The Economic Impact of Increased Congestion for Freight Dependent Businesses in Washington State

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ABSTRACT

Congestion in the transportation system causes freight dependent businesses to alter their business model to satisfy consumer demands under uncertain operational conditions. Wasted fuel, lost productivity, and reduced mobility on the urban road network cost the nation’s network users billions every year. Despite the magnitude of this cost, it is not in itself useful to inform public policy at the state level. Instead, transportation agencies need additional knowledge to understand how industries are impacted by congestion, what their likely response will be to increasing congestion, and the net impact of these industry responses to the economy.

Data from a survey of freight dependent businesses and seven IMPLAN models were used to calculate the costs of congestion and estimate the annual economic impact of increased congestion for freight dependent businesses in the State of Washington. Responses from freight dependent businesses indicate that consumers would likely pay 60 to 80 percent of the increased cost of congestion. Ultimately, this means that consumers will pay higher prices for freight dependent goods and freight dependent businesses will spend more to provide those goods.

The primary areas of increased cost for freight dependent businesses were identified as additional trucking costs and inventory costs. It is estimated that the consumer cost for a 20 percent congestion increase, 60 percent cost realization, in Washington State is $8.7 billion. The economic impact of this redistribution of wealth and inefficiency is a loss of $3.3 billion dollars in total output and over 27,000 jobs.
The economic vitality and livability of any state readily depends on reliable, responsible, and sustainable transportation. Maintaining the transportation system at a level that allows for the safe, efficient movement of freight is an important component of this sustainable system. Wasted fuel, lost productivity, and reduced mobility on the urban road network are estimated to cost the nation’s network users roughly $85 billion annually (1). As impressive in magnitude as this estimate is, it is not useful to inform public policy at the state level. Instead, transportation agencies need additional knowledge to understand how industries are impacted by congestion, what their likely response will be to increasing congestion, and the net impact of these industry responses to the economy.

To answer these questions, a study was designed and completed by the Washington State Department of Transportation’s (WSDOT) Freight Systems Division, in coordination with the Washington State University’s (WSU) Freight Policy Transportation Institute and the WSU Social and Economic Sciences Research Center (SESRC) (2). The goal of this study was to increase WSDOT’s knowledge about the impacts of congestion on businesses deemed to be dependent upon goods movement, and how these impacts are felt through the State’s economy. Typically, economic impact statements report how an economy changes when an external source of funds moves into a regional economy (i.e., a new manufacturing plant locates in a town). Congestion however, is somewhat unique in that “new” money is not being injected into the economy. Instead, congestion causes freight dependant businesses to operate less efficiently.

DEVELOPING AN IMPACT ASSESSMENT
To fully explore the relationship between congestion, associated costs to industries, and the ripple effects to the State’s economy, a new set of data and industry relationships was needed. To produce this data, a four-step methodology was developed, beginning with an extensive survey of freight-dependent businesses. Survey results were then used to attain a direct cost of congestion to freight dependent industries. The direct costs were subsequently used as inputs to a series of regional and statewide IMPLAN I-O models (Figure 1).
Survey of Freight Dependent Industries

A survey of freight dependent businesses was conducted by SESRC through a developed Computer-Assisted Telephone Interview (CATI) protocol that was administered between 2009 and 2011. A total of 6,624 private-sector freight companies and carriers were invited to take the CATI, representing industries such as agribusiness, construction, global gateways (ports, etc.), food manufacturing, manufacturing, retail, trucking warehousing, wholesale, and lumber companies. Respondent industries were later grouped in accordance with their 2-digit NAICS codes making them compatible with the IMPLAN aggregation used in later stages. The survey dataset recorded sufficient responses from 1,062 businesses (29.6 percent). Questions focused on gathering data necessary to input into the economic assessment tool, including questions about industry classification, main freight activity, average hourly trucking costs, trucking cost components (wages, fuel, etc.), inventory carrying costs, and strategies to combat congestion. Respondents were asked to identify, and direct their responses to, the region of the state where they face the most congestion or where the majority of their shipments occur. This region was then used to provide context for the remainder of the survey questions. Six regions were provided as response options. The regions were: Northwest, Southwest, Central basin, Northeast, Southeast, and Central Puget Sound Metro Area (Table 1). The key component of the survey asked respondents a series of questions regarding how they would respond if their travel time due to congestion increased by 20, 30, and 40 percent. Particular emphasis was asked in regards to the anticipated number of trucks that would be necessary to combat congestion.
TABLE 1 Number of Observations, by Congestion Region.

