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ASSESSING THE ECONOMIC IMPACT OF AN AGRICULTURAL EXPORT SHOCK ON THE WASHINGTON ECONOMY: A TALE OF TWO MODELS

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ABSTRACT

The results of an economic impact analysis with a regional input-output (IO) model are compared with results from a regional computable general equilibrium CGE) model. The I0 model embodies a number of restrictive assumptions. These assumptions are consistent with the long run equilibrium of the economy where there is no capacity constraint for production, fixed coefficients in production, and no price changes or due to Leontief technology, and fixed input prices. For all of these reasons input-output results are often viewed as over estimates of regional supply response given the lack of effective regional supply constraints. In this situation, regional CGE models serve as a better alternative because of their flexibility to mimic various technology and factor market condition characteristic of real world regional economies. In this study we summarize the results of an assumed export shock on Washington economy under an input-output model and under a regional CGE model. Further, we simulate our CGE model under various factor market constraints and behaviors. We show that contrary to the conventional wisdom, the positive secondary impacts of increasing agricultural exports are usually actually larger with a regional CGE model than estimates of secondary impacts of the same shock estimated with a regional IO model.

***Keywords: T*he Washington CGE model, the Washington IO model, comparing estimated economic impacts with regional CGE and IO models.**

JEL Classification: R13

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I. INTRODUCTION:

Input output models are widely used for regional policy analysis despite their very restrictive assumptions. Though regional economies may reflect these assumptions in the real world in the long run, they do not in the short run. Therefore policy initiatives based on input output analysis are debatable and subject to challenge. Regional Computable General Equilibrium Models (CGE) serve as a better alternative regional modeling framework because they are more flexible and can be modified to reflect the real world regional economy. Regional policy initiatives should be based on the results of a model that reflects the real economy more than that reflecting the economy to a lesser extent.

With this broad objective in mind, we illustrate our point by comparing and contrasting the economic impact simulation results from a regional flexible price CGE model and a regional fixed price input output model. For this, we develop a Washington economy CGE model and simulate the results under various labor and capital market conditions for an assumed three percent increase in crops exports from Washington State. Specifically we discuss the results measured as changes in output, number of jobs, labor income, welfare, domestic imports and exports, and foreign imports and exports.

The following section reviews past studies related to our study, section 3 describes the analysis, section 4 gives the description of the data, section 5 discusses the flexible and fixed price models and their results, section 6 describes the welfare effects, section 7 describes the export behavior Washington state's crop sector due to an assumed three percent shock under two different constant elasticity of transformation conditions, and the final section is summary and conclusions.

II. LITERATURE REVIEW:

In this section, we briefly discuss some of the literature that has compared and contrasted fixed price and flexible price general equilibrium models.

Mutti (1981) divided regional goods into two categories, export and non-traded goods. The increase in output of export goods decreased the output of non-traded goods as opposed to an economic base model where there is no supply constraint. In this study, capital is mobile within the region but the labor is immobile.

Merrifield (1987, 1990) showed numerically the differences in multiplier responses between economic base and neo-classical models. In his analysis, capital was mobile, labor partially mobile, and immobile land was added as another factor of production. He demonstrated the reasons for differences in multiplier responses between the neoclassical model and the economics base model. Further, comparisons of the responses were done with the computable general equilibrium model.

Harrigan and McGregor (1989) developed a CGE model for Malaysia, which was divided into two regions with the rest of the world as a third region. In this model a fixed price input-output model was embedded as a limiting case i.e., when the supply side of the economy in the CGE model was switched off it reflects the fixed input-output model. Capital was assumed to be fixed regionally and labor was assumed as partially mobile across regions, but not internationally. The main conclusion was the strong negative relationship between the degree of regional price and wage flexibility and the size of employment and output multipliers.

Harrigan et al. (1991) constructed a CGE model (referred to as AMOS meaning A micro-macro model of Scotland) with an input-output model embedded in it (i.e., when the supply side of the economy is switched off or made passive). In their model, Scotland, the rest of the United

Kingdom, and rest of the world are the three regions. A policy shock in the form of increased exports in manufacturing goods was analyzed under different labor closure assumptions and the model predicts less expansion in manufacturing goods compared to fixed price model i.e., the multipliers are smaller in magnitude. The role of price endogenity and limited factor supplies was emphasized in this study. The important conclusions of this study are that CGE multipliers are sensitive to factor market assumptions, and regional CGE models should be the first choice in doing regional economic analysis rather than the input-output analysis.

McGregor, Swales and Yin (1996) extended the AMOS model which differentiates between short run and long run through a period by period simulation. The short run and long run properties of the model were then compared with fixed price input – output model. They argued that the input output model behaved similar to the neoclassical CGE model in long run, i.e., when there is perfect factor mobility and the rate of return for capital is determined in the national market.

In an extension of the AMOS model by McGregor, Swales, and Yin (1995), an impact analysis of an increase in local consumption amenities was examined. The distinguishing feature of this study is the inclusion of an econometrically estimated labor migration equation. The results were then compared with alternative assumptions within the model which were essentially input – output in character.

Despotakis and Fisher (1988) embedded an input-output model within a CGE framework for California economy i.e., when the supply side of the economy is switched off or made passive. The predicted effects of an increase in price of oil on California economy were less compared to results from an input-output model. This is because of substitutability between

factors of production and absorption of factors of production released by affected industries by the other industries.

Kraybill, Johnson, and Orden (1992) analyzed the impact of US macroeconomic imbalances on the state of Virginia and the rest of the United States. They demonstrated that the effects of current account deficit and the federal budget deficit had different effects across regions and sectors than the effects by a fixed share disaggregation from a national model. Consistent with other studies their study also revealed that the linear relationship between sectors typical of input-output models did not hold.

Liew (1984) examined the effects of a increase in tariffs on gross state product in Australia. By comparing the bottom up multiregional CGE model for Australia with top down ORANI model he contended that greater differences exist in multiregional models because of different responses in factor prices, presence of regional supply constraints, and transportation costs as opposed to the ORANI model where the relative prices were fixed across regions.

Gazel (1996) examined the regional effects in United States due to the Free Trade Agreement with Canada. He reported relative gains by regions if the model differs from the assumption of fixed relative regional prices and if it allows for price endogenity. He also suggested that the predictions of the model are sensitive to labor mobility assumptions for which a CGE framework is required.

Hoffman, Robinson, and Subramanian (1996) used a CGE model to examine the effects of defense cuts on California economy. The model with fixed wages and prices predicted substantial loss in employment and output under the assumption of perfect mobility of capital and labor, i.e., model similar to fixed price input-output model. But, the model predicted losses

that were close to actual values under the assumptions of mobile labor and immobile capital, i.e., in a short run model.

Rickman (1992) compared the predicted regional impacts of eliminating the corporate income tax under both neoclassical and Keynesian closures in a CGE framework. The results under Keynesian closures were too optimistic as there were no supply constraints and no price endogenity, whereas under neo-classical closure results were close to the econometric evidence on employment and output effects on regional tax policies.

Patridge and Rickman (1998) provide a good summary review of literature on the use of regional CGE models in analyzing regional economic issues. They also outline the basic structure of regional CGE models and discuss its contribution to regional economic analysis vis-à-vis various other regional economic models like the economic base multiplier model, and input-output models.

III. ANALYSIS

In line with the main objective of the study we compare and contrast the predicted economic impact from SAM based fixed price input output model with the results from a flexible price CGE model. For this, we first describe the models, i.e., SAM based fixed price model and the flexible price CGE models. In our flexible price model, we simulate results under different labor and capital closure assumptions. Following a description of each model, we present the results from each model.

IV. DATA

The year 2002 social accounting matrix (SAM) of the state of Washington from the IMPLAN (Impact Analysis for Planning) database is used for this analysis. There are 528 industries in the IMPLAN database. For this study, a 16-sector model of the Washington economy is constructed for both fixed price (I-O) and flexible price (CGE) models. The sector aggregation scheme for the models is identified in Appendix A. The economic shock is an assumed increase in agricultural crop foreign exports. The sectors that are most likely to be affected by the export shock, directly or indirectly, have been kept at the most disaggregated level. The industries that are not closely related to crops sectors and are likely to have more negligible effects are aggregated into broader multi-sector composites.

V. MODELS AND RESULTS

SAM Based Fixed Price Model

A SAM for the state of Washington for 2002 was constructed and used to generate a household endogenous SAM model, using the IMPLAN software. A SAM is a table showing industry sales to and purchases from other industries in a given region, along with information involving the income and expenditures of regional households and government. This information allows more accurate estimation of induced effects, relating household income to household consumption than simple IO accounts. The SAM economic model can be used to capture the extent to which the state's total industry sales and jobs are dependent on the exports of crops sector. Changes in final demand drive the model, to generate the direct, indirect and induced effects throughout the economy. Type SAM multipliers show the direct, indirect and induced effects of a change in final demand (in this model crops sector foreign exports). The

indirect effect reflects the change in the output of the industries that supply inputs to crops sector. The induced effect captures the change in household income and household consumption as a result of the change in payrolls.

