

Economic Impact of Seattle HEMPFEST™ Festival 2014 on the King County Economy

William B. Beyers
Department of Geography
University of Washington
Seattle, WA 98195-3550
beyers@u.washington.edu

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Executive Summary

The Seattle HEMPFEST™ Festival is a multidimensional event, with exhibitors, volunteers musicians, food vendors, and thousands of patrons attending the festival over a 3 three period. In 2014 approximately 120,000 persons attended Seattle HEMPFEST™ Festival. It is estimated that 48.9% of these patrons came from King County, 31.6% from elsewhere in Washington State, and 19.5% from out-of-state. Produced locally, this festival has a significant economic impact on the King County economy. This report is a tentative estimate of these economic impacts, utilizing a mixture of data gathered by Seattle HEMPFEST™ Festival organizers and secondary data measured at similar festivals.

Seattle HEMPFEST™ Festival patrons spent approximately \$7.1 million in King County in relation to their visits to the festival. Volunteers and musicians were estimated to have spent \$0.226 million in relation to their participation in the festival in King County, while Seattle HEMPFEST™ Festival exhibitors and food vendors are estimated to have had expenses of \$1.8 in relation to participation in the festival in King County. In addition, Seattle HEMPFEST™ Festival organizers incurred costs of \$0.924 million, of which \$0.744 million were made in King County. Exhibitors and food vendors incur expenses in setting up and taking down their exhibits/booths, as well as in their operation. It should be noted that each of the groups incurs expenses that are made outside King County in relation to their participation in Seattle HEMPFEST™ Festival; these expenses are not included in this study.

Each of these streams of expenditures were brought together in a model of the King County economy, known as an input-output model. This model, derived from the 2007 Washington State input-output model, allows estimates of indirect and induced economic impacts related to the streams of spending described above. It is estimated that Seattle HEMPFEST™ Festival in 2014 generated 234 jobs in King County, led to \$18.145 million in output (sales of all industries), and generated \$8.172 million in labor income. Labor income is the combination of direct earnings (wage and salary) plus estimated benefits/indirect labor expenses such as employee benefits). This model was used to estimate selected tax revenue impacts, which totaled \$1.2 million. This estimate includes sales taxes (both state and local tax distributions), the lodging tax, and state and local business and occupation tax.

It should again be emphasized that these estimates should be regarded as provisional. Their accuracy could be improved through better survey data from each of the participants in Seattle HEMPFEST™ Festival.

I. Introductory Comments

This report presents estimates of the economic impact of Seattle HEMPFFEST™ Festival on the King County economy, benchmarked against the year 2014. The report is based on data provided to the author by Seattle Events (the organization that presents the Seattle HEMPFFEST™ Festival), as well as on data from studies of a similar nature. The results presented in this report should be regarded as provisional, as there was very limited economic data gathered on key aspects of the Seattle HEMPFFEST™ Festival that would allow more precise estimates of economic impact.

The Seattle HEMPFFEST™ Festival is a multi-dimensional event held in on the Seattle waterfront, in Olympic Sculpture Park, Myrtle Edwards Park, and on property owned by the Port of Seattle. It has three days of public visitation (which is free), with 520 exhibitors and food sellers. Approximately 120 musical groups perform at Seattle HEMPFFEST™ Festival, and approximately 1,000 people volunteer to work at Seattle HEMPFFEST™ Festival. In 2014 approximately 120,000 people attended this event. The sponsoring organization is a non-profit—Seattle Events. It takes four days for Seattle Events to set up their equipment before the festival opens, and it takes another three days to remove Seattle Events equipment from the spaces used for the festival. The Hempfest organization started in 1991, and has grown larger over the years. Seattle Events also has a retail shop located in Lake City.

The author has conducted numerous economic impact studies. Many of these studies have been of exhibitions or trade shows similar to the Seattle HEMPFFEST™ Festival. Normally, they have relied on a sample of data on expenditures of patrons attending these events, as well as data on expenditures of the organizations involved in presenting at these events. Seattle Events has done some survey work that provides clues to the type of data usually gathered for these studies, but does not have the full amount data needed to undertake an analysis of the economic impact of the event to a level of accuracy found in some other studies undertaken by the author. This report is based on a mixture of data from Seattle Events, and data coming from similar events that have been used to proxy estimates of economic impacts in cases where data were not available from Seattle Events.