<table>
<thead>
<tr>
<th>Congestion Region</th>
<th>Number of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>267</td>
</tr>
<tr>
<td>Southwest</td>
<td>100</td>
</tr>
<tr>
<td>Central Basin</td>
<td>99</td>
</tr>
<tr>
<td>Northeast</td>
<td>84</td>
</tr>
<tr>
<td>Southeast</td>
<td>75</td>
</tr>
<tr>
<td>Central Puget Sound</td>
<td>239</td>
</tr>
<tr>
<td>Missing</td>
<td>198</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1062</strong></td>
</tr>
</tbody>
</table>

Direct Costs of Congestion

The increased truck needs were translated into cost information using respondent provided hourly trucking costs. Hourly trucking costs were annualized by multiplying the hourly rate by 2,080 hours per year. The annual cost of operating a truck was then multiplied by the number of trucks identified in the survey that the respondents said would be necessary to combat the various congestion increases. Each company’s total trucking cost due to increased congestion was then divided by their reported annual revenue to calculate the percentage trucking cost increase.

A series of survey questions asked respondents if they held inventory and the value of those goods. This series additionally prompted the respondent to estimate how much more inventory would need to be held if congestion levels increased. It was assumed that companies that do not currently hold inventories will not be induced to hold inventory to combat congestion. Respondents were asked to identify their inventory carrying cost as a percentage of inventory value and the components of that carrying cost. The total value of inventory was first divided by the number of days of inventory held to calculate a daily inventory value. The number of additional days of inventory was multiplied by the daily inventory value and the carrying cost percentage to calculate the inventory cost due to congestion. The inventory cost percentages and the trucking cost percentages from survey respondents provided an integral component for the calculation of the economic shock created by congestion.

Cost Realization

Survey respondents were asked what strategies their companies would employ if travel times permanently increased by 20 percent. These responses provided insight to how individual businesses would manage increased congestion and the resulting costs. Over half of the respondents indicated that they would continue their current operations and pass the costs on to consumers and another 20 percent said the additional costs would be absorbed by the company. Two other groups of firms indicated that they would modify their business operations to manage the travel time increases; 16 percent would change routes and 3 percent would relocate. Finally, 6 percent reported that they would go out of business.

These responses can be further analyzed to describe the range of costs that consumers might face due to increased congestion. First, while individual firms might go out of business their consumers will likely still exist. Therefore, it can be assumed that they will be provided goods from other firms that still face congestion costs. Secondly, altering business operations to manage increased travel time is not free of costs. Firms will only incur these costs to the point
where profits are equivalent to employing the other strategies. Uncertainty about costs from firms that alter their business operations makes it infeasible to calculate exact costs to consumers from congestion. Therefore, all of the results are presented at 60 percent cost realization [for 80 percent cost realization evaluation, see (2)]. In other words, consumers could expect to likely pay 60 percent of the increased cost of congestion. However, the consumers’ cost of congestion for freight dependent businesses does not provide complete measure of the economic shock. How businesses spend resources to combat congestion must be considered as well.

Economic Impact Model Specification

Traffic congestion is caused when traffic demand meets or exceeds transportation capacity. Freight dependent businesses are not able to control the capacity of the transportation system so they must develop strategies to avoid congestion and/or employ resources to offset its effects. Economic theory suggests that businesses will allocate resources optimally to maximize profits. This optimal allocation of resources specifies a production function. When faced with congestion, firms must reallocate resources and operate on a different, less efficient, production function.

Economic Costs and Benefits

The cost of congestion is modeled two ways simultaneously. Once as a negative value that simulates consumers decreased purchases of services and non-freight dependent goods (consumer cost). The second value is positive and simulates freight dependent businesses adding employment and assets to combat congestion (societal benefits). The economic impacts that result from these two offsetting impacts are the net impacts of increased congestion for freight dependent businesses.

