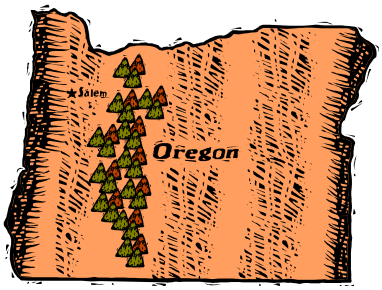
Oregon Freight Plan Modeling Analysis Technical Memo



Prepared for the ODOT Freight Mobility Unit

Prepared by the ODOT Transportation Planning Analysis Unit

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Executive Summary

The purpose of the Oregon Freight Plan analysis is to gain an understanding of the spatial land use and transportation implications of different economic conditions. This analysis illustrates the variation in statewide and regional activity and commodity flow in order to help evaluate the risk associated with economic volatility on alternative Freight Plan strategies. Decision makers will be able to better assess the robustness of freight strategies and avoid the creation of barriers that may prohibit the freight industry from reacting nimbly to economic change.

The StateWide Integrated Model 2 (SWIM2) was used for this analysis. Four model scenarios were produced: business-as-usual Reference; Optimistic Economic Forecast; Pessimistic Economic Forecast; and High Transportation Cost. Highlights of the analysis findings include:

- Future demands on the freight system will be large, even if economic growth is muted. Economic inertia causes the dominant commodity mix and geographic flow patterns in Oregon to remain intact, with relatively small changes over time under various scenarios.
- Higher per-mile highway transportation costs result in less congestion, providing the impetus for shippers to increase the length of individual truck tours to increase operating efficiency Higher transport costs result in reduced miles of travel and hours of travel statewide.
- Households relocate to reduce transport costs, causing urban density to rise and statewide auto miles of travel to fall.
- Commodities have unique and diverse patterns and logistics. Transportation services used to move these commodities are just as varied. Maintaining access to markets is key to economic competitiveness. Larger urban areas produce the state's top commodity Machinery, Instruments, Transportation Equipment, and Metals. Oregon production of Food and Kindred Products occurs in Central, East, and Northwest Oregon. Forest or Wood Products are produced in Southwest, South, and Central Oregon.
- Some regions have dominant industries, making them more susceptible to economic risk associated with these industries. This is evident for the dominant urban industry of Machinery, Instruments, Transportation Equipment and Metals, and the Eastern Oregon dominance of Food and Kindred Products
- The net results of thousand of shippers and buyers of goods and services are complex and at times counter intuitive. Modeling the dynamic nature of these forces provides valuable insight into the collective Oregon freight system needs.
- Oregon sells goods outside the state: Oregon is projected to export nearly 60% of goods produced in terms of value.
- Oregon buys goods from outside the state: Oregon is projected to import about 70% of all goods consumed within the state. This heavy global trading will require reliable highway, rail, air, and waterway systems.
- Assessing system performance and economic impacts is multifaceted. Attention must be given to regional issues, commodity characteristics, industry logistics, and employment patterns when evaluating alternative strategies.
- The largest commodity flows are on the I-5 and I-84 corridors, with significant flows on US-97 and US-20
- Highway traffic congestion will increase in the future under all scenarios. A slower economy will reduce congestion growth rates and an increase in transportation cost will slow congestion growth even more

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Oregon Freight Plan Modeling Analysis

Introduction

The purpose of this analysis is to gain an understanding of the spatial land use and transportation implications of different economic conditions. This analysis illustrates the variation in statewide and regional activity and commodity flow in order to help evaluate the risk of economic volatility to alternative Freight Plan strategies. The focus is not identifying the causes and effects on particular industries or commodity groups. The objective is to illustrate the variation of forecasted statewide and regional activities and commodity flows and the risk associated with economic uncertainty. This information will be used to evaluate alternative Freight Plan strategies and support formulation of policies sustaining the economic resilience of Oregon's freight system. Decision makers will be able to better assess the robustness of freight strategies and avoid the creation of barriers that may prohibit the freight industry from reacting nimbly to economic change.

Modeling Analysis Overview

The ODOT Transportation Planning Analysis Unit has a variety of tools available for analysis. The second generation StateWide Integrated Model (SWIM2) was used for the Freight Plan analysis to evaluate future conditions and identify implications for freight movement in Oregon. SWIM2 is an integrated model, incorporating land use, the economy and the transportation system into one dynamic environment. This tool supports analysis that accounts for the intricate connections and feedbacks amongst these three areas of activity. More information on the history, development and characteristics of the SWIM2 is provided in Appendix A.

SWIM2's integrated framework makes it ideal for illustrating economic activity, commodity flow patterns, travel and land use patterns at the state and regional level. This analysis tool is used to explore the potential risks to the Oregon freight system by evaluating the impacts of various economic forecasts on Oregon freight patterns. Further detailed analysis at the transportation facility level or within specific metropolitan areas would require additional time and analytical tools, such as metropolitan travel demand models.