This report makes use of a version of the 2007 Washington State input-output model, benchmarked against King County, to calculate economic impacts. This model has been used recently for economic impact studies for King County International Airport, and for the City of Bellevue. Appendix I contains details about the mathematics of computing economic impacts from input-output models.

The next section of this report describes the sources of data utilized in calculating economic impacts with the input-output model. This section is followed by the presentation of impact estimates from the input-output model, and then by some concluding remarks.

II. Data Sources

Direct expenditure data were estimated for five categories of expenditures related to Seattle HEMPFFEST™ Festival: (the Seattle Events organization, patrons coming to the event,

musicians performing at the event, volunteers working at the event, and exhibitors and food vendors at the event). These data were brought together in the process of undertaking the economic impact estimates. It should be noted that these data are in most cases proxies for more accurate data that would come from direct surveys of expenditures of the different participants in Seattle HEMPFEST™ Festival.

Seattle Events and Seattle HEMPFEST™ Festival

Seattle Events provided detailed accounting information for its 2014 outlays for the Seattle HEMPFEST™ Festival. Seattle Events staff identified cases where these expenditures were made outside of King County, and were not therefore a basis for local economic impacts. Of the total budget of Seattle HEMPFEST™ Festival in 2014 (\$0.924 million), it was estimated that \$0.744 million were made of goods, services, and labor purchases in King County. These expenditures were reclassified from the Seattle Events accounting statement into the categories used in the input-output model. It was estimated that Seattle Events, as an organization, had 5 employees related to Seattle HEMPFEST™ Festival for the purposes of this impact analysis. It is recognized that the Seattle Events organization hires many temporary employees, and labor income identified from the Seattle Events accounting information included this labor income in the economic impact analysis.

Patron Spending

Seattle HEMPFEST™ Festival patrons incur expenses in relation to their visits to the event. While Seattle HEMPFEST™ Festival does not charge admission fees, there are a myriad of other costs typically incurred by people attending an event of this type. Seattle Events has done some survey work on patrons, but the questionnaires used did not ask a comprehensive set of questions about patron expenditures. The author has been involved with many studies of arts, sports, cultural, and exhibitions that have asked questions of patrons about their direct expenditures in relation to their attendance at these events. Data from these various surveys make it clear that per capita expenditures are inversely related to the distance travelled. Local patrons have much lower per capita outlays than people from out-of-state. Table 1 presents data from the latest Seattle HEMPFEST™ Festival survey, which asked people if they came from Seattle or up to 20 miles away, from more than 20 miles and up to 50 miles away, from elsewhere in Washington State, and from Out of State. Three alternative interpretations of these data were developed, and the distribution labelled Hempfest III was used in this analysis. Some people coming to Seattle HEMPFEST™ Festival no doubt lived in King County, but drove more than 20 miles to the event. Hempfest I below reports the percentage indicating that they came within 20 miles, while Hempfest II below reports the percentage saying that they came within 50 miles. A split of these Washington patrons is presented in Hempfest III below, that has a percentage of patrons from the local area similar to other studies calculated by the author, and accepts the percentage of out-of-state patrons estimated in the Seattle HEMPFEST™ Festival survey. It is recognized that a clearer request from patrons as to their origin would have produced somewhat different geographic origins.

Table 1 Seattle HEMPFEST™ Festival Data on Patron Origins

	Hempfest - I	Hempfest - II	Hempfest III	# of Patrons
% Seattle or up to 20 miles away	38.33%		48.94%	58,727
% Seattle or up to 50 miles away		59.55%		
Other WA	42.19%	20.97%	31.59%	37,913
Out of State	19.48%	19.48%	19.48%	23,376
	100.00%	100.00%	100.00%	

The second issue related to patron outlays is their average spending. The author reviewed several studies he has been involved with that appear to have similar patron compositions to the Seattle HEMPFEST™ Festival. The Seattle Center study, benchmarked against data for the year 2005 was selected for use for the purposes of this study (Seattle Center Study, Table 17, pp. 17). The consumer price index was used to update per attendee expenditures from 2005 to 2014. Table 2 below presents estimates of these expenditures per attendee. This distribution has been modified to reflect Seattle HEMPFEST™ Festival; no ticket or admission charge is levied at Seattle HEMPFEST™ Festival, and purchases made at Seattle HEMPFEST™ Festival and food and beverage purchases made at Seattle HEMPFEST™ Festival were calculated to be a fraction of reported overall sales by exhibitors and food stands at Seattle HEMPFEST™ Festival.