Before the gross congestion costs can be divided into cost and benefit categories, the costs incurred due to goods that were exported from the state must be examined. From the consumer cost perspective, the costs attributable to exports do not belong in the state or regional I-O models. If firms are able to pass the congestion cost on to consumers, these costs would be paid for by consumers that do not live in Washington. From a societal benefit perspective, the inclusion or exclusion of these costs is not as clear. This uncertainty primarily comes from the elasticity of demand for the exported goods. It could be argued that firms would be less capable of passing along congestion costs to export customers because their demand for these goods is more elastic than in-state consumers. Furthermore, if firms are not able to increase export prices it is feasible that in-state consumers would be charged even higher rates. Due to the uncertainty of the existence or direction (i.e., cost or benefit) of congestion costs attributable to exported goods, they were subtracted from the gross congestion costs for consumer costs and societal benefits. Therefore, the costs and benefits used in the I-O models are those paid by Washington consumers and spent by Washington freight dependent businesses.

Three of the inventory carrying cost components also require attention before costs and benefits can be calculated. First, obsolescence and pilferage are legitimate expenses for firms but they do not garner benefits to society. Secondly, taxes are a transfer from businesses and households to government. These dollars are used to provide non-market goods and services and do not circulate through the economy like spending in other economic sectors. Therefore, all three of these components are included in the consumer cost calculations but are excluded from the societal benefit calculations.
**Distribution**

In regional I-O modeling, it is necessary to know the size of the direct costs and where they are accrued. This spatial component applies to both consumer costs and societal benefits. Since the congestion costs have been limited to those paid and spent in Washington, there is no real distinction to be made for the state level model. However, this is a critical step to understand how different regions of the state are affected by congestion.

**Trade Flow**  Trade flow data from IMPLAN specifies the value of exports from one region to another. By linking all of the regional models, an industry level map of all the interregional transfers was created. Augmenting this information with the total production and export data, also from IMPLAN, provides a complete picture of where goods from each region are shipped. This distribution of production was transformed from values to percentages and used as a roadmap (trade flow matrix) for assigning consumer costs and societal benefits to the region where they would be accrued.

**Consumer Cost** The congestion costs for each regional industry were multiplied by the trade flow matrix to assign the appropriate values to each region. State level costs were calculated after subtracting the costs attributable to exports. The state and regional consumer cost values at each congestion level were then summed across industries to calculate total consumer costs (Error! Reference source not found.). The vast majority (95 percent) of the consumer cost of congestion is attributable to trucking costs.

**Societal Benefits** Societal benefits are accrued in different regions based on where the expenditures will be made. Trucking expenses (wages and inputs) are presumed to be spent in each firm’s home region. Capital and insurance inventory costs are also accrued in the home region. Warehousing, handling, and clerical expenses are accrued in the destination regions. Handling and clerical are considered to be inventory wage expenses. State level benefits were calculated after subtracting the costs attributable to exports. The state and regional societal benefit values at each congestion level were then summed across industries to calculate total consumer costs (Table 2).

**Net Effects**  The net economic impacts are calculated through the I-O models, however the net effects are provided in Table 2 for illustrative purposes. Juxtaposing the societal benefits and consumer costs from congestion by region shows the diversity in the effects. The Northwest and Southeast regions have benefits in excess of their consumer costs. The deficit in the other regions ranges from $1.3 million in the Northeast to $205 million in the Puget Sound. The net effects presented here differ from the economic impacts because they do not account for how the industries or households spend or withdraw money in the local economies.
TABLE 2 Net Effect of Consumer Cost and Societal Benefit.

<table>
<thead>
<tr>
<th>Region</th>
<th>Societal Benefits</th>
<th>Consumer Cost</th>
<th>Net Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>$839,777,837.00</td>
<td>$786,951,341.00</td>
<td>$52,826,496.00</td>
</tr>
<tr>
<td>Southwest</td>
<td>$726,634,062.00</td>
<td>$764,545,407.00</td>
<td>-$37,911,345.00</td>
</tr>
<tr>
<td>Central Basin</td>
<td>$535,672,497.00</td>
<td>$588,952,830.00</td>
<td>-$53,280,333.00</td>
</tr>
<tr>
<td>Northeast</td>
<td>$497,611,946.00</td>
<td>$498,952,830.00</td>
<td>-$1,346,422.00</td>
</tr>
<tr>
<td>Southeast</td>
<td>$209,026,349.00</td>
<td>$193,562,034.00</td>
<td>$15,464,315.00</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>$6,847,315,653.00</td>
<td>$7,052,246,826.00</td>
<td>-$204,931,173.00</td>
</tr>
<tr>
<td>State</td>
<td>$8,529,297,034.00</td>
<td>$8,720,889,371.00</td>
<td>-$191,592,337.00</td>
</tr>
</tbody>
</table>

Spending Patterns

The consumer costs and societal benefits of congestion are entered into the I-O models as changes to the baseline economy. Additionally, the models require that a pattern of spending be specified to define what industries are affected by the change and by how much. This section discusses how all of the cost categories were incorporated into the regional and state models.