Results for Fixed Price Model

The economic impact of an assumed three percent increase in the rest of the world (foreign) crops exports from Washington State are discussed below in a fixed price model framework. The impact on output (sales), number of jobs, and labor income are discussed under three separate sections (output, jobs, and labor income). Direct effects are the changes in the industry due to the assumed increase in crops exports, indirect effects are the changes in inter-industry output as they respond to the new demand in the crops sector, and induced effects reflect the changes in spending from households as income increases due to changes in production. The total effect is the sum of direct effect, indirect effect, and induced effect.

Change in Output:

A three percent increase in foreign exports of crops increases the output in crops sector to the value of $21.89million. The indirect effect on the crops sector is $ 1.35 million the induced effect as a result of change in household income is $0.05 million and hence the total output (supply) change on the crops sector is $ 23.29 million. To meet the increase in demand in crops sector, the other sectors in the economy responds by increasing their output. The manufacturing sector increases its output by $ 2.02 million services sector by $ 2.36 million, transportation sector by $1.28 million, and the government enterprises sector by $0.32 million. The corresponding induced and total effect of manufacturing sector is $ 1.06 million and $ 3.08

million, services sector is $ 3.35 million and $ 5.70 million, transportation sector is $ 0.78 million and $ 2.07 million, and the government enterprise sector is $ 1.40 million and $ 1.72 million. The aggregate induced effect on the economy is $ 8.52 million, which is higher than the aggregate indirect effect. So, the total change in sales for the economy, including the secondary response by all the sectors, is $ 38.25 million. The output multiplier is 1.74, implying that for every dollar increase in crop export sales, total sales in economy increases by 1.74 dollars including the initial dollar increase.

Table 1.1. Change in Output in Response to Increase in Agricultural Exports ($ Millions)

SECTORS	Direct	Indirect	Induced	Total
CROPS-C	21.89	1.35	0.05	23.29
ANIMALS-C		0.12	0.07	0.18
FISHING-C		0.00	0.00	0.00
FOREST-C		0.03	0.01	0.03
MIN-C		0.03	0.01	0.04
UTIL-C		0.13	0.08	0.22
CONSTR-C		0.10	0.05	0.15
CROPFOOD-C		0.01	0.09	0.10
ANFOOD-C		0.01	0.17	0.18
MAN-C		2.02	1.06	3.08
SERV-C		2.36	3.35	5.70
FOODSERV-C		0.03	0.41	0.44
TRAN-C		1.29	0.78	2.07
WRTRADE-C		0.04	0.84	0.88
RETAIL-C		0.01	0.16	0.17
GOVENT-C		0.32	1.40	1.72
TOTAL		7.84	8.52	38.25

Change in Number of Jobs:

The effect of three percent increase in foreign exports of crops on number of jobs is displayed in Table 1.2. As a direct effect, the number of jobs in the crops sector increases by 372, the indirect effect increases the jobs by 23, and the total increase in the number of jobs is 395. The increase in number of jobs as a result of indirect and induced effects respectively in

manufacturing sector is 8 & 4, services sector is 22 & 31, transportation sector is 9 & 6, and the government enterprise sector is 3 & 13. The greatest increase in the number of jobs is in the services sector as can be seen from the Table 1.2. The aggregate increase in the number of jobs in the economy due to the indirect effect is about 70 jobs and due to the induced effect is about 84 jobs. As expected the total aggregate induced effect is greater than the aggregate indirect effect. Hence the total increase in the number of jobs as a result of an assumed increase in agricultural foreign exports is about 526 jobs. The job multiplier is 1.41, which means that for every job increase in the crops sector due to crops exports, the increase in jobs throughout the economy will be 1.41 jobs.

Table 1.2. Change in Number of Jobs in Response to Increase in Agricultural Exports (Jobs)

SECTORS	Direct	Indirect	Induced	Total
CROPS-C	371.52	22.97	0.76	395.27
ANIMALS-C		1.48	0.88	2.36
FISHING-C		0.00	0.00	0.00
FOREST-C		0.09	0.03	0.15
MIN-C		0.18	0.09	0.24
UTIL-C		0.24	0.15	0.39
CONSTR-C		0.85	0.42	1.27
CROPFOOD-C		0.03	0.33	0.36
ANFOOD-C		0.03	0.61	0.64
MAN-C		7.70	4.03	11.70
SERV-C		22.24	31.55	53.79
FOODSERV-C		0.64	9.97	10.61
TRAN-C		9.58	5.79	15.36
WRTRADE-C		0.67	13.67	14.33
RETAIL-C		0.09	2.55	2.67
GOVENT-C		3.12	13.58	16.70
TOTAL		69.91	84.39	525.85

Change in Labor Income:

As a result of a change in foreign exports of crops, the direct effect in crops sector, i.e., increase in labor income is $ 7.92 million, the indirect effect is $ 0.49 million, and the induced

effect is $0.02 million. Hence, the total effect on crops sector is 8.42 million. The change in labor income in million dollars due to indirect effect in manufacturing is $ 0.55, in services sector is $ 0.99, in transportation sector is $ 52, and in the government enterprise sector is $ 0.15. The induced effect in manufacturing sector in million dollars is $ 0.29, services sector is $1.40, transportation sector is $ 0.31, and in the government enterprise sector is $ 0.64. The aggregate induced effect, i.e., sum of all the sectors induced effect is $3.37 million, which is higher than the aggregate indirect effects ($2.82 million).

Table 1.3. Change in Labor Income in Response to Increase in Agricultural Exports (Million)

SECTORS	Direct	Indirect	Induced	Total
CROPS-C	7.92	0.49	0.02	8.42
ANIMALS-C		0.01	0.01	0.02
FISHING-C		0.00	0.00	0.00
FOREST-C		0.01	0.00	0.01
MIN-C		0.01	0.00	0.01
UTIL-C		0.03	0.02	0.05
CONSTR-C		0.04	0.02	0.06
CROPFOOD-C		0.00	0.01	0.02
ANFOOD-C		0.00	0.03	0.03
MAN-C		0.55	0.29	0.84
SERV-C		0.99	1.40	2.39
FOODSERV-C		0.01	0.16	0.17
TRAN-C		0.52	0.31	0.83
WRTRADE-C		0.02	0.38	0.40
RETAIL-C		0.00	0.08	0.08
GOVENT-C		0.15	0.64	0.79
TOTAL		2.82	3.37	14.11

The total change in labor income as a result of a three percent increase in agricultural exports from Washington State is $ 14.11 million. The labor income multiplier is 1.78, which says that for every dollar increase in labor income in crops sector will result in an increase of 1.78 dollars in labor income throughout the economy.

Since the input-output models assumes no supply constraint, no relative price effect, and the assumption of fixed proportion technology we observe positive ripple effects in every industry throughout the economy because of the assumed foreign export shock. Output, employment, and labor income increases in all the sectors of the economy, which means the sectors, do not compete for limited resources in the economy, which is not often realistic in terms of neoclassical economic theory. This is where the role of regional CGE models may appreciated in the sense that such models allows for various factor market and technology assumptions and also allows the sectors in the economy compete for resources through the price changes.

Flexible Price CGE Model

For the purpose of convenience, we term this model as our base model 1. CGE models are multi-sector models of the economy. They are based on Walrasian general equilibrium principles of market-clearing on both the product and the factor markets. CGE models have been extensively used to analyze tax and trade policies. As in any neo-classical model, producers are assumed to be profit maximizers, and in typical CGE methodology they can sell their output either on the domestic market or on the export market, based on relative prices. Households maximize utility by consuming a mix of domestic and imported goods. The composition of domestic supply depends on the relative prices of domestic products and imports.

Households are modeled as a representative agent assumed to have Stone-Geary preferences and industries are modeled as representative producers assumed to have CES production technologies. There is endogenous determination of equilibrium prices (commodity prices, factor prices and the exchange rate) to clear the product, factor, and foreign exchange

markets.[1] Specific functional forms are used to capture the behavior of economic agents. The parameters of these functional forms are obtained by 'calibration' to a dataset (usually a Social Accounting Matrix – a matrix showing income and expenditure flows in an economy) for a given year. The benchmark year is considered to be in equilibrium for calibration purposes.

A sixteen-sector model of the Washington economy was created using the year 2002 SAM (social accounting matrix) of Washington (the same data is used in the I-O model). The model equations are available upon request from the authors. Like many other CGE models, a Leontief-cum-constant elasticity of substitution (CES) type production function was used to model producer behavior. This production function for a given industry has the following features – fixed proportions of intermediate inputs, but CES technology and capital/labor substitution for primary factors for a given industry. The Leontief part of the production function ensures "weak separability" between primary (labor and capital) and intermediate factors.

The demand for factors is derived from the first-order conditions of profit maximization taking into account the value-added or net price. A Stone-Geary utility function (which produces a Linear Expenditure System) is used to model consumer behavior.

CGE models allow for imperfect substitution between regionally produced goods and foreign goods in the Washington (regional) market place. The Armington function is used to capture the substitution possibilities between domestic goods and imported goods for households. In other words, the Armington aggregate is a composite good consisting of both domestic and imported goods. The Armington function is of the CES type. The higher the value of the Armington elasticity, the easier is the substitution between Washington and imported goods.

[1]Several alternative treatments are possible regarding the current account balance. The foreign exchange rate may be assumed fixed and the current account balance changes. Alternatively, the current account balanced may be assumed fixed and the foreign exchange rate adjusts.