Table 2 Per Capita Expenditures- Seattle HEMPFEST™ Festival Patrons

	<u>Local</u>	<u>Other WA</u>	<u>Out of State</u>
Tickets/Admissions	\$0	\$0	\$0
Purchases at Seattle HEMPFEST™ Festival	3.91	3.91	3.91
Souvenirs and gifts	3.96	7.53	10.19
Parking fees	2.21	2.24	1.99
Bus/ferry/taxi	0.36	1.85	3.52
Auto travel	2.15	4.35	6.73
Food / beverages before or after Seattle HEMPFEST™ Festival	6.64	11.49	13.58
Food / beverages at Seattle HEMPFEST™ Festival	3.00	3.00	3.00
Entertainment	0.95	2.62	3.61
Lodging / Accommodations	0.75	8.98	28.98
Air travel	1.83	7.58	65.04
Child care	0.25	0.27	0.29
Other	1.41	2.47	3.09
Total	\$27.42	\$56.29	\$143.93

Given the per capita expenditures in Table 2, the number of patrons by region of origin was multiplied by the values in Table 2 to derive the total spending estimate in Table 3.

Table 3 Estimated Total Seattle HEMPFEST™ Festival Patron Expenditures

	Local	Other WA	Out of State	Total
Tickets/Admissions	0	0	0	0
Purchases at Seattle HEMPFEST™ Festival				
Festival	\$229,621	\$148,199	\$91,400	\$469,220
Souvenirs and gifts	232,779	285,314	238,302	756,396
Parking fees	129,559	84,997	46,470	261,026
Bus/ferry/taxi	21,356	70,295	82,173	173,824
Auto travel	126,000	164,940	157,263	448,202
Food / beverages before or after Seattle HEMPFEST™ Festival				
Food / beverages at Seattle HEMPFEST™ Festival	390,101	435,552	317,359	1,143,012
Entertainment	176,180	113,708	70,128	360,016
Lodging / Accommodations	55,525	99,240	84,440	239,205
Air travel	44,136	340,447	677,504	1,062,087
Child care	107,491	287,152	1,520,488	1,915,131
Other	14,949	10,108	6,801	31,857
Total	<u>82,576</u>	<u>93,726</u>	<u>72,256</u>	<u>248,558</u>
Total	\$1,610,274	\$2,133,676	\$3,364,583	\$7,108,534

Musicians

Seattle Events reported that it had 120 groups of musicians who performed at the Seattle HEMPFEST™ Festival. Some of these were paid, and some were not. An average of 4 persons were estimated to be in each musical group, and 60% of these groups were estimated to be local, and 40% from outside the local area. No data were gathered by Seattle Events on musicians expenses, although Seattle Events reported payments to these people as a part of their expense, and these payments have been regarded as labor income. Seattle Events also reported that it paid travel costs for musicians, so these values have been set to zero in Table 4, except for parking fees. Given the lack of detail on expenses incurred by musicians, it was assumed that their expenses were like those of patrons attending the event. In the future, Seattle Events could do surveys of the musicians to sharpen these expense estimates. The split of Other WA vs. Out of State was made the same as for Seattle HEMPFEST™ Festival Patrons.

Table 4 Musician Expenses

Total Spending Musicians	Local \$0	Other WA \$0	Out of State \$0	Total \$0
Tickets/Admissions				
Purchases at Seattle HEMPFEST™ Festival	1,126	465	285	1,877
Souvenirs and gifts	1,142	896	744	2,782
Parking fees	635	267	145	1,047
Bus/ferry/taxi	0	0	0	0
Auto travel	0	0	0	0
Food / beverages before or after Seattle HEMPFEST™ Festival	1,913	1,367	991	4,272
Food / beverages Seattle HEMPFEST™ Festival	864	357	219	1,440
Entertainment	272	312	264	848
Lodging / Accommodations	216	1,069	2,116	3,401
Air travel	0	0	0	0
Child care	73	32	21	126
Other	<u>405</u>	<u>294</u>	<u>226</u>	<u>925</u>
Total	\$6,647	\$5,059	\$5,011	\$16,717