**Consumer Costs**  Consumers’ income must increase or their total expenditures must decrease for them to pay the increased cost of freight dependant goods. Assuming that consumers’ income is held constant, the amount spent on services and non-freight dependant goods must decrease by the cost of congestion. The household consumption function from IMPLAN was modified to incorporate the spending decrease into each model.

The household consumption function specifies the percentage of a consumer’s dollar that is spent in each industry in the economy. Furthermore, it shows how much of that industry expenditure is spent in the local economy. The magnitude of the industry specific consumer expenditures in these consumption functions vary depending on the household’s income level and the region. We do not have information on which households will incur congestion costs; therefore a composite consumption function was created for each region.

The composite function was calculated as a weighted average industry expenditure for all income ranges. The number of households in each income range was used for weighting. The composite consumption functions were then modified to remove all freight dependant industries and normalized to sum to one. Finally, scenarios were created in each model with the composite consumption function and the corresponding consumer costs.

**Societal Benefits** The societal benefits are experienced when freight dependent companies begin to spend additional money on resources to counteract increased congestion. For modeling purposes, adding societal benefits to the economy is straightforward. Spending on the insurance and capital is placed in the corresponding IMPLAN industries. Wages are modeled as an increase to employee compensation.

Warehousing and trucking input expenditures are not discrete goods, therefore existing consumption functions were used to estimate the distribution of expenses across industries. The warehousing expenditures were modeled using the warehousing and storage consumption function and the transport by truck industry consumption function was used for the trucking input expenditures. Scenarios for each congestion level were created in each model using the appropriate consumption function and expenditure values.
RESULTS

The strength of an I-O model comes from the vast amount of data that it contains to describe how all of the industries and institutions in an economy interact. These interactions allow the model to estimate the full impacts from a change in the economy. The direct costs are entered into the model as the changes to the primary industries (specified in the spending patterns). Multipliers are then used to calculate the direct, indirect, and induced impacts. Direct impacts are a measure of how the local economy is affected by changes to the primary industries. Indirect impacts are the changes that would occur to the industries that support the primary industries. Induced impacts quantify the economic changes that results from household incomes being altered in the direct and indirect phases.

In this case, freight dependant industries spend money on employees and inputs when transporting and storing goods to counteract increased congestion. This money is spent on goods that are supplied by local purveyors or imported. In turn, the local purveyors spend additional money on employees and inputs from inside and outside the local economy. Employees of the freight dependant industries and the purveyors also spend their additional income on goods and services from the local economy or imports. All of this additional spending is financed by in-state consumers that are paying higher prices for freight dependant goods and decreased profits.

The remainder of this paper discusses the economic impact estimates from increased congestion in Washington State. All of these estimates are annual figures in 2011 dollars and are based on 2008 IMPLAN datasets for Washington State and six regions of the state.

Statewide Model

There are several measures that can be used to discuss economic impact. Table 3 presents three of the most common measures for a 20 percent congestion increase in Washington. Employment is a straightforward metric that shows the number of full and part-time jobs affected by increased congestion for freight-dependent businesses. The net employment effect of a 20 percent congestion increase is a decrease of 27,256 jobs (0.7 percent). The value of economic output from the state decreases by $3.3 billion (0.5 percent). Total value added (sales minus cost of inputs) also decreases by $2.6 billion (0.8 percent).

As congestion increases to 30 and 40 percent levels, the losses increase substantially. An additional 10 percent congestion increase causes job losses of 40,859 and output to decrease by $4.9 (50 percent increase). A further 10 percent congestion increase would cut 57,239 jobs and decrease output by $7 billion (40 percent increase). The magnitude of all the economic impacts from congestion increases is large. However, the changes relative to the industry totals are reasonable.

Table 3 Summary Impact, 20 percent Congestion Increase.