Since this is a Washington model, we have used the Armington function at two levels – in the first stage we allow for substitution between domestic goods (produced in Washington) and imported goods; in the second stage we differentiate between domestic imports (imports from rest of the United States) and foreign imports (imports from rest of the world), and allow substitution to take place between them. The foreign exchange rate is assumed flexible. The US-Rest of the World current account is fixed (at the benchmark year level), with the foreign exchange rate fluctuations assumed to maintain the current account balance. Federal government expenditure and investment are exogenous in the model. As mentioned before, there is endogenous determination of factor and commodity prices to clear all the markets. Initially, consumer prices of domestic goods and imports, the world price of exports, factor prices, and the exchange rate are all set equal to one. The price of foreign imports (from rest of the world) is assumed exogenous, that is, the world price of imports is given. In this setting, we can therefore make the "small" country assumption and consider the terms of trade to be fixed. The consumer price index is set to be the numeraire.

The export supply function, derived from the constant elasticity of transformation (CET) function, specifies the value of exports as a function of domestic and export prices. The CET function defines the production possibilities available to a given industry assuming exported products are differentiated from products produced for the Washington market by a given industry. Again, a two level function is used depicting the production possibilities between goods produced for the Washington market and the rest of the U.S. market. The second level depicts the production transformation between this aggregate and goods produced for the rest of the world market.

Import price is a function of the world price, possible import tariffs and the exchange rate (foreign). Import demand is the first-order condition obtained from the cost minimization problem of buying a given amount of the composite good. Composite supply (Armington aggregate) is a function of the price of imports and the price of regionally produced goods. The regional import composite is a function of the price of imports from Rest of the US and foreign sources. The regional export composite is a function of the price of exports to the rest of the U.S. and foreign sources. Household income is obtained from capital and labor payment, government transfers and household borrowing.

On the factor side of the economy, labor is assumed mobile across sectors but fixed for the region, and there is a market-clearing regional wage rate for the economy. In the base model, capital is assumed to be fixed for all sectors. The model thus captures the fixed resource endowment of the Washington economy and represents economic adjustments in the relatively short-run given the assumption of sector specific capital.

The GAMS software (using the PATH solver) is used to construct and solve the model, a simultaneous system of non-linear equations. The model is initially solved to replicate the base year SAM by appropriately calibrating the parameters of the model.[2] Empirical estimates of the Armington elasticities were used in this model (typically the range was between 0.5 and 1.75). The CET elasticities were set equal to 2 for the traded sectors, and 0.5 for the non-traded sectors.

[2]Most of the parameters of the model can be and are calibrated from the SAM, however, the Armington elasticities, the constant elasticity of transformation (CET) elasticities (counterparts of the Armington elasticities on the export side), the elasticity of substitution in production, the household income elasticity, and the export demand elasticity are obtained from the literature.

Effects on Output, Employment and Labor Income

Model 1

The shock to Model 1 was an assumed increase in the intercept of foreign export demand function for crops. In the CGE models, a new (counterfactual) equilibrium is determined for the Washington economy after all industries, commodity markets, and factor markets have had a chance to adjust to the increase in crops export demand.

In response to the demand increase, both the foreign export crop price and quantity of foreign crop exports increase. The increase in the value of foreign exports of crops was three percent, which means the quantity increase is less than three percent given that the foreign price increases. With the foreign demand shock, the total output of crops in the Washington economy increases by 19.16 million units (slightly less than the 21.89 million increase from the fixed price model), while output of manufacturing sector and services sector decreases by 13.81 and 21.68 million units respectively in the economy (Table2.1)—a much different story than the fixed price model. The other sectors whose output decreases as a result of an export shock are transportation, government, utility and wholesale retail sectors. To meet its output expansion, the crops sector absorbs labor primarily from manufacturing and services sectors because of which there is a gain in number (652) of jobs in the crops sector and loss in the number of jobs in manufacturing (69) and service (344) sectors (Table 2.2). The other sectors that lose jobs are government enterprises (92), transportation (45), wholesale retail trade (43), and retail trade (11) sectors. It is interesting to note that all the sectors except crops and animals sectors lose jobs as well as output due to the export shock. This is because of the fixed labor endowment assumption, which stipulates that the total change in the number of jobs in the economy must be zero. Because of the increased demand for labor in the crops sector caused by export shock and

increased production, the total wage bill to that sector increases by $11.26 millions (Table 2.3). Likewise, market clearing wage increases for all other sectors like construction, animal food, food services, transportation, wholesale retail, government, etc labor income increases for those industries despite a slight decrease in the number of jobs. This is because the increase in the wage rate in these sectors is more than the decrease in number of jobs resulting in increased labor income.

We next modify our base model 1 to include two alternative capital closure assumptions. The first assumption allows capital to be mobile across sectors with fixed endowment for Washington (Modelcc1) and the second assumption allows capital to be mobile across the sectors and the total endowment for the state to vary (Modelcc2). In other words, there is a perfectly inelastic supply constraint for regional capital in Modelcc1 and the supply of regional capital is inelastic with an elasticity of 0.5 in Modelcc2.

Table 2.1. Output Responses under Different Closure Assumptions (Million Units)

SECTORS	Model 1	Model1cc1	Model1cc2
CROPS-C	19.16	49.73	50.05
ANIMALS-C	0.07	1.72	1.76
FISHING-C	-0.15	-1.01	-0.90
FOREST-C	-0.22	2.10	2.27
MIN-C	-0.14	-0.57	-0.51
UTIL-C	-1.21	-2.78	-2.13
CONSTR-C	-0.89	-1.51	-1.35
CROPFOOD-C	-0.92	1.46	1.79
ANFOOD-C	-0.34	0.95	1.03
MAN-C	-13.81	-23.09	-21.72
SERV-C	-21.68	-45.96	-40.99
FOODSERV-C	-0.80	-1.03	-0.90
TRAN-C	-4.44	-6.45	-5.62
WRTRADE-C	-1.83	-3.31	-2.92
RETAIL-C	-0.49	-0.90	-0.81
GOVENT-C	-3.97	-7.20	-6.20
TOTAL	-31.67	-37.85	-27.16

First, we compare the results between base Model 1 and Modelcc1. We see a crop output increase more than double in magnitude in Modelcc1 compared to base model 1. Likewise in all the sectors of the economy output loss is greater as capital is mobile in Modelcc1 compared to Model 1 where capital is fixed and only labor is mobile. For example, the output increase in base model is 19.16 million units whereas in Modelcc1 it is 49.75 million units. In terms of change in number of jobs, we observe some interesting results. Though the forest, animal food, and crop food sectors lose jobs in Model 1, there is gain in jobs for those sectors in Modelcc1 (see Table 1.2). In all the other sectors, the number of job losses is greater in Modelcc1 compared to Model 1.

Table 2.2. Change in Number of Jobs under Different Closure Assumptions (Jobs)

SECTORS	Model 1	Model1cc1	Model1cc2
CROPS-C	652.26	842.19	844.42
ANIMALS-C	1.08	22.29	22.64
FISHING-C	-3.51	-9.37	-8.76
FOREST-C	-2.53	7.70	7.89
MIN-C	-1.86	-3.68	-3.52
UTIL-C	-0.83	-1.72	-1.29
CONSTR-C	-10.28	-17.92	-20.92
CROPFOOD-C	-7.26	4.27	4.53
ANFOOD-C	-1.42	3.31	3.44
MAN-C	-68.96	-93.33	-92.43
SERV-C	-344.08	-483.17	-480.76
FOODSERV-C	-21.37	-26.26	-24.81
TRAN-C	-44.84	-52.33	-51.17
WRTRADE-C	-43.36	-61.62	-62.85
RETAIL-C	-10.91	-15.76	-15.90
GOVENT-C	-92.15	-114.62	-120.52
TOTAL	0.00	0.00	0.00

In spite of the overall loss in economy wide supply (Table 2.1) the change in total labor income is positive (Table 2.3). The predicted wage bill increase is $13.60 million in Model 1compared to the fixed price (IO) result of $ 14.11 million. The changes in total wage bill are

similar, but the pattern of changes in labor payment is quite different between the IO and Model 1 results. In the IO findings, the secondary effects on Manufacturing and Services are positive, while in the Model 1 CGE finding the wage bill decreases in both Manufacturing and Service industries in spite of a higher market-clearing wage.

Table 2.3. Change in Labor Income under Different Closure Assumptions

SECTORS	Model 1	Model1cc1	Model1cc2
CROPS-C	11.26	14.57	14.62
ANIMALS-C	0.04	0.20	0.21
FISHING-C	-0.04	-0.18	-0.16
FOREST-C	-0.01	0.37	0.39
MIN-C	-0.03	-0.09	-0.08
UTIL-C	0.01	-0.03	0.00
CONSTR-C	1.51	1.91	1.91
CROPFOOD-C	-0.06	0.49	0.51
ANFOOD-C	0.08	0.35	0.36
MAN-C	-1.01	-1.33	-1.05
SERV-C	-1.01	-1.89	-1.08
FOODSERV-C	0.38	0.57	0.63
TRAN-C	0.31	0.87	1.08
WRTRADE-C	0.60	0.75	0.83
RETAIL-C	0.09	0.09	0.11
GOVENT-C	1.50	2.57	2.64
TOTAL	13.60	19.22	20.94

Predicted changes in labor income are higher in Modelcc1 than in the Model 1. While labor income decreases in forest and crop food sector in Model 1 it increases in those sectors in Modelcc1.