Volunteers

Seattle HEMPFEST™ Festival has a huge number of volunteers, who help with all aspects of the event. They are involved with set up, the event, and take down. Seattle Events provided data that estimate that there are 1,000 volunteers who spend an average of 4 days volunteering. Seattle Events also estimated that 60% of the volunteers were local and 40% from outside the local area. As with musicians, no data were gathered by Seattle Event on volunteers expenses. Thus, the same data were used as for musicians, but Seattle had an expense item for food/beverages at Seattle HEMPFEST™ Festival for volunteers, so this expense was considered to be zero for them. Again, if Seattle Events did more detailed survey work in the future, it could develop more accurate estimates of the expenses incurred by volunteers. Table 5 shows estimated expenses incurred by volunteers.

Table 5 Volunteer Expenses

	<u>Local</u>	<u>Other WA</u>	<u>Out of State</u>	<u>Total</u>
Tickets/Admissions	0	0	0	0
Purchases at Seattle HEMPFEST™ Festival	\$9,384	\$3,863	\$2,393	\$15,640
Souvenirs and gifts	9,513	7,437	6,239	23,189
Parking fees	5,295	2,216	1,217	8,727
Bus/ferry/taxi	873	1,832	2,151	4,856
Auto travel	5,149	4,299	4,117	13,566
Food / beverages before or after Seattle HEMPFEST™ Festival	15,942	11,353	8,309	35,605
Food / beverages at Seattle HEMPFEST™ Festival	,0	0	0	0
Entertainment	2,269	2,587	2,211	7,067
Lodging / Accommodations	1,804	8,874	17,738	28,416
Air travel	1,098	1,871	9,952	12,921
Child care	611	263	178	1,052
Other	<u>3,375</u>	<u>2,443</u>	<u>1,892</u>	<u>7,710</u>
Total	\$65,808	\$55,618	\$88,087	\$209,513

Exhibitors/Food Booths

Seattle HEMPFEST™ Festival reported 520 exhibitors and food booths at the 2014 event, of which 45 were food booths. Only a portion of these were located on City of Seattle property and were required to report their revenues. However, an extrapolation of these revenues made by Seattle HEMPFEST™ Festival suggests that these exhibitors and food booths had revenues of approximately \$XXX. There was not a clear set of data on the split between food booths and exhibitors revenue. However, based on the required payments to the City of Seattle as a commission on sales, it was estimated that across all locations for Seattle HEMPFEST™ Festival in 2014 (City of Seattle land was only a portion of the venue), total vendor revenue was XXX).

Exhibitors have expenses well beyond their revenues at an expense of this type. The author undertook three studies for O’Loughlin Trade Shows, a Tacoma firm that employed him for exhibitions similar to Seattle HEMPFEST™ Festival. Seattle HEMPFEST™ Festival has limited data from its exhibitors and food booths on their expenses. The data from the 2004 Portland Home and Garden Show seemed most similar to the author to the Seattle HEMPFEST™ Festival. It was used as a proxy for actual costs for Seattle HEMPFEST™ Festival exhibitors, and it is realized that these expenditures could be very different for Seattle HEMPFEST™ Festival exhibitors and food booths. Like Seattle HEMPFEST™, the O’Loughlin Trade Show exhibitions had substantial move-in and move-out costs, and considerable costs for the exhibitions themselves. Many exhibitors were not from the local area, and many found the trade show to be a basis for getting business down-stream.

Seattle HEMPFEST™ Festival reported that there an average of six persons working in each exhibitors booth/display. Seattle HEMPFEST™ Festival also reported that it took one days

to set up booths for exhibitors and food vendors, and one day after Seattle HEMPFEST™ Festival to take down these booths. This implies 5 days of work for 520 exhibitors with 6 persons per booth, or 124,800 hours associated with these exhibitors/food booths. If the average person works 2000 hours per annum, this implies FTE employment of 62 persons. Seattle HEMPFEST™ Festival reported that 32% of these vendors were nonlocal, so their wages and employment are not directly in King County. An estimated 42FTE were linked to King County activity by exhibitors/food booths Table 6 reports estimated expenses by exhibitors/food vendors; they are estimated to be \$1.8 million.