<table>
<thead>
<tr>
<th>Impact Type</th>
<th>Employment</th>
<th>Value Added</th>
<th>Output</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Employment</td>
</tr>
<tr>
<td>Direct Effect</td>
<td>-49,033</td>
<td>-$4,259,110,941</td>
<td>-$7,051,171,371</td>
<td>-1.30%</td>
</tr>
<tr>
<td>Indirect Effect</td>
<td>11,146</td>
<td>$754,724,562</td>
<td>$2,167,768,066</td>
<td>0.30%</td>
</tr>
<tr>
<td>Induced Effect</td>
<td>10,631</td>
<td>$894,924,391</td>
<td>$1,568,440,631</td>
<td>0.30%</td>
</tr>
<tr>
<td>Total Effect</td>
<td>-27,256</td>
<td>-$2,609,461,988</td>
<td>$3,314,962,675</td>
<td>-0.70%</td>
</tr>
</tbody>
</table>
Table 4 shows the total impact for each industry in the state and the percentage change from their baseline employment and output. Almost half (10 to 11) of the industries have a change in employment and output of plus or minus one percent. The industries losing the most jobs, in percentage terms, are Health and Social Services, Educational Services, and Arts-Entertainment-Recreation. The 60 percent cost realization job losses in these industries range from 3.4 to 4.5 percent. These three industries also have the greatest percentage losses in output value, 4.1 to 4.9 percent.

These results are understandable considering that Health and Social Services expenditures are almost all local (84 percent) and it is the largest non-freight dependant household expenditure category second largest overall, (2). The Educational Services and Arts-Entertainment-Recreation expenditures are highly localized as well (63 and 83 percent, respectively). However, these industries are two of the smallest industries based on employment and output. Therefore, any decrease in household expenditures for these industries has a large effect.

Table 4 Total Impact by Industry, 20 percent Congestion Increase.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Employment</th>
<th>Output</th>
<th>Employment</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ag, Forestry, Fish &amp; Hunting</em></td>
<td>-1</td>
<td>$281,859</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td><em>Mining</em></td>
<td>67</td>
<td>$30,221,017</td>
<td>1.30%</td>
<td>1.80%</td>
</tr>
<tr>
<td><em>Utilities</em></td>
<td>-111</td>
<td>-$83,024,003</td>
<td>-2.10%</td>
<td>-2.00%</td>
</tr>
<tr>
<td><em>Construction</em></td>
<td>-516</td>
<td>-$63,877,436</td>
<td>-0.20%</td>
<td>-0.20%</td>
</tr>
<tr>
<td><em>Manufacturing</em></td>
<td>243</td>
<td>$1,266,264,942</td>
<td>0.10%</td>
<td>0.80%</td>
</tr>
<tr>
<td><em>Wholesale Trade</em></td>
<td>861</td>
<td>$173,828,805</td>
<td>0.60%</td>
<td>0.60%</td>
</tr>
<tr>
<td><em>Retail Trade</em></td>
<td>2,678</td>
<td>$237,128,393</td>
<td>0.70%</td>
<td>0.70%</td>
</tr>
<tr>
<td><em>Transportation &amp; Warehousing</em></td>
<td>8,595</td>
<td>$1,040,011,974</td>
<td>7.60%</td>
<td>6.20%</td>
</tr>
<tr>
<td><em>Information</em></td>
<td>-852</td>
<td>-$351,819,756</td>
<td>-0.70%</td>
<td>-0.60%</td>
</tr>
<tr>
<td><em>Finance &amp; Insurance</em></td>
<td>-2,403</td>
<td>-$601,477,474</td>
<td>-1.70%</td>
<td>-1.70%</td>
</tr>
<tr>
<td><em>Real Estate &amp; Rental</em></td>
<td>-4,566</td>
<td>-$2,012,319,651</td>
<td>-2.50%</td>
<td>-3.60%</td>
</tr>
<tr>
<td><em>Professional-Scientific &amp; Tech Svcs</em></td>
<td>-1,252</td>
<td>-$153,672,541</td>
<td>-0.50%</td>
<td>-0.40%</td>
</tr>
<tr>
<td><em>Management of Companies</em></td>
<td>169</td>
<td>$46,157,877</td>
<td>0.50%</td>
<td>0.60%</td>
</tr>
<tr>
<td><em>Administrative Services</em></td>
<td>4,062</td>
<td>$237,267,293</td>
<td>2.30%</td>
<td>2.00%</td>
</tr>
<tr>
<td><em>Waste Management</em></td>
<td>-38</td>
<td>-$9,805,661</td>
<td>-0.30%</td>
<td>-0.30%</td>
</tr>
<tr>
<td><em>Educational Svcs</em></td>
<td>-2,236</td>
<td>-$134,253,839</td>
<td>-3.60%</td>
<td>-4.10%</td>
</tr>
<tr>
<td><em>Health &amp; Social Services</em></td>
<td>-16,130</td>
<td>-$1,668,845,334</td>
<td>-4.50%</td>
<td>-4.90%</td>
</tr>
<tr>
<td><em>Arts-Entertainment &amp; Recreation</em></td>
<td>-2,795</td>
<td>-$252,897,663</td>
<td>-3.40%</td>
<td>-4.10%</td>
</tr>
<tr>
<td><em>Accommodation &amp; Food Services</em></td>
<td>-7,812</td>
<td>-$503,159,853</td>
<td>-3.20%</td>
<td>-3.30%</td>
</tr>
<tr>
<td><em>Other Services</em></td>
<td>-6,376</td>
<td>-$404,962,415</td>
<td>-3.00%</td>
<td>-2.80%</td>
</tr>
<tr>
<td><em>Government &amp; non NAICs</em></td>
<td>1,156</td>
<td>-$106,009,207</td>
<td>0.20%</td>
<td>-0.20%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-27,257</td>
<td>-$3,314,962,673</td>
<td>-0.7%</td>
<td>-0.5%</td>
</tr>
</tbody>
</table>

