	2.95
Max	38,163,540,000	41,685,686,347	3,522,146,347	9.23	25,478.13	26,372.39	1,053.57	5.21
Min	39,626,000	42,411,346	2,785,346	7.03	12,289.12	12,704.29	-38.73	-0.15

Table 8. Simulation Results of Total Government Revenues and Per Capita Government Revenues Variables

	Total Gov. Revenue				Per Capita Gov. Revenue			
COUNTY NAME	Baseline Value	Simulated Value	Net Impact	Percent Change	Baseline Value	Simulated Value	Net Impact	Percent Change
Clallam	15,352,000	16,463,681	1,111,681	7.24	271.89	280.45	8.56	3.15
Clark	75,954,000	82,518,680	6,564,680	8.64	319.06	331.91	12.85	4.03
Cowlitz	38,531,000	40,830,216	2,299,216	5.97	469.21	476.17	6.96	1.48
Grays Harbor	23,545,000	24,973,342	1,428,342	6.07	366.89	374.07	7.19	1.96
Island	19,033,000	20,301,586	1,268,586	6.67	316.19	322.16	5.97	1.89
Jefferson	12,085,000	12,831,786	746,786	6.18	599.87	609.05	9.18	1.53
King	638,754,000	685,386,237	46,632,237	7.30	423.77	433.61	9.84	2.32
Kitsap	58,671,000	63,785,096	5,114,096	8.72	309.23	318.51	9.28	3.00
Lewis	25,484,000	26,955,258	1,471,258	5.77	429.33	435.61	6.29	1.46
Mason	15,976,000	16,925,493	949,493	5.94	416.68	424.15	7.47	1.79
Pacific	9,569,000	10,143,266	574,266	6.00	506.78	513.45	6.67	1.32
Pierce	189,777,000	203,329,736	13,552,736	7.14	323.74	333.15	9.41	2.91
San Juan	9,190,000	9,935,524	745,524	8.11	915.79	923.66	7.86	0.86
Skagit	32,374,000	34,328,659	1,954,659	6.04	406.94	413.63	6.69	1.64
Skamania	9,938,000	10,428,208	490,208	4.93	1,198.94	1,215.03	16.09	1.34
Snohomish	142,997,000	155,465,326	12,468,326	8.72	307.10	321.59	14.49	4.72
Thurston	57,781,000	62,770,300	4,989,300	8.63	358.36	372.60	14.24	3.97
Wahkiakum	3,182,000	3,380,283	198,283	6.23	956.42	971.79	15.38	1.61
Whatcom	44,480,000	48,273,411	3,793,411	8.53	348.10	362.43	14.33	4.12
Western Avg.	74,877,526	80,475,057	5,597,531	7.48	486.54	496.48	9.93	2.04
Adams	7,219,000	7,661,687	442,687	6.13	530.69	541.20	10.50	1.98
Asotin	5,651,000	6,036,117	385,117	6.82	320.99	330.65	9.67	3.01
Benton	22,161,000	23,974,944	1,813,944	8.19	196.882	204.069	7.187	3.65
Chelan	17,039,000	18,164,304	1,125,304	6.60	326.11	332.23	6.12	1.88
Columbia	4,285,000	4,550,464	265,464	6.20	1,064.86	1,074.53	9.66	0.91
Douglas	11,402,000	12,037,442	635,442	5.57	435.11	445.28	10.17	2.34
Ferry	5,549,000	5,845,701	296,701	5.35	881.49	896.95	15.46	1.75
Franklin	9,939,000	10,619,192	680,192	6.84	265.23	270.04	4.80	1.81
Garfield	2,961,000	3,146,235	185,235	6.26	1,317.17	1,331.44	14.27	1.08
Grant	19,770,000	20,892,518	1,122,518	5.68	361.04	367.16	6.12	1.70
Kittitas	10,129,000	10,767,600	638,600	6.30	379.01	385.58	6.58	1.73
Klickitat	7,721,000	8,231,021	510,021	6.61	464.67	476.51	11.84	2.55
Lincoln	8,136,000	8,608,190	472,190	5.80	917.87	930.05	12.18	1.33
Okanogan	13,763,000	14,516,006	753,006	5.47	412.68	420.28	7.60	1.84
Pend Oreille	7,380,000	7,780,718	400,718	5.43	827.82	840.65	12.83	1.55
Spokane	113,573,000	119,755,063	6,182,063	5.44	314.29	318.39	4.10	1.30
Stevens	12,609,000	13,332,105	723,105	5.73	407.43	416.98	9.55	2.34
Walla Walla	13,121,000	14,015,489	894,489	6.82	270.88	276.13	5.25	1.94
Whitman	12,091,000	12,884,805	793,805	6.57	311.82	316.35	4.53	1.45
Yakima	41,320,000	43,767,141	2,447,141	5.92	218.83	223.71	4.88	2.23
Eastern Avg.	17,290,950	18,329,337	1,038,387	6.01	511.24	519.91	8.67	1.69
Average	45,345,949	48,605,457	3,259,508	7.19	499.21	508.49	9.28	1.86
Max	638,754,000	685,386,237	46,632,237	8.72	1,317.17	1,331.44	16.09	4.72
Min	2,961,000	3,146,235	185,235	4.93	196.88	204.07	4.10	0.86