Table 6 Estimated Exhibitor Setup/Operations Costs

	Per capita Costs	Total Expenses
Lodging / Accommodation Costs	\$48.10	\$150,080
Parking Fees	\$17.33	\$54,062
Bus / Ferry / Public Transit / Taxi Costs	\$0.36	\$1,125
Auto / Truck Operating Costs (fuel, oil, etc.)	\$28.81	\$89,899
Auto / Truck Rental Costs	\$6.77	\$21,124
Seattle HEMPFEST™ Festival Move-in & Move-out Costs	\$85.47	\$266,670
Equipment Rental Costs	\$55.01	\$171,626
Printing and Postage	\$75.63	\$235,962
Food / Beverages Before, During or After Seattle HEMPFEST™ Festival	\$41.61	\$129,826
Entertainment Before or After Seattle HEMPFEST™ Festival	\$6.53	\$20,389
Souvenirs and Gifts	\$50.51	\$157,588
Air Travel / Train Costs	\$18.55	\$57,868
Child Care / Baby-Sitting	\$1.75	\$5,449
Other 1	\$81.78	\$255,160
Other 2	\$48.69	\$151,927
Total	\$571.62	\$1,768,755

III. Economic Impact Estimates

The preceding direct economic impact components were brought together into a version of the 2007 Washington State input-output model, which was benchmarked against King County. Consumer expenditure categories were translated into the sectoring scheme used in the input-output model. This model provides impact estimates based on direct spending, and indirect and induced economic impacts. The indirect effects result from inter-industry purchases resulting from direct purchases (such as Seattle HEMPFEST™ Festival’s purchase of rental services for equipment for the festival). The induced effects are related to the payment of labor income and its spending on consumption. Table 7 below reports \$18.1 million in output in the King County economy as a result of Seattle HEMPFEST™ Festival in 2014, leading to 234 jobs and 8.2 million in labor income. A consolidated version of Table 7 is reported in Table 8.

Table 7 Output, Employment and Labor Income Impacts of Seattle HEMPFEST™ Festival 2014

	Output (Mils. \$2013)	Employment	Labor Income (Mils. \$2013)
1. Crop Production	0.001	0	0.000
2. Animal Production	0.001	0	0.000
3. Forestry and Logging	0.000	0	0.000
4. Fishing, Hunting, and Trapping	0.050	0	0.015
5. Mining	0.018	0	0.004
6. Electric Utilities	0.279	0	0.090
7. Gas Utilities	0.063	0	0.005
8. Other Utilities	0.053	0	0.014
9. Highway, Street, and Bridge Construction	0.112	0	0.027
10. Other Construction	0.763	3	0.179
11. Food, Beverage and Tobacco Manufacturing	0.313	0	0.026
12. Textiles and Apparel Mills	0.013	0	0.003
13. Wood Product Manufacturing	0.005	0	0.001
14. Paper Manufacturing	0.017	0	0.002
15. Printing and Related Activities	0.245	1	0.075

	0.153	0	0.002
16. Petroleum and Coal Products Manufacturing			
	0.004	0	0.001
17. Chemical Manufacturing			
	0.038	0	0.006
18. Nonmetallic Mineral Products Manufacturing			
	0.001	0	0.000
19. Primary Metal Manufacturing			
	0.019	0	0.004
20. Fabricated Metals Manufacturing			
	0.017	0	0.003
21. Machinery Manufacturing			
	0.008	0	0.002
22. Computer and Electronic Product Manufacturing			
	0.003	0	0.000
23. Electrical Equipment Manufacturing			
	0.002	0	0.000
24. Aircraft and Parts Manufacturing			
	0.001	0	0.000
25. Ship and Boat Building			
	0.007	0	0.001
26. Other Transportation Equipment Manufacturing			
	0.006	0	0.001
27. Furniture Product Manufacturing			
	0.017	0	0.003
28. Other Manufacturing			
	0.576	2	0.199
29. Wholesale			
	0.026	0	0.007
30. Non-Store Retail			
	1.438	15	0.580
31 Other Retail			
	1.113	2	0.159
32. Air Transportation			
	0.079	0	0.017
33. Water Transportation			
	0.387	2	0.123
34. Truck Transportation			
	0.311	2	0.124
35. Other Transportation/Postal Offices			
36. Support Activities for Storage, Transportation and Warehousing			
	0.140	1	0.051
37. Software Publishers & Data Processing & related services			
	0.104	0	0.036
	0.428	1	0.071
38. Telecommunications			
	0.163	1	0.072
39. Other Information			
	0.855	2	0.157
40. Credit Intermediation and Related Activities			