Seven industry sectors had positive changes to their employment. Administrative Services and Transportation and Warehousing are the only industries with employment job
changes greater than 2 percent, 2.3 and 7.6 percent respectively. Transportation and
Warehousing was the only industry with output values increasing by more than 3 percent. The
gains to freight dependant industries were expected as more resources are devoted to the
transportation of goods to combat congestion. The only freight dependent sectors with losses are
the Agriculture and Construction industries. The Agriculture industry losses are negligible;
however the Construction industry losses are not. This loss is largely attributable to the industries
interdependence with the Real Estate and Rental industry. The Real Estate and Rental sector
receives the third largest proportion of household expenditures (17 percent) and 95 percent is
spent locally. Two non-freight dependant industries, Administrative Services and Management
of Companies, show positive changes from increased congestion. Both of these industries
provide support services for businesses and benefit from the increased expenditure by freight
dependant businesses.

As congestion levels increase to 30 and 40 percent, the magnitude of the impacts also
increases (2). The relative order of industries being affected by congestion does not change.
Health and Social Services continues to take the largest losses in jobs (6.8 and 9.6 percent,
respectively) and output value (7.5 and 10.5 percent, respectively). Similarly, Transportation and
Warehousing gains in employment by 11.7 percent and 16.4 percent and output values grow by
9.5 percent and 13.4 percent.

It is important to note that all of the cost calculations are based on the survey responses
and relying heavily on the respondents’ ability to forecast cost changes for congestion increases
may be misleading. However, some general comments can be made. As congestion increases, the
number of industries negatively affected increases as does the severity of the losses. For
example, at a 20 percent increase in congestion, 38 percent of the industries have employment
losses greater than one percent; that percentage grows to 43 percent when congestion increases
by 40 percent. The average negative employment effect for those industries changes from 3-4
percent up to 6-8 percent as congestion increases from 20 to 40 percent. Correspondingly, the
industries that gain from congestion have average employment increases of 5 percent and 7-8 at
congestion levels of 20 and 40 percent respectively.

Regional Model

The trade flow matrix derived from the regional IMPLAN models contains a vast amount
of information on where goods are produced and used. These data allow us to allocate consumer
costs and societal benefits in the region where they are accrued. Subsequently, the magnitude of
the congestion impacts varies significantly across the regions.

**TABLE** Table 5 shows the total effect of congestion for the three primary metrics in each
region. All of the regions are negatively affected by increases in congestion, but the Puget Sound
faces the largest costs in both absolute and percentage terms. Their output decrease of $3.6
billion (0.8 percent) is greater than all other regions combined. The industries affected the most
in each region closely follow the state level results (2). At 20 percent congestion increases 10 of
the industries in each region have total employment and output effects of plus or minus one
percent of their baseline levels. For the industries with losses in excess of one percent, the
average employment and output effects range from 2 to 4 percent of the baseline level. Health
and Social Services, Educational Services, and Arts-Entertainment-Recreation industries
consistently have the largest percentage losses in all of the regions. However, the Real Estate and
Rental industry appears in 4 of the 7 regions as the second most affected for output losses. The
Accommodation and Food Service industry ranks as the third most affected industry in the Puget
Sound and Southeast regions for employment losses.
TABLE 5 Total Effect, 20 percent Congestion Increase, by Region.

<table>
<thead>
<tr>
<th>Region</th>
<th>Employment</th>
<th>Value Added</th>
<th>Output</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Employment</td>
<td>Value Added</td>
<td>Output</td>
<td>Employment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Value Added</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Output</td>
</tr>
<tr>
<td>Northwest</td>
<td>-1,786</td>
<td>-$163,102,595</td>
<td>-$162,360,385</td>
<td>-0.48%</td>
</tr>
<tr>
<td>Southwest</td>
<td>-1,622</td>
<td>-$174,475,347</td>
<td>-$265,810,407</td>
<td>-0.52%</td>
</tr>
<tr>
<td>Central Basin</td>
<td>-1,793</td>
<td>-$141,465,489</td>
<td>-$244,442,954</td>
<td>-0.47%</td>
</tr>
<tr>
<td>Northeast</td>
<td>-2,213</td>
<td>-$162,922,959</td>
<td>-$289,661,584</td>
<td>-0.77%</td>
</tr>
<tr>
<td>Southeast</td>
<td>-345</td>
<td>-$27,408,355</td>
<td>-$30,848,239</td>
<td>-0.31%</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>-21,741</td>
<td>-$2,305,044,223</td>
<td>-$3,639,269,096</td>
<td>-0.90%</td>
</tr>
<tr>
<td>Total</td>
<td>-29,500</td>
<td>-$2,974,418,968</td>
<td>-$4,632,392,665</td>
<td>-0.76%</td>
</tr>
</tbody>
</table>

The Administrative Services and Transportation and Warehousing industries consistently have the highest gains from congestion across the regions (20 percent congestion increases). Wholesale Trade and Mining industries also appear in at least two regions as one of the top three gaining industries. For the industries with gains in excess of percent, the average employment effects range from 3 to 6 percent and output effects range from 2 to 5 percent of the baseline level.

CONCLUSION

Washington’s economic vitality and livability depend on reliable, responsible, and sustainable transportation. Maintaining the transportation system at a level that allows for the safe, efficient movement of freight is an important component of this sustainable system. To this end, the findings of this study suggest several “lessons learned” and recommendations for WSDOT.

Congestion causes freight-dependent businesses, such as manufacturing, retail and wholesale trade, agriculture, construction, and timber/wood products, to operate less efficiently by increasing the amount of time for each truck trip and increasing the time that trucks (and drivers) spend in traffic, wasting time in an unproductive manner. This study estimates that a 20 percent increase in congestion experienced by commercial trucks would result in over $14 billion of increased operating costs to Washington’s freight-dependent industries. Since many freight industries have the ability to pass on their rising transportation costs in the form of higher cost goods, consumers and service industries may feel the biggest impacts from increasing congestion. When multiplied into economic impacts, this translates into losses of over 27,250 jobs (0.70 percent of statewide total) and $3.3 billion (0.51 percent of statewide total) (in 2011 dollars) in economic output.

Results suggest that economic impacts of rising congestion will be felt in every region of the State. However, they will be the most acute in the central Puget Sound Metropolitan region. The investment prioritization process should take this into account when selecting the most efficient projects to alleviate congestion. An increase of 20 percent over today’s congestion levels is projected to cause over 21,700 job losses (0.90 percent of the Puget Sound regional total), as well as decreased regional output of over $3.6 billion (0.82 percent of the Puget Sound region’s total output). The other five regions in Washington would see decreased regional output of between $31 million and $290 million (between 0.21 percent and 0.80 percent of each region’s total output), and would cause each region to lose between 345 and 2,200 jobs (between...
0.31 percent and 0.77 percent of each region’s total jobs).

These demonstrated economic impacts suggest that WSDOT should prioritize investments that enhance mobility for trucks and freight industries as a way to support the State’s goals of a strong economy. Washington State law directs public investments in transportation to support economic vitality, preservation, safety, mobility, the environment, and system stewardship. A demonstrated economic link between truck congestion and increased costs to consumers and industry means that WSDOT could prioritize investments that enhance the mobility of trucks.
REFERENCES