The results of the assumed three percent export shock under Modelcc1 and Modelcc2 are discussed next. The crop output increase in Modelcc1 is slightly higher than Modelcc2 (49.72 and 50.05 million units respectively). This is because of a less binding capital constraint in Modelcc2. Even though labor is freely mobile across the sectors, the economy does not have as much capital to expand its output in Modelcc1 as in Modelcc2. The output in all the other

sectors of the economy decreases except the animals sector. The decrease in output in Modelcc1 is more than the decrease in Modelcc2 because the sectors in scenario 2 compensate their output loss by substituting more capital for labor loss, which the sectors in scenario 1 cannot because of the assumption of a state level fixed capital endowment. The sector-wise and scenario-wise loss in output for all the sectors under the two alternative capital closure assumptions is illustrated in Table 2.1.

As regards to the number of jobs gained or lost in the economy, each sector responds differently depending on their labor-capital substitution. In Modelcc1 the crops sector gains 842 jobs whereas in Modelcc2 it gains a few more (844) jobs. Manufacturing, services, utility, fishing, and transportation sector lose more jobs in scenario 1 than in scenario 2. This is because the above-mentioned sectors utilized the extra capital available Modelcc2 retain some of labor that would have migrated to the crops sector. If the crops sector was a capital-intensive sector, then it would have absorbed the extra capital and the labor loss from the other sectors in Modelcc2 would have been larger than in Modelcc1, which is not the case. In our case, rather it is in the opposite direction. This very fact denotes that crops sector is labor intensive relative to other sectors or the other sectors are capital intensive relative to crops sector. When compared to the results of base Model 1, the results under two capital closure assumptions for the export shock illustrate more flexible and responsive economy as a function of the assumed capital mobility.

The increase in labor income despite decrease in the number of jobs in certain sectors is due to the decrease in market clearing wages in those sectors. It may be noted that when capital is assumed mobile the economy wide increase in labor income in both Modelcc1 and Modelcc2 is much larger than the figure associated with the IO model. In fact, because of the shift in

capital to the crops sector, the predicted increase in the wage bill for the crops industry is approximately equal to the increase in the wage bill for the entire economy for the IO model. This is a function of capital and labor market assumptions, but also the non-linear CES type production function that characterizes industries in the CGE models. The CGE models with capital mobile depict much greater responsiveness to a favorable event in a given industry (Crops) in the CGE models than is true of the IO model.

Model 2

The results under this base model are displayed in Tables 3.1, 3.2, and 3.3. Base model 2 is same as Model 1 (capital fixed by sector) except for the labor market behavior assumption. In this model, we assume that wages are fixed across the sectors, which means that the labor market adjusts by changes in jobs rather than wage changes. Labor is perfectly mobile across industries and across the region. In this base Model 2, total supply of labor is the market-clearing variable for the labor market equilibrium. The labor supply curve is infinitely elastic. The results of foreign exports shock are discussed below.

The output of all the sectors in the economy except fishing sector increases in this model in response to the export shock, which is different from the results of model1. Also, the magnitude of response to shock is greater in this model than in model 1 because of the labor market assumption. All the sectors in the economy gain jobs as opposed to base model 1. Crops, services, government, wholesale retail trade, transportation, and food services gain 684, 105, 55, 31, 24, and 22 jobs respectively. In total, the economy generates 952 jobs because of the export shock (Table 3.2) compared to the 526 jobs with the IO model. Since the labor employed in all the sectors except fishing increases, the total wage bill paid to those sectors in the economy also

Table 3.1. Output Responses under Different Closure Assumptions (Million Units)

SECTORS	Model 2	Model2cc1	Model2cc2
CROPS-C	20.10	51.51	52.14
ANIMALS-C	0.41	2.21	2.31
FISHING-C	0.00	-0.64	-0.43
FOREST-C	0.14	2.95	3.27
MIN-C	0.00	-0.28	-0.17
UTIL-C	0.70	-0.18	1.00
CONSTR-C	0.29	0.00	0.35
CROPFOOD-C	0.29	3.56	4.23
ANFOOD-C	0.42	2.03	2.22
MAN-C	1.71	-1.00	2.66
SERV-C	6.71	-4.83	5.75
FOODSERV-C	0.83	1.25	1.61
TRAN-C	2.42	3.33	5.31
WRTRADE-C	1.31	0.82	1.71
RETAIL-C	0.26	0.11	0.31
GOVENT-C	2.35	0.90	3.01
TOTAL	37.95	61.75	85.29

Table 3.2. Change in Number of Jobs (Jobs)

SECTORS	Model 2	Model2cc1	Model2cc2
CROPS-C	684.13	890.32	897.14
ANIMALS-C	6.15	29.76	30.82
FISHING-C	-0.11	-3.77	-2.43
FOREST-C	1.57	13.72	14.43
MIN-C	-0.02	-0.92	-0.48
UTIL-C	0.37	0.22	1.03
CONSTR-C	3.36	18.57	16.44
CROPFOOD-C	2.28	17.66	18.99
ANFOOD-C	1.76	7.95	8.46
MAN-C	8.55	14.50	23.40
SERV-C	105.00	140.62	187.72
FOODSERV-C	22.23	37.09	43.76
TRAN-C	24.41	45.30	53.89
WRTRADE-C	31.07	45.02	50.50
RETAIL-C	5.91	7.93	9.36
GOVENT-C	54.77	91.56	96.72
TOTAL	951.44	1355.53	1449.73

increases. Wage bill paid by the crops sector increases by $11.47 million dollars, compared to $11.26 million for Model 1 and $7.92 for the IO model. The change in labor income for the whole economy increases by $21.46 million compared to $14.11 million in the I-O model.

Table 3.3. Change in Labor Income ($ Million)

SECTORS	Model 2	Model2cc1	Model2cc2
CROPS-C	11.47	14.93	15.05
ANIMALS-C	0.04	0.21	0.22
FISHING-C	0.00	-0.10	-0.06
FOREST-C	0.05	0.48	0.50
MIN-C	0.00	-0.04	-0.02
UTIL-C	0.03	0.02	0.07
CONSTR-C	0.13	0.72	0.63
CROPFOOD-C	0.09	0.71	0.77
ANFOOD-C	0.08	0.37	0.40
MAN-C	0.58	0.99	1.60
SERV-C	3.88	5.20	6.94
FOODSERV-C	0.35	0.59	0.69
TRAN-C	1.23	2.28	2.72
WRTRADE-C	0.77	1.12	1.26
RETAIL-C	0.16	0.21	0.25
GOVENT-C	2.58	4.31	4.55
TOTAL	21.46	32.02	35.57

As we did previously in our base model 1, we simulate our base model 2 under two capital closure assumptions called Model3cc1 and Model3cc2. In Model3cc1, capital is mobile across the sectors with a perfectly inelastic regional (state) supply constraint whereas in Model3cc2, the supply of regional capital is inelastic with elasticity of 0.5. These are the same capital supply assumptions made in Model2cc1 and Model2cc2 respectively.

The differences in the results under the base Model 2 and Model2cc1 are discussed first. The magnitude of changes in output responses is higher in Model2cc1 than in base Model 2. While output increases in mining, utility, construction, manufacturing, and services sector increase in base model 2, output decreases in Model2cc1 in all these sectors. This is because in

the base Model 2 capital remains fixed by sector, whereas there is loss in capital in these sectors in Model2cc1 as capital moves to the more profitable industries. The direction of change in number of jobs is same in base Model 2 and Modelcc1 is the same, whereas the magnitude of changes are relatively higher in Model2cc1. For example, in the animals sector, 6 jobs are created in base Model 2 whereas 30 jobs are created in Model2cc1.

Comparing Model2cc1 and Model2cc2, we see that because of the export shock, output in both models increases for crops, animals, forest, crop food, animal food, food services, transportation, wholesale retail trade, retail trade and government sectors. Output decreases in fishing, and mining in both the scenarios. In the case of utility, construction, manufacturing, and services sector output decreases in Model2cc1 whereas it increases in Model2cc2.

All the sectors, except fishing and mining, gain jobs in both the models. However, the job response is larger in Model2cc1 than Model2cc2, because the regional supply of capital is not fixed in Model2cc2. Thus, the total job gain in Model2cc2 is 1450 jobs whereas in Model2cc1 it is 1355. In terms of labor income measured as wage bill paid to the labor in each sector of the economy, increases (decreases) are proportionate to the number of jobs gained (lost) by each sector. Thus labor income decreases in fishing and mining sectors whereas it increases in all the other sectors of the economy. The increase in labor income and jobs in Model2cc1 or Model2cc2 is nearly twice the increase predicted to the I-O model.

Model 3

Our base Model 3 is the same as our base model 1 except for the labor market behavioral assumption. Here we assume labor to be perfectly mobile across sectors, with a labor supply function having an elasticity of 4.0, and the wages are flexible as opposed to the fixed wages in

Model 2. Therefore, the regional labor supply function is elastic but not perfectly elastic as in Model 2. We make the same capital closure assumption as we did in our base Models 1 and 2. The results of foreign crops export shock under base Model 3 are as follows.