	0.640	3	0.205
41. Other Finance and Insurance			
	1.206	12	0.241
42. Real Estate and Rental and Leasing			
43. Legal /Accounting and Bookkeeping /Management Services	0.311	3	0.248
	0.148	1	0.082
44. Architectural, Engineering, and Computing Services			
	0.126	2	0.043
45. Educational Services			
	0.536	4	0.277
46. Ambulatory Health Care Services			
	0.405	2	0.151
47. Hospitals			
48. Nursing and Residential Care Facilities, Social Assistance	0.260	4	0.118
	2.793	110	2.573
49. Arts, Recreation, and Accommodation			
	2.257	30	0.688
50. Food Services and Drinking Places			
	0.294	5	0.208
51. Administrative/Employment Support Services			
	1.344	10	0.436
52. Waste Management/Other, and Agriculture Services			
		14	0.842
State & Local Government			
	18.145	234	8.172
Total			

Table 8 Aggregate Economic Impacts of Seattle HEMPFEST™ Festival 2014

	Output (\$ Millions)	Employment	Labor Income (\$ Millions)
	\$0.466	1	\$0.128
Natural Resources and Utilities			
	\$1.743	5	\$0.337
Construction and Manufacturing			
	\$2.040	18	\$0.786
Retail and Wholesale Trade			
	\$6.177	34	\$1.793
Producer and Transport Services			
	<u>\$7.720</u>	<u>176</u>	<u>\$5.129</u>
Consumer Services & S&L Govt.			
	\$18.145	234	\$8.172
Total			

Seattle HEMPFEST™ Festival leads to tax revenues to state and local governments. Selected tax impacts are reported in Table 9. Some direct spending by people attending Seattle HEMPFEST™ Festival subject to sales tax, such as spending on souvenirs and meals. Labor

income earned directly and as a result of economic impacts of Seattle HEMPFEST™ Festival also lead to sales tax revenues. Using data from the Washington Office of the Forecast Council, estimated sales tax revenues as a share of labor income are reported in Table 9. The sales of industries are subject to the B&O tax. Using data from the Department of Revenue, state and local government collections of B&O tax were estimated by industry, and summed to the values reported in Table 9. Seattle collects a lodging tax (which includes sales tax), and it is estimated to amount to \$.213 million related to Seattle HEMPFEST™ Festival patrons, exhibitors, musicians, and volunteers.

Table 9 Tax Impacts of Seattle HEMPFEST™ Festival

Tax Impacts	\$ Millions
	\$0.305
State Sales on Direct Sales	
	\$0.164
Local Sales on Direct Sales	
	\$0.244
State sales as a share of labor income	
	\$0.113
Local Sales as a share of labor income	
	\$0.191
Seattle Lodging Tax (Direct sales)	
	\$0.129
State B&O Tax	
	\$0.063
Local Business & Occupation Tax	
	\$1.209

IV. Concluding Comments

This report is based on limited information about the spending of patrons to Seattle HEMPFEST™ Festival, and on the part of exhibitors, musicians, and volunteers. The results presented here should be regarded as provisional, pending measurement through survey work of actual outlays for these categories of participants in Seattle HEMPFEST™ Festival. The author recommends that Seattle HEMPFEST™ Festival undertake surveys of this type, so that future estimates of economic impact would be based on more solid data.

While the results reported here are provisional, their magnitude is not dissimilar to those obtained in other studies conducted by the author. Seattle HEMPFEST™ Festival is a major festival in Seattle, with significant sales, employment, labor income and tax revenue impacts in King County.