The approach to this analysis is to use SWIM2 to evaluate hypothetical scenarios in order to provide a broad spectrum of potential futures. These alternative futures serve as "book ends," providing a range of conditions to be considered for long-range freight planning. This enables decision makers to identify areas of concern and formulate strategies to mitigate such conditions, if they were to arise. This supports the goal of creating a nimble long-range plan in the face of uncertainty. Information from scenario analysis will reveal how different areas of the state are affected, as well as the state as a whole. Decision makers will be able to better assess the robustness of freight strategies and avoid the creation of barriers that may prohibit the freight industry from reacting nimbly to change.

The first step of analysis is to create a Reference scenario representing business-as-usual, with which the other scenarios will be compared. This makes it easier to evaluate alternative futures when comparing conditions to a future based on current laws, general patterns and conditions.[1] Three other analysis scenarios were created using SWIM2: Optimistic Economic Forecast, Pessimistic Economic Forecast and a High Transportation Cost scenarios. The initial planned analysis included a forth

[1] An example of other statewide planning analysis can be found in the "Oregon Transportation Plan," adopted September 20, 2006.

scenario with higher levels of activity in key industries. However, once the Optimistic scenario was reviewed, the analysis team determined this additional scenario would not be different enough from the Optimistic scenario to significantly contribute to the analysis. The model was run out to year 2027 instead of 2035 to reduce runtime and expedite analysis. By year 2027 the long-range trends were evident enough to form robust analytical conclusions.

The following section presents detailed descriptions of the analysis scenarios and key findings. Brief descriptions of the Oregon Freight Plan scenarios are as follows. It should be noted that this analysis did not account for the impact of the economy or higher transport costs on freight mode split. Brief descriptions of the Oregon Freight Plan scenarios are as follows:

Reference Scenario: "business-as-usual" forecast of Oregon activity based on current trends and policies. Oregon's economy grows in accordance with the Office of Economic Analysis state forecast; the rest-of-the-world grows at rates consistent with national forecasts. Urban growth boundaries maintain 20-year land supplies. Projects in the Statewide Transportation Improvement Plan and Oregon Transportation Investment Act programs are built, but limited additional modernization will occur; the system will be operated similar to today. Transportation costs will remain stable. This forecast assumes the economy suffers no major shocks over the next twenty-five years. It grows smoothly over time and follows a similar pattern of long-run activity observed over the past 20 years; accounting for the current recession's dampening effects. SWIM2 industry output grows at a compound annual growth rate (CAGR) of 2.0%.

Optimistic Scenario: assumes a higher average economic growth rate than the Reference scenario, resulting from optimistic assumptions associated with changes in technology, faster productivity gains, and lower inflation. SWIM2 industry output grows at a CAGR of 2.7%.

Pessimistic Scenario: assumes a lower average economic growth rate than the Reference scenario, resulting from pessimistic assumptions associated with changes in technology, slower productivity gains, and higher inflation. SWIM2 industry output grows at a CAGR of 1.2%.

High Transport Cost Scenario: assumes the variable cost per-mile for highway transportation increases three-fold. The cause of such an increase is unspecified. It is treated as an increase in generalized network costs, which could be caused by higher fuel prices (all else being equal), mileage taxes, or emission taxes. The assumption is the higher costs are global, apply equally to all highway vehicles, and do not put Oregon at a competitive disadvantage. The higher transport costs were added to the Pessimistic scenario to reveal the added effects of higher transport costs when coupled with a weak economy.

Oregon Freight Plan "Business-As-Usual" Reference Scenario

The Freight Plan Reference scenario represents a forecast based on "business-as-usual" for Oregon. It serves as the basis of comparison for the other analysis scenarios. The Reference activity modeled using SWIM2 represents a likely future of Oregon activity given current trends and policies. Any forecast beyond a few years is subject to variability in the literal sense. However, such forecasts are quite useful when comparing system performance when specific changes occur, such as economic conditions or public policy. The scenarios can be used to reveal how long term trends are affected by change in terms of direction and magnitude, As such, they are helpful for "what if" analysis needed for long-range planning, such as the Oregon Freight Plan. The Reference scenario represents activity consistent with the most recent state forecasts of economic conditions, land use patterns, and transportation system investment. This scenario serves as a reasonable and understandable basis of comparison for other potential futures.

In order to create the Reference scenario, the following inputs were used:

- Employment figures are consistent with the "Oregon Economic and Revenue Forecast, March 2009" produced by the Office of Economic Analysis, Oregon Department of Administrative Services.[2]
- Outside of Oregon forecast is consistent with the IHS Global Insight forecast used for the Oregon March 2009 economic forecast. This forecast assumes the economy suffers no major mishaps over the next twenty-five years. It grows smoothly over time and follows a similar pattern of long-run activity observed over the past twenty years.
- Statewide commodity flows are consistent with the base year updated "Oregon Commodity Flow Forecast," October 2009[3].
- Transportation system maintenance, preservation and improvement assumptions are consistent with the current Statewide Transportation Improvement Plan (STIP), Metropolitan Transportation Improvement Plans (MTIP), and local capital improvement plans. Longer-term investment assumptions are consistent with the Oregon Transportation Plan (OTP), and Transportation System Plans (TSP.)
- Transportation costs are assumed to remain fairly stable over time in real [4]terms, consistent with IHS Global Insight national forecast.
- Urban growth boundaries maintain 20-year land supplies.
- Variation caused by business