The output in crops sector increased by 19.87 million units, which is higher, compared to base Model 1 but less than Model 2 (Table 4.1). The number of crop jobs gained is less (676) compared to Model 2 (684), but higher when compared to base Model 1 (652). The labor supply function is upward sloping and the market-clearing wage in Model 3 is slightly higher (thereby increasing the production cost) than the fixed wage in Model 2. The other way to look this phenomenon is through the marginal productivity of labor, which is higher in model 3 than in model 2. The point to note is that the results in model 3 show the effect of allowing the labor endowment to change but with an increase in the market clearing Washington wage.

Table 4.1. Output Responses (Million Units)

SECTORS	Model 3	Model3cc1	Model3cc2
CROPS-C	19.88	51.07	51.62
ANIMALS-C	0.33	2.09	2.17
FISHING-C	-0.04	-0.73	-0.54
FOREST-C	0.05	2.74	3.02
MIN-C	-0.03	-0.35	-0.25
UTIL-C	0.25	-0.82	0.21
CONSTR-C	0.01	-0.37	-0.07
CROPFOOD-C	0.00	3.04	3.62
ANFOOD-C	0.24	1.77	1.92
MAN-C	-1.98	-6.43	-3.45
SERV-C	-0.05	-14.95	-5.96
FOODSERV-C	0.44	0.69	0.98
TRAN-C	0.79	0.92	2.57
WRTRADE-C	0.56	-0.20	0.55
RETAIL-C	0.09	-0.14	0.03
GOVENT-C	0.85	-1.09	0.70
TOTAL	21.37	37.24	57.12

Table 4.2. Change in Number of Jobs (Jobs)

SECTORS	Model 3	Model3cc1	Model3cc2
CROPS-C	676.54	878.47	883.93
ANIMALS-C	4.94	27.92	28.77
FISHING-C	-0.92	-5.15	-4.02
FOREST-C	0.60	12.24	12.79
MIN-C	-0.46	-1.60	-1.25
UTIL-C	0.09	-0.26	0.45
CONSTR-C	0.11	9.59	7.08
CROPFOOD-C	0.01	14.36	15.37
ANFOOD-C	1.00	6.81	7.20
MAN-C	-9.91	-12.04	-5.62
SERV-C	-1.97	-12.92	20.25
FOODSERV-C	11.84	21.50	26.58
TRAN-C	7.91	21.27	27.57
WRTRADE-C	13.34	18.77	22.11
RETAIL-C	1.91	2.10	3.03
GOVENT-C	19.78	40.81	42.29
TOTAL	724.82	1021.87	1086.54

Those sectors whose output decreases as a result of the export shock also lose jobs to other sectors whose output has increased. The aggregate gain in employment is 725 jobs, which is less than the number (951) in Model 2 where there is no supply constraint for labor use. Next, we simulate our base model 3 under the two different capital closure assumptions as in previous models. The comparison of results under base Model 3 and Model3cc1 are as follows.

Output increases in base Model 3 in utility, construction, wholesale retail, retail, and government enterprise sectors whereas it decreases in all these sectors in Model3cc1. The direction of change in number of jobs and labor income is same in base model 3 and Model3cc1 whereas the magnitude is relatively higher in Model3cc1. Comparison of results under two capital closure assumptions are discussed below.

As a result of the export shock, output increases in crops, animals, forest, crop food, animal food, food services, and transportation sectors in both Model3cc1 and Model3cc2, but output decreases in fishing, mining, construction, manufacturing, and services sectors in both the

scenarios 1 and 2. In the case of wholesale retail trade, retail trade, and government sector the output decreases in Model3cc1, but increases in Model3cc2. This is because in Model3cc1 the output was constrained by the fixed endowment of capital but not so in Model3cc2.

Perhaps the main point to note about the differences between Model 2, where the labor supply curve is assumed perfectly elastic, and Model 3, where the labor supply curve is inelastic with an elasticity of 4.0, is that both the output response and job response for the economy as a whole is, as expected, smaller in the Model 3 variations than in the Model 2 variations. However, the directly affected crops response is almost identical in each model. So the upward sloping regional labor supply curve exerts it influence on the regional supply and job response to the export shock, but does not much change the response of the directly affected crops sector.

Table 4.3. Change in Labor Income ($ Millions)

SECTORS	Model 3	Model3cc1	Model3cc2
CROPS-C	11.42	14.84	14.94
ANIMALS-C	0.04	0.21	0.21
FISHING-C	-0.01	-0.12	-0.09
FOREST-C	0.04	0.45	0.47
MIN-C	-0.01	-0.05	-0.04
UTIL-C	0.02	0.00	0.06
CONSTR-C	0.46	1.01	0.95
CROPFOOD-C	0.06	0.66	0.70
ANFOOD-C	0.08	0.37	0.39
MAN-C	0.20	0.42	0.94
SERV-C	2.72	3.46	4.93
FOODSERV-C	0.36	0.58	0.68
TRAN-C	1.01	1.93	2.31
WRTRADE-C	0.73	1.03	1.15
RETAIL-C	0.14	0.18	0.22
GOVENT-C	2.32	3.88	4.08
TOTAL	19.59	28.87	31.91

Model 4

Our base Model 4 is exactly same as base Model 1 except that the constant elasticity of transformation function (CET) is changed to be more elastic for the crops sector in this model. This means Washington crops exports will be more responsive to price changes in the external markets viz., Rest of US (RUS) and Rest of the World (ROW). The value of the transformation elasticity for crops was changed from 2.0 in Model 1 to 4.0 in Model 4.

Because of the ROW export shock, in the base model, the exports of crops to ROW increase but exports decrease to the RUS market. Since in Model 4 CET function for crops is made more elastic, the response to price changes in external markets is also higher (Table 5.4) compares Model 1 export changes (24.91 & - 4.61) for ROW (FT) and RUS (DT) in base model 1 and 32.29 & -14.89 respectively to ROW and RUS in base model 4). The aggregate increase in exports to ROW in base Model 4 are 26.05 million units compared to 15.75 million units in base Model 1. All the other sectors respond to the external markets in the same way as in Model 1.

In Model 1 the export price of the crops increases by 1.62% in the world market, whereas it increases by 0.03% in the rest of US market (Table 5.1). Due to this price increase, crops exports to rest of the world increases by 3.03%. But the exports from Washington decline because of the assumed product-product transformation embodied in the CET function. Since we assume no change in rest of US crop demand in our model, the decrease in the supply of crops to the rest of US increases the export price of crops by 0.03% in this market (Table 5.1). As more of domestic output is diverted to the rest of the world market, the quantity of exports from Washington to the rest of US decreases by about 0.16% (Table 5.1).

Table 5.1. Percentage Change Price and Quantity of Crops Exports

Price of Exports (Crops)	Model1	Model1cc1	Model1cc2
Rest of World	1.627510	1.489678	1.488336
Rest of US	0.033750	-0.101922	-0.103242
Qty. of Exports (Crops)			
Rest of World	3.037838	3.739419	3.746275
Rest of US	-0.168577	0.511171	0.517814

In Mode1lcc1 and Model1cc2, the export price of crops in rest of the world market increases by same proportion and export price declines in rest of the US market. This is due to the supply increase (0.5% increase in both scenarios) in that market. The increase in exports from Washington to the rest of the world market is higher in scenario 2 (3.75%) than in scenario 1(3.74%) as a function of a larger capital base in Model1cc2.

In Model 4, the direction of change in the policy variables is the same as in Model 1, but the magnitude of the rest of world export response is larger than Model 1 (Table 5.2) as is the reduction if rest of the U.S. exports. This is because it is easier to substitute crops produced for the rest of the US market for crops produced for the rest of the world under Model 4 as a result of the higher elasticity of the CET function for crops. In Mode 4, the export price of crops increases by 1.34% in the world market because of which the quantity of exports to the rest of world increases by 4.5%; higher than the increase in Model 1. The percentage increase in exports to the rest of the world under Models4cc1 and Model4cc2 are about 5.19%, whereas in Model 1 the increase is about 3.75% in both Models.

Table 5.2. Percentage Change Price and Quantity of Crops Exports

Price of Exports (Crops)	Model4	Model4cc1	Model4cc2
Rest of World	1.347513	1.209291	1.207945
Rest of US	0.109168	-0.027365	-0.028694
Qty. of Exports (Crops)			
Rest of World	4.469062	5.184384	5.191376
Rest of US	-0.544059	0.136937	0.143593

The following tables (Table 5.3 and Table 5.4) show the changes in exports to rest of the world (labeled as FT) and rest of US (labeled as DT) on a sector-by-sector basis. The results show that total exports to the rest of the US, and the decrease in total exports to the rest of the US, is greater in Model 4 than in Model 1 as expected. It may be noted that the export shock to the crops sector actually results in decreased exports to the rest of world by other sectors as a function of labor movement away from those sectors towards crops thus decreasing the competitiveness of those sectors in rest of the world and rest of the US markets. This implicates that a policy, which succeeds in increasing the exports of crops sector, comes at the cost of lesser exports to rest of US by other industries in Washington.