Table 9. Simulation Results of Total Government Expenditures and Per Capita Government Expenditures Variables

	Total Gov. Expenditure				Per Capita Gov. Expenditure			
COUNTY NAME	Baseline Value	Simulated Value	Net Impact	Percent Change	Baseline Value	Simulated Value	Net Impact	Percent Change
Clallam	22,589,000	24,060,100	1,471,100	6.51	400.06	409.86	9.80	2.45
Clark	82,323,000	89,611,248	7,288,248	8.85	345.82	360.44	14.62	4.23
Cowlitz	38,761,000	41,151,496	2,390,496	6.17	472.01	479.92	7.91	1.68
Grays Harbor	26,867,000	28,496,732	1,629,732	6.07	418.65	426.85	8.20	1.96
Island	20,361,000	21,746,488	1,385,488	6.80	338.25	345.09	6.84	2.02
Jefferson	15,441,000	16,368,867	927,867	6.01	766.45	776.93	10.48	1.37
King	717,067,000	769,750,604	52,683,604	7.35	475.72	486.98	11.26	2.37
Kitsap	55,361,000	60,548,577	5,187,577	9.37	291.79	302.35	10.56	3.62
Lewis	28,529,000	30,185,862	1,656,862	5.81	480.63	487.82	7.19	1.50
Mason	18,076,000	19,153,066	1,077,066	5.96	471.45	479.98	8.52	1.81
Pacific	9,808,000	10,412,836	604,836	6.17	519.44	527.09	7.66	1.47
Pierce	217,946,000	233,510,340	15,564,340	7.14	371.79	382.60	10.81	2.91
San Juan	9,755,000	10,553,595	798,595	8.19	972.10	981.12	9.02	0.93
Skagit	40,674,000	43,069,934	2,395,934	5.89	511.27	518.95	7.68	1.50
Skamania	12,852,000	13,462,606	610,606	4.75	1,550.49	1,568.58	18.09	1.17
Snohomish	178,330,000	193,091,627	14,761,627	8.28	382.98	399.42	16.45	4.29
Thurston	62,443,000	67,963,891	5,520,891	8.84	387.27	403.42	16.15	4.17
Wahkiakum	3,316,000	3,526,937	210,937	6.36	996.69	1,013.95	17.26	1.73
Whatcom	53,454,000	57,890,801	4,436,801	8.30	418.33	434.64	16.31	3.90
Western Avg.	84,944,895	91,292,400	6,347,506	7.47	556.38	567.68	11.31	2.03
Adams	8,523,000	9,040,069	517,069	6.07	626.55	638.56	12.01	1.92
Asotin	6,585,000	7,030,157	445,157	6.76	374.04	385.11	11.07	2.96
Benton	23,231,000	25,205,204	1,974,204	8.50	206.388	214.540	8.153	3.95
Chelan	16,971,000	18,143,676	1,172,676	6.91	324.80	331.85	7.05	2.17
Columbia	4,568,000	4,853,950	285,950	6.26	1,135.19	1,146.19	11.00	0.97
Douglas	12,607,000	13,321,868	714,868	5.67	481.09	492.79	11.70	2.43
Ferry	6,437,000	6,776,439	339,439	5.27	1,022.56	1,039.76	17.20	1.68
Franklin	13,712,000	14,607,326	895,326	6.53	365.92	371.45	5.53	1.51
Garfield	2,545,000	2,713,300	168,300	6.61	1,132.12	1,148.23	16.11	1.42