Appendix I. Technical Notes on the input-output model

The impact estimates developed in this study stem from the utilization of an “Input-Output model.” Models of this type are based on static, cross-sectional measures of trade relationships in regional or national economies. They document how industries procure their inputs and where they sell their outputs. Pioneered by Wassily Leontief, who won the Nobel Prize in Economic Science for his insights into the development of Input-Output models at the national level, these models have become “workhorses” in regional economic impact analysis in recent decades.

Washington State is fortunate to have a rich legacy of research developing Input-Output models. Early work was led by Philip J. Bourque and Charles M. Tiebout. Input-Output models have now been estimated in Washington State for the years 1963, 1967, 1972, 1982, 1987, 1997, 2002 and 2007. No other state in the U.S. has this rich historical legacy of survey-based or quasi-survey based regional Input-Output models. The current economic impact study is based on work completed in 2011-2012 by a team of Washington State government staff and Beyers (Beyers and Lin 2012).

Input-Output models decompose regional economies into “sectors”—groups of industries with a common industrial structure. At the heart of these models are “Leontief production functions,” which are distributions of the cost of producing the output of sectors. Leontief augmented the national accounts schema developed by Kuznets (also a Nobel laureate in Economics) to take into account the significant levels of intermediate transactions that occur in economic systems in the process of transforming raw materials and services into “finished products” or “final products.” Sales distributions among intermediate and final sources of demand are used as the accounting bases for the development of the core innovation of Leontief: that these relationships can be used to link levels of final demand to total industrial output by way of a system of “multipliers” that are linked through the channels of purchase in every industry to the production of output for final demand.

This system of relationships is based on accounting identities for sales. Mathematically, the system may be represented as follows. For each industry we have two balance equations:

$$(1) X_i = x_{i,1} + x_{i,2} + \dots + x_{i,n} + Y_i$$

$$(2) X_j = x_{1,j} + x_{2,j} + \dots + x_{n,j} + V_j + M_j$$

where: X_i = total sales in industry i ,

X_j = total purchases in industry j

$x_{i,j}$ = intermediate sales from industry i to industry j

Y_i = final sales in industry i

M_j = imports to sector j

V_j = value added in sector j .

For any given sector, there is equality in total sales and total purchases:

$$(3) X_i = X_j \text{ when } i=j.$$

This system of transactions is generalized through the articulation of Leontief production functions, which are constructed around the columns of the regional Input-Output model. They are defined in the following manner.

Let us define a regional purchase coefficient:

$$r_{i,j} = x_{i,j}/X_j.$$

Rearranging,

$$x_{i,j} = r_{i,j}X_j$$

Substituting this relationship into equation (1) we have:

$$(4) \quad X_i = r_{i,1}X_1 + r_{i,2}X_2 + \dots + r_{i,n}X_n + Y_i$$

Each sector in the regional model has this equation structure, and since the values of X_i equal X_j when $i=j$, it is possible to set this system of equations into matrix notation as:

$$(5) \quad X = RX + Y$$

This system of equations can then be manipulated to derive a relationship between final demand (Y) and total output (X). The resulting formulation is:

$$(6) \quad X = (I-R)^{-1}Y$$

where the $(I-R)^{-1}$ matrix captures the direct and indirect impacts of linkages in the Input-Output model system. The Input-Output model utilized in the modeling for this research project was developed by a committee led by Dr. William Beyers and Dr. Ta-Win Lin, and was published in 2012 by the Washington State Office of Financial Management. The model has 52 sectors.

A major issue that surrounds the estimation of the $(I-R)^{-1}$ matrix is the level of “closure” with regard to regional final demand components, which are personal consumption expenditures, state and local government outlays, and capital investment. It is common practice to include the impacts of labor income and the disposition of this income in the form of personal consumption expenditures in the multiplier structure of regional Input-Output models. The additional leveraging impact of these outlays is referred to as “induced” effects in the literature on models of this type. It is less common to include state and local government expenditures in the induced effects impacts, but it can be argued that demands on state and local governments are proportional to the general level of business activity and related demographics. In contrast, investment is classically argued to be responsive to more exogenous forces, and is not a simple function of local business volume. In the model developed for this impact study, personal consumption expenditures and state and local government outlays have been included as a part of the induced-demand linkages system. Washington personal consumption expenditures have

been considered to be a function of labor income, while state and local government expenditures have been considered to be a function of other labor income.

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