Table 5.3. Change in Regional Exports under Model 1 ($ Million Dollars)

SECTORS	Model 1		Model1cc1		Model1cc2	
	FT	**DT**	**FT**	**DT**	**FT**	**DT**
CROPS-C	21.95	-4.61	27.01	13.99	27.06	14.17
ANIMALS-C	0.00	0.03	0.03	0.70	0.03	0.71
FISHING-C	-0.15	0.00	-1.00	0.00	-0.88	0.00
FOREST-C	0.00	-0.05	0.14	1.35	0.15	1.44
MIN-C	-0.01	-0.08	-0.04	-0.36	-0.04	-0.32
UTIL-C	0.00	-0.76	0.00	-1.85	0.00	-1.50
CONSTR-C	0.00	-0.35	0.00	-0.53	0.00	-0.50
CROPFOOD-C	-0.05	-0.74	0.07	1.04	0.09	1.29
ANFOOD-C	-0.03	-0.17	0.08	0.41	0.09	0.44
MAN-C	-4.50	-5.08	-7.64	-8.62	-7.25	-8.18
SERV-C	-0.70	-10.12	-1.47	-21.40	-1.34	-19.50
FOODSERV-C	0.00	-0.17	0.00	-0.21	0.00	-0.20
TRAN-C	-0.69	-1.17	-1.10	-1.87	-1.02	-1.72
WRTRADE-C	0.00	-0.42	0.00	-0.73	0.00	-0.67
RETAIL-C	0.00	-0.19	0.00	-0.34	0.00	-0.32
GOVENT-C	-0.07	-0.41	-0.12	-0.71	-0.11	-0.65
TOTAL	15.74	-24.27	15.95	-19.12	16.77	-15.51

The supply and jobs changes across the economy in Model4 and Model1 are very similar except that and shown before the crops sector is more responsive to the export shock in Model 4 (see Tables 5.5, 5.6 and 5.7).

Table 5.4. Change in Regional Exports under Model 4 ($ Million Dollars)

SECTORS	Model 4		Model4cc1		Model4cc2	
	FT	**DT**	**FT**	**DT**	**FT**	**DT**
CROPS-C	32.29	-14.89	37.45	3.75	37.50	3.93
ANIMALS-C	0.00	0.03	0.03	0.70	0.03	0.71
FISHING-C	-0.15	0.00	-1.01	0.00	-0.89	0.00
FOREST-C	0.00	-0.05	0.14	1.36	0.15	1.45
MIN-C	-0.01	-0.08	-0.04	-0.36	-0.04	-0.32
UTIL-C	0.00	-0.76	0.00	-1.86	0.00	-1.51
CONSTR-C	0.00	-0.35	0.00	-0.53	0.00	-0.50
CROPFOOD-C	-0.05	-0.74	0.07	1.05	0.09	1.30
ANFOOD-C	-0.03	-0.17	0.08	0.41	0.09	0.44
MAN-C	-4.52	-5.11	-7.68	-8.67	-7.29	-8.23
SERV-C	-0.70	-10.17	-1.48	-21.52	-1.35	-19.61
FOODSERV-C	0.00	-0.17	0.00	-0.21	0.00	-0.20
TRAN-C	-0.69	-1.18	-1.11	-1.88	-1.02	-1.73
WRTRADE-C	0.00	-0.43	0.00	-0.73	0.00	-0.67
RETAIL-C	0.00	-0.19	0.00	-0.34	0.00	-0.32
GOVENT-C	-0.07	-0.41	-0.12	-0.72	-0.11	-0.65
TOTAL	26.05	-34.66	26.33	-29.54	27.15	-25.91

Table 5.5. Output Responses under Different Closure Assumptions

SECTORS	Model 4	Model4cc1	Model4cc2
CROPS-C	19.27	50.00	50.33
ANIMALS-C	0.07	1.73	1.77
FISHING-C	-0.15	-1.02	-0.90
FOREST-C	-0.23	2.11	2.28
MIN-C	-0.14	-0.57	-0.51
UTIL-C	-1.22	-2.79	-2.15
CONSTR-C	-0.90	-1.51	-1.35
CROPFOOD-C	-0.93	1.46	1.80
ANFOOD-C	-0.34	0.96	1.03
MAN-C	-13.89	-23.22	-21.85
SERV-C	-21.80	-46.22	-41.22
FOODSERV-C	-0.81	-1.04	-0.91
TRAN-C	-4.46	-6.49	-5.65
WRTRADE-C	-1.84	-3.33	-2.94
RETAIL-C	-0.49	-0.90	-0.82
GOVENT-C	-3.99	-7.24	-6.24
TOTAL	-31.84	-38.07	-27.31

Table 5.6. Change in Number of Jobs under Different Closure Assumptions

SECTORS	Model 4	Model4cc1	Model4cc2
CROPS-C	655.91	846.92	849.17
ANIMALS-C	1.09	22.42	22.77
FISHING-C	-3.53	-9.42	-8.81
FOREST-C	-2.54	7.74	7.94
MIN-C	-1.87	-3.70	-3.54
UTIL-C	-0.84	-1.73	-1.29
CONSTR-C	-10.34	-18.02	-21.04
CROPFOOD-C	-7.30	4.29	4.55
ANFOOD-C	-1.43	3.33	3.46
MAN-C	-69.34	-93.85	-92.95
SERV-C	-346.00	-485.88	-483.46
FOODSERV-C	-21.49	-26.41	-24.95
TRAN-C	-45.09	-52.62	-51.45
WRTRADE-C	-43.60	-61.96	-63.21
RETAIL-C	-10.97	-15.84	-15.98
GOVENT-C	-92.66	-115.26	-121.19
TOTAL	0.00	0.00	0.00

Table 5.7. Change in Labor Income under Different Closure Assumptions

SECTORS	Model 4	Model4cc1	Model4cc2
CROPS-C	11.33	14.65	14.71
ANIMALS-C	0.04	0.20	0.21
FISHING-C	-0.04	-0.18	-0.16
FOREST-C	-0.01	0.38	0.39
MIN-C	-0.03	-0.09	-0.08
UTIL-C	0.01	-0.03	0.00
CONSTR-C	1.52	1.92	1.92
CROPFOOD-C	-0.06	0.49	0.52
ANFOOD-C	0.08	0.35	0.37
MAN-C	-1.02	-1.34	-1.05
SERV-C	-1.01	-1.90	-1.09
FOODSERV-C	0.38	0.57	0.64
TRAN-C	0.31	0.87	1.09
WRTRADE-C	0.60	0.76	0.83
RETAIL-C	0.09	0.09	0.11
GOVENT-C	1.51	2.58	2.66
TOTAL	13.67	19.33	21.05

VI. WELFARE IMPACTS:

Model 1

Household Income and Welfare Impacts

The household income and welfare impacts due to the export shock under model 1 are displayed in Table 6.1. In Model 1, the average net household income of all the categories of households is displayed (there are nine categories of households based on the household's income range and they are <10K, 10-15K, 15-25K, 25-35K, 35-50K, 50-75K, 75-100K, 100-150K, and 150K+). In the following Tables under this section HHD1 denotes the first household category and HHD9 the highest category of household income) Average household income increases very moderately, but welfare measured in terms of equivalent variation decreases for all households This is because the effect of increased commodity prices more than offsets the increased household income. This can be seen from the increase in consumer price index to 1.001 from 1.00. Due to the export shock GDP increases by 26.63 million dollars, which is about 0.013 percentage increase from its base value. As labor shifts to the crop sector to accommodate the increase in rest of the world demand the market clearing wage of increases slightly and this increases labor costs per unit of labor for all industries. The result is a slight increase in the consumer price index in Washington that more than offsets the modest increase in household income.

As we did previously, we simulate our base Model 1 under two capital closure assumptions, i.e., in Model1cc1 we allow the capital to be mobile with fixed supply of capital and in Model1cc2 we allow the capital to be mobile and its total endowment to vary.

In Model1cc1, average net household income increases for all the categories of the household and this increase is more than the increase in our base model 1 (Table 6.1). This is

because we allow capital to be mobile across the sectors, which is not the case in our base Model 1. Nevertheless, welfare measured in terms of equivalent variation decreases for all the

Table 6.1 Welfare Impacts of Agricultural Exports in Model 1

	AVERAGE HOUSEHOLD INCOME			
Model 1	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31596.59	0.59	-2.48
HHD2	36779	36780.46	1.46	-2.09
HHD3	35999	36001.08	2.08	-1.39
HHD4	42901	42903.58	2.58	-1.58
HHD5	57871	57875.12	4.12	-1.66
HHD6	65886	65891.70	5.70	-0.96
HHD7	91167	91174.80	7.80	-1.46
HHD8	110494	110504.08	10.08	-1.14
HHD9	134633	134645.71	12.71	-0.96
GDP($ millions)	234929.71	234956.34	26.63	
GDP(% increase)	0.011337			
CPI	1.0001			
Model 1cc1	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31596.84	0.84	-4.34
HHD2	36779	36781.07	2.07	-3.89
HHD3	35999	36001.93	2.93	-2.87
HHD4	42901	42904.64	3.64	-3.30
HHD5	57871	57876.81	5.81	-3.82
HHD6	65886	65894.04	8.04	-3.12
HHD7	91167	91178.00	11.00	-4.78
HHD8	110494	110508.22	14.22	-4.91
HHD9	134633	134650.92	17.92	-5.38
GDP($ millions)	234929.71	234967.32	37.61	
GDP(% increase)	0.016011			
CPI	1.000169			
Model 1cc2	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31596.91	0.91	-3.94
HHD2	36779	36781.23	2.23	-3.34
HHD3	35999	36002.16	3.16	-2.25
HHD4	42901	42904.93	3.93	-2.57
HHD5	57871	57877.27	6.27	-2.76
HHD6	65886	65894.69	8.69	-1.78
HHD7	91167	91178.89	11.89	-2.93
HHD8	110494	110509.36	15.36	-2.60
HHD9	134633	134652.36	19.36	-2.52
GDP($ millions)	234929.71	234970.31	40.60	
GDP(% increase)	0.017284			
CPI	1.000158			

categories of the household and this decrease is more than the decrease in our base model 1. This is again due to price effect more than offsetting the income effect. Consumer price index (CPI) increases to 1.00169. Due to the export shock increase in GDP in terms of nominal dollars is 37.61 millions, which is about 0.016 percentage increase from its base value. Again, the story is that with capital fixed by sector and the endowment of labor fixed the crop export shock is not welfare increasing. In other words the increased use of labor and capital in the crops sector implies that a loss of welfare because crops increased production while profitable generates opportunity costs in the rest of the economy that are greater that the increased income from crop production.