Grant	23,299,000	24,612,108	1,313,108	5.64	425.49	432.53	7.04	1.65
Kittitas	12,961,000	13,753,999	792,999	6.12	484.98	492.53	7.55	1.56
Klickitat	8,174,000	8,726,847	552,847	6.76	491.94	505.22	13.28	2.70
Lincoln	8,303,000	8,797,899	494,899	5.96	936.71	950.55	13.84	1.48
Okanogan	15,441,000	16,293,671	852,671	5.52	463.00	471.75	8.75	1.89
Pend Oreille	9,753,000	10,258,439	505,439	5.18	1,094.00	1,108.35	14.35	1.31
Spokane	120,401,000	127,108,706	6,707,706	5.57	333.18	337.94	4.75	1.43
Stevens	15,071,000	15,916,890	845,890	5.61	486.98	497.82	10.84	2.23
Walla Walla	15,299,000	16,337,460	1,038,460	6.79	315.84	321.88	6.04	1.91
Whitman	11,339,000	12,122,187	783,187	6.91	292.43	297.63	5.20	1.78
Yakima	45,149,000	47,891,242	2,742,242	6.07	239.11	244.79	5.68	2.38
Eastern Avg.	19,018,450	20,175,572	1,157,122	6.08	561.62	571.47	9.86	1.76
Average	51,136,462	54,822,232	3,685,770	7.21	559.06	569.63	10.56	1.89
Max	717,067,000	769,750,604	52,683,604	9.37	1,550.49	1,568.58	18.09	4.29
Min	2,545,000	2,713,300	168,300	4.75	206.39	214.54	4.75	0.93

Table 10. Simulation Results of Unemployment Rate

COUNTY NAME	Unemployment Rate: Baseline Unemployment Rate (%)	Unemployment Rate: Simulated Unemployment Rate (%)	Percent Change
Clallam	8.09	7.35	-0.73
Clark	5.95	6.37	0.41
Cowlitz	7.41	7.09	-0.33
Grays Harbor	9.51	9.03	-0.48
Island	4.57	5.02	0.45
Jefferson	7.32	7.35	0.03
King	4.21	3.61	-0.60
Kitsap	5.81	6.32	0.51
Lewis	8.13	7.86	-0.26
Mason	7.02	7.24	0.22
Pacific	6.94	6.97	0.02
Pierce	6.02	6.06	0.04
San Juan	3.96	4.98	1.02
Skagit	5.87	5.70	-0.18
Skamania	10.85	11.04	0.19
Snohomish	4.21	4.37	0.16
Thurston	6.83	6.84	0.01
Wahkiakum	7.06	7.47	0.41
Whatcom	4.90	4.37	-0.53
Western Avg.	5.11	4.90	-0.22
Adams	6.25	5.93	-0.32
Asotin	8.48	8.71	0.23
Benton	6.16	5.95	-0.21
Chelan	8.08	7.62	-0.46
Columbia	14.40	14.21	-0.18
Douglas	8.40	8.53	0.13
Ferry	17.02	16.25	-0.76
Franklin	8.34	8.35	0.01
Garfield	2.55	2.82	0.27
Grant	7.93	7.29	-0.63
Kittitas	7.22	7.14	-0.08
Klickitat	11.19	10.84	-0.35
Lincoln	4.23	4.30	0.07
Okanogan	10.40	9.42	-0.99
Pend Oreille	15.30	15.12	-0.18
Spokane	7.23	6.48	-0.75
Stevens	10.96	10.58	-0.38
Walla Walla	7.37	7.03	-0.34
Whitman	4.49	4.27	-0.22
Yakima	9.98	9.25	-0.73
Eastern Avg.	7.98	7.45	-0.53
Average	5.70	5.42	-0.28
Max	17.02	16.25	1.02
Min	2.55	2.82	-0.99

5. Conclusions

The Washington economic impact model takes counties as its economic and geographic unit. We developed and estimated a simultaneous model of labor force and fiscal behavior that can be used in conjunction with county input-output models for economic impact analysis. The input-output model provides predicted change in place of work employment and county income, but says nothing about the impact of these predicted changes on population, labor force, commuting behavior, unemployment and local government revenues and expenditures. The labor force model and the fiscal model represent important additional tools that can be conjoined with regional input-output models for economic impact analysis in Washington State.

Using the estimated model, a 5 percent economic growth scenario is simulated for each county in Washington. In the simulation, we imposed an employment impact on one county at a time. Based on the simulation result, we found that the 5 percent growth scenario has somewhat different impacts from county to county. Support was found for the idea that economic growth is likely to result in higher tax revenues (Myth 1). However, the predicted change in county revenues was closely matched by the predicted change in county expenditures. And the increase in per capita government revenues and expenditures were predicted to be less than the increase in the per capita income growth in all counties. New taxes are likely to be necessary to cover new costs, but the increase in per capita income is even greater than per capita increase in taxes.

Relative to the idea that local economic growth attracts more people who require more jobs (Myth 2), the simulation showed mixed results. On average, over all counties, both the predicted number of unemployed and the unemployment rate declined in response to the simulated employment expansion. However, in a large number of counties the simulated expansion did result in a predicted increase in the number of unemployed people. This occurred in counties that were adjacent to large metropolitan counties or in counties characterized by high natural capital. If Fodor's contention is that employment growth cannot reduce the number of unemployed, there is mixed support for that view in selected Washington counties, but in general employment growth lowered the unemployment rate.

A limitation of the model is that we cannot estimate what proportion of new labor force participants is from within the county or outside of the county in our framework. If the new participants could be divided according to county of origin, we would know who benefits from local growth - local residents or new residents. There is mixed research regarding the extent that new migrants tend to account for new POW employment. Timothy J. Bartik (1993) found that around one-quarter of the new jobs go to local workers because of the increase in the labor force participation rates of local residents in the long run. On the other hand Blanchard and Katz's (1992) research reaches the opposite conclusion - in five to seven years the employment response consists entirely of the migration of new migrants. Most of research for these studies uses time series data. If we were able to identify the origins of the new participants - those coming from in a county versus migrants from outside the county - in a cross-sectional system of simultaneous equations framework, it would give us additional insight into this issue. This is an important question for both local government administrators and regional economists. The classification of the origin of new labor force participants in the labor market model is an important subject for future study, Yeo and Holland (2000).

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Appendix 1: Normality Test for Error Terms

The Q-Q plot is used to test normality of error terms. If a plot of ordered error term of an equation against normal quantiles $q_{(j)}$ lies very nearly along a straight line, then we would not reject the null hypothesis of normality. To measure the straightness of the Q-Q plot, we use the correlation coefficient for the Q-Q plot that is defined by

$$r_Q = \frac{\sum_{j=1}^{n}(x_{(j)} - \bar{x})(q_{(j)} - \bar{q})}{\sqrt{\sum_{j=1}^{n}(x_{(j)} - \bar{x})^2}\sqrt{\sum_{j=1}^{n}(q_{(j)} - \bar{q})^2}}$$

where n is the observation number.

Formally, at the significant level a, if the r_Q is less than corresponding critical value, then we reject the hypothesis of normality. From the critical points table (Johnson and Wichern, 1992), at the 5 percent significant level and n = 40, we find that the corresponding value is 0.9726. The Q-Q plot of each residual looks very close to a straight line and Table A.1 shows that the value of r_Q for every error term is greater than the critical value 0.9726. Therefore, we don't reject the hypothesis of normality for every noise component e_i, i = 1, 2, …, 6.

Table A.1. Correlation Coefficients for the Q-Q Plot

	e_1	e_2	e_3	e_4	e_5	e_6	Critical Value (n=40, a =0.05)
r_Q	0.98971	0.98066	0.97792	0.98741	0.98163	0.97788	0.9726

Appendix 2: Transfer Function Analysis

Two time series were used to characterize the historical relationship between total personal income and employment. Real personal income for Washington is considered as output series (Y_t) and Washington employment is considered as input series (X_t). These are a quarterly series over the period 1958-1993 so that the number of observations is 144. Achieving two stationary series by the proper transformation, in a single-input, single-output linear system, the output series y_t and the input series x_t are related through a linear filter

$$y_t = v(B)x_t + h_t$$

where $v(B) = \sum_{j=-\infty}^{\infty} v_j B^j$ is referred to as the transfer function of filter by Box and Jenkins (1976), weight v_j's are called the impulse response function, and h_t is the noise series of the system that is uncorrelated to the input series x_t. If the sequence of the impulse response weights are absolutely summable, i.e., $\sum |v_j| < \infty$, then the transfer function model is said to be stable. The purposes of transfer function modeling are to identify and estimate the transfer function $v(B)$ and the noise model h_t based on the available information of the input series x_t and the output series y_t (Wei, 1994).

Based on the Dickey-Fuller unit root test both the employment series X_t and the real personal income series Y_t have a unit root. Therefore, from now on, we consider the input series x_t as the first differenced series of original series, $(1-B)X_t$ and consider the output series y_t as $(1-B)Y_t$, where the backshift operator $B^j x_t = x_{t-j}$. Now we assume the input series x_t follows an AutoRegressive MovingAverage (ARMA) process, $f_x(B)x_t = q_x(B)a_t$, where a_t is white noise. The series a_t, $a_t = q_x(B)^{-1} f_x(B)x_t$ is called the prewhitened input series. Applying the prewhitening transformation in the input series to the transfer function equation, we obtain an equation, $q_x(B)^{-1} f_x(B)y_t = q_x(B)^{-1} f_x(B)v(B)x_t + q_x(B)^{-1} f_x(B)h_t$. Letting a filtered output series, $b_t = q_x(B)^{-1} f_x(B) y_t$ and $e_t = q_x(B)^{-1} f_x(B) h_t$, the transfer function model becomes $b_t = v(B) a_t + e_t$.

Empirically, we found the overall transfer function plus noise model as follows:

$$y_t = m + \frac{w_0 - w_1 B}{1 - d_1 B} x_t + h_t , \quad h_t = f_1 h_{t-1} + e_t$$

where constant term, $m = 229.37088$ (86.34062), $w_0 = 16.57099$ (2.88896), $w_1 = 11.54295$ (3.94197), $d_1 = 0.86521$ (0.07112), $f_1 = -0.28653$ (0.08196), $y_t = Y_t - Y_{t-1}$, $x_t = X_t - X_{t-1}$ and the numbers in parentheses are the corresponding standard deviations.