In Model1cc2, where the supply of capital is not constrained the net household income increases for all the categories of the household relative to Model 1 and Model1cc1 as expected, but even with capital mobile and variable, welfare decreases for all the categories of households again with price increase effect overtaking the income effect. In this scenario the percentage increase in net household income is more than in Model 1 and Model1cc1, but welfare reduction is less in Model1cc2 than in Modelcc1 because the increase in consumer price index in Model1cc1 (1.000158) is less than in Model1cc1 (1.000169). GDP due to export shock increases by 40.6 millions in terms of nominal dollars, which is about 0.017 percentage increase from its base value. As long as the regional supply of labor is fixed, the reallocation of labor and capita to the crops sector is not welfare increasing.

Model 2

The welfare impacts due to export shock under model 2 are displayed in Table 6.2. In our base Model 2, employment increases because of the assumption of fixed wages across the

Table 6.2. Welfare Impacts of Agricultural Exports in Model 2

	AVERAGE HOUSEHOLD INCOME			
Model 2	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31596.89	0.89	0.08
HHD2	36779	36781.24	2.24	1.30
HHD3	35999	36002.19	3.19	2.28
HHD4	42901	42904.97	3.97	2.88
HHD5	57871	57877.34	6.34	4.85
HHD6	65886	65894.79	8.79	7.08
HHD7	91167	91179.03	12.03	9.63
HHD8	110494	110509.55	15.55	12.64
HHD9	134633	134652.60	19.60	16.06
GDP($ millions)	234929.71	234971.10	41.39	
GDP(% increase)	0.017619			
CPI	1.000026			
Model 2cc1	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31597.33	1.33	-0.82
HHD2	36779	36782.32	3.32	0.87
HHD3	35999	36003.73	4.73	2.36
HHD4	42901	42906.89	5.89	3.07
HHD5	57871	57880.39	9.39	5.46
HHD6	65886	65899.03	13.03	8.42
HHD7	91167	91184.82	17.82	11.14
HHD8	110494	110517.05	23.05	14.94
HHD9	134633	134662.05	29.05	19.17
GDP($ millions)	234929.71	234990.89	61.18	
GDP(% increase)	0.026044			
CPI	1.00007			
Model 2cc2	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31597.47	1.47	0.04
HHD2	36779	36782.67	3.67	2.06
HHD3	35999	36004.22	5.22	3.67
HHD4	42901	42907.50	6.50	4.66
HHD5	57871	57881.36	10.36	7.76
HHD6	65886	65900.39	14.39	11.29
HHD7	91167	91186.68	19.68	15.11
HHD8	110494	110519.44	25.44	19.91
HHD9	134633	134665.07	32.07	25.32
GDP($ millions)	234929.71	234997.17	67.47	
GDP(% increase)	0.028718			
CPI	1.000047			

sectors. In Model 2, e average net household income increases for all the categories of the households, welfare measured in terms of equivalent variation increases, the GDP increases by

41.39 million dollars, which is about 0.0177 percentage increase from its base value. In our base Model2cc1, welfare for all the household increases in spite of the inflation in the economy, this means that income effect overcomes the price effect.

When we allow the capital to be mobile across the sectors, the increase in average net household income, welfare (except for household category HHD1), and GDP (61.8 million dollars) is more than the increase in Model 2. When there is no constraint for capital availability, i.e., average net household income, welfare, and GDP (67.47 million dollars) increases for all the categories of the household and this increase is higher than the increase in Model2cc1, i.e., when capital availability is constrained. CPI increase to 1.000047 from the base value 1.00. When the labor endowment is not fixed, that is when the labor supply function is assume perfectly elastic, then the expansion of the crops sector does not generate major opportunity costs in the form of reduced output in the rest of the economy and the welfare change is positive in all three models.

Model 3

The welfare impacts due to the policy shock under Model 3 are displayed in Table 6.3. In this model there is a supply constraint for the availability of labor i.e., labor is mobile across the sectors as in previous models but there is an upward sloping supply curve in our base model 3. The elasticity of labor supply curve is 4.0. When there is an export shock, the average net household income, welfare (except household category HHD1) of all the categories increases. Even though there is inflation in the economy, welfare increases because of the income effect more than offsets the price effect. When we allow the capital to be mobile, although its supply still fixed, average net household income, welfare (except for HHD1), CPI, and GDP (55.38 million dollars) all increase in the economy. In the next model where capital is mobile we see a

larger increase in net household income, welfare (except for HHD1), etc but the increases are not as great as in Model2cc1 with its labor supply curve.

Table 6.3. Welfare Impacts of Agricultural Exports in Model 3

	AVERAGE HOUSEHOLD INCOME			
Model 3	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31596.82	0.82	-0.53
HHD2	36779	36781.05	2.05	0.50
HHD3	35999	36001.93	2.93	1.40
HHD4	42901	42904.64	3.64	1.82
HHD5	57871	57876.81	5.81	3.30
HHD6	65886	65894.05	8.05	5.16
HHD7	91167	91178.02	11.02	6.99
HHD8	110494	110508.25	14.25	9.36
HHD9	134633	134650.96	17.96	12.01
GDP($ millions)	234929.71	234967.58	37.88	
GDP(% increase)	0.016123			
CPI	1.000044			
Model 3cc1	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31597.21	1.21	-1.69
HHD2	36779	36782.01	3.01	-0.30
HHD3	35999	36003.29	4.29	1.07
HHD4	42901	42906.33	5.33	1.50
HHD5	57871	57879.51	8.51	3.18
HHD6	65886	65897.80	11.80	5.58
HHD7	91167	91183.14	16.14	7.22
HHD8	110494	110514.87	20.87	10.05
HHD9	134633	134659.31	26.31	13.12
GDP($ millions)	234929.71	234985.09	55.38	
GDP(% increase)	0.023574			
CPI	1.000095			
Model 3cc2	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31597.33	1.33	-0.96
HHD2	36779	36782.31	3.31	0.71
HHD3	35999	36003.70	4.70	2.19
HHD4	42901	42906.85	5.85	2.85
HHD5	57871	57880.34	9.34	5.12
HHD6	65886	65898.96	12.96	8.02
HHD7	91167	91184.73	17.73	10.59
HHD8	110494	110516.92	22.92	14.27
HHD9	134633	134661.88	28.88	18.35
GDP($ millions)	234929.71	234990.44	60.74	
GDP(% increase)	0.025854			
CPI	1.000075			

Model 4

The welfare impacts due to the export shock under model 4 are displayed in Table 6.4. This model is same as Model 1 except for a greater elasticity of transformation (CET) for crops. In this model the direction of changes in net household income, welfare, GDP, and CPI are similar to model 1, but the welfare losses are slightly higher than Model 1. The same situation holds under two different capital closure assumptions when compared to Model 1. In Model 4 the economy is more flexible in a sense and the export shock results in greater crops output and rest of the world exports in response to the demand shock as compared to Model 1. However, this response generates higher output losses in other sectors as labor and capital shift out of those sectors resulting in more welfare loss in Model 4 compared to Model 1.

When there is an increased activity in a particular sector in the economy in our case crops sector, there is an increase in demand for factors of production, which may or may not be available depending on the labor and capital closure assumptions. Because of this, the production is affected in terms of increased cost of production, which in turn, makes goods costlier. This causes the price level to increase and decrease household consumption for a given level of income. Since welfare change is measured by the change in equivalent variation, the direction of welfare change depends on which effect (Income or Price) is dominant. In short-run models where capital and labor were assumed fixed for the state, the welfare change was negative indicating that income effect was more that offset by increased prices generated by increased factor and commodity costs. In longer run models the welfare change was unambiguously positive except for low income households.

Table 6.4. Welfare Impacts of Agricultural Exports in Model 4

	AVERAGE HOUSEHOLD INCOME			
Model 4	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31596.60	0.60	-2.49
HHD2	36779	36780.47	1.47	-2.10
HHD3	35999	36001.09	2.09	-1.40
HHD4	42901	42903.59	2.59	-1.59
HHD5	57871	57875.14	4.14	-1.66
HHD6	65886	65891.73	5.73	-0.96
HHD7	91167	91174.84	7.84	-1.47
HHD8	110494	110504.14	10.14	-1.14
HHD9	134633	134645.78	12.78	-0.96
GDP($ millions)	234929.71	234956.49	26.78	
GDP(% increase)	0.011401			
CPI	1.000101			
Model 4cc1	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31596.85	0.85	-4.36
HHD2	36779	36781.08	2.08	-3.91
HHD3	35999	36001.95	2.95	-2.88
HHD4	42901	42904.66	3.66	-3.32
HHD5	57871	57876.84	5.84	-3.85
HHD6	65886	65894.08	8.08	-3.14
HHD7	91167	91178.06	11.06	-4.81
HHD8	110494	110508.30	14.30	-4.93
HHD9	134633	134651.02	18.02	-5.41
GDP($ millions)	234929.71	234967.53	37.83	
GDP(% increase)	0.016101			
CPI	1.00017			
Model 4cc2	**Base**	**Calculated**	**Difference**	**EV (dollars/household)**
HHD1	31596	31596.91	0.91	-3.96
HHD2	36779	36781.24	2.24	-3.36
HHD3	35999	36002.18	3.18	-2.27
HHD4	42901	42904.95	3.95	-2.58
HHD5	57871	57877.31	6.31	-2.78
HHD6	65886	65894.74	8.74	-1.79
HHD7	91167	91178.95	11.95	-2.95
HHD8	110494	110509.45	15.45	-2.61
HHD9	134633	134652.47	19.47	-2.53
GDP($ millions)	234929.71	234970.54	40.83	
GDP(% increase)	0.017381			
CPI	1.000159			

VII. SUMMARY AND CONCLUSIONS

The results of an economic impact analysis from an input-output model are a function of restrictive assumptions of the model. These assumptions are consistent with an economy where there is no capacity constraint for production, fixed coefficients in production, and no price changes or due to Leontief technology, and fixed input prices. Sometimes input-output models are used for short run economic impact analysis, which may be misleading. This is because the assumptions of the input-output models do not hold in the short- run. In this situation, regional CGE models serve as a better alternative because of their flexibility to mimic various technology and factor market conditions. In this section, we summarize the results under various factor market assumptions and behaviors.

The Crops Sector

Table 7.1 provides a comparison of effect of the assumed three percent increase in crops exports under the flexible price model and the fixed price model. From Table 7.1 we see that except for the short-run where capital is assumed fixed by sector, the output change is greater in the CGE models than the IO model. In fact, the short-run CGE model provides a good approximation of the output change predicted by the IO model. For instance, the output increase in crops sector in model 4 is $ 19.27 million dollars, whereas in fixed price model it is $ 21.89 million dollars. The fixed coefficient technology of the IO model depicts a crops sector much less responsive to the export shock than the CES production function represented in the CGE model. Turning to the number of jobs and labor income, the estimated impact is much larger in every flexible price model (even in the short-run capital fixed model compared to fixed price models. This is due to the presence of relative price effect in the flexible price models. The

increase in number of jobs ranges from a low of 652 jobs to a high of 897 in the long-run CGE model (Table 7.1). This compares to an increase of 371 jobs in the IO model. Our conclusion is that the predicted job response in directly effected sector using IO model is likely to dramatically underestimate the CGE job response and furthermore that the CGE estimated response is likely to more accurately represent actual response given the more accurate treatment of labor and capital market behavior in regional CGE models.

Table 7.1. Comparison of Flexible Price Model with Fixed Price Model in Crops Sector

	Comparison of Flexible Price Model with Fixed Price Model				
		Flexible Price Model			
Model 1	**VARIABLES**	Model 1	Model1cc1	Model1cc2	Fixed Price
Crops Sector	Output	19.16	49.73	50.05	21.89
	Jobs	652.26	842.19	844.42	371.00
	Labor Income	11.26	14.57	14.62	7.92
Model 2		Model 2	Model2cc1	Mode21cc2	Fixed Price
Crops Sector	Output	**20.10**	**51.51**	**52.14**	21.89
	Jobs	**684.13**	**890.32**	**897.14**	371.00
	Labor Income	**11.47**	**14.93**	**15.05**	7.92
Model 3		Model 3	Model3cc1	Model3cc2	Fixed Price
Crops Sector	Output	19.88	51.07	51.62	21.89
	Jobs	676.54	878.47	883.93	371.00
	Labor Income	11.42	14.84	14.94	7.92
Model 4		Model 4	Model4cc1	Model4cc2	Fixed Price
Crops Sector	Output	19.27	50.00	50.33	21.89
	Jobs	655.91	846.92	849.17	371.00
	Labor Income	11.33	14.65	14.71	7.92

Economy Wide Effects

Table 7.2 gives a comparison of effect of an assumed three percent increase in crops exports on the total Washington state economy under the flexible price models and under the fixed price model.

Table 7.2. Comparison of Flexible Price Model with Fixed Price Model Economy Wide Results

	Comparison of Flexible Price Model with Fixed Price Model				
		Flexible Price Model			
Model 1	**VARIABLES**	Model 1	Model1cc1	Model1cc2	Fixed Price
	Output	-31.67	-37.85	-27.16	38.25
	Jobs	0.00	0.00	0.00	525.85
	Labor Income	13.60	19.22	20.94	14.11
		Model 2	Model2cc1	Mode21cc2	Fixed Price
Model 2	Output	**37.95**	**61.75**	**85.29**	38.25
	Jobs	951.44	1355.53	1449.73	525.85
	Labor Income	**21.46**	**32.02**	**35.57**	14.11
		Model 3	Model3cc1	Model3cc2	Fixed Price
Model 3	Output	21.37	37.24	57.12	38.25
	Jobs	724.82	1021.87	1086.54	525.85
	Labor Income	19.59	28.87	31.91	14.11
		Model 4	Model4cc1	Model4cc2	Fixed Price
Model 4	Output	-31.84	-38.07	-27.31	38.25
	Jobs	0.00	0.00	0.00	525.85
	Labor Income	13.67	19.33	21.05	14.11

From Table 7.2 we see that in Model 1 the economy's total output decreases in all version of Model 1. Because of the assumption, labor is mobile across the sectors but fixed for the region and activity specific capital, the output increases in some sectors (crops) must be offset by decreases in other sectors of the economy. On balance, the decrease in output outweighs the increase in output from the crop sector. There is always a positive ripple effect on the economy in input-output models because of the assumption of no supply constraint, which we can observe in Table 3.2. Also, we see that as we move from an economy with more restrictions to one with less restriction there are more positive effects in terms of less reduction in output and larger increase in labor income. It is interesting to note that the predicted change in labor income is larger in the two alternative scenarios in Model 1 than the fixed price model despite the fact that the regional labor endowment is fixed. If we allow capital to be mobile then the increase in labor income is larger than the estimate for the fixed price model is considered as an upper bound to the true regional wage bill increase. The IO model's estimated labor income

is good approximation only in the very limited case assuming fixed capital by sector and a fixed endowment of labor. In Model 2 the entire economy's output increases because we assume that wages are fixed across the sectors, which means that the labor market adjusts by changes in jobs rather than wage changes and the labor endowment increases. The output responses are greater (higher among all flexible price models) than the response from fixed price models except the base Model 2. Base Model 2 has the highest increase in number of jobs and labor income compared to all other flexible price models. . In Model 3, the output responses are smaller compared to Model 2 because the labor supply function is not perfectly elastic (elasticity of 4.0). When wages are flexible, producers are constrained by increased production costs. . The jobs and labor income changes in all Model 3 variations are higher than in the fixed price model. Model3cc2 is some similar to the flexible price model in that the factor markets are assumed to be perfectly mobile with relaxed supply constraints, yet we see from Table 3.2 that the labor markets response is more than t double compared to fixed price model.

From the discussion above we see that the economy responds differently under assumptions. The result reiterates our assertion that the multiplier effects are sensitive to factor market assumptions about labor and capital market behavior. Also, the results emphasizes the need to consider flexible price models as a first option in any regional economic analysis as it will give a more realistic view when regional specific labor and capital market behavioral assumptions are incorporated. In general, the short-run assumption of fixed capital and a fixed labor endowment result in economic impact results more in line with neoclassical economic theory. Namely, secondary (indirect) output effects tend to be negative. As we relax the assumptions capital fixity and labor endowment fixity then the export shock generates a much greater predicted direct and indirect economic effect with CGE models than the IO model. IO

models are often criticized for their lack of supply constraints. This study show that when supply constraints are introduced through the CGE model that even in the short run with capital fixed if the labor is not assumed fixed (as it would not be in a regional model) the IO model tends to under estimates supply and job response rather than over estimate these variables.

APPENDIX A

Table A1. Aggregation Scheme for the Washington State Economy

Sectors	Aggregated Individual IMPLAN Sector Codes
Crops	1-10, 18
Animals	11-13
Fishing	16, 17
Forest	14, 15
Mining	19,29
Utility	30-32
Construction	33-45
Crop Food	46-61&72-91
Animal Food	62-71
Manufacturing	92-389
Services	413-494
Food Services	481
Transportation	390-400
Wholesale Retail Trade	401-412
Food Retail	405
Government Enterprise	495-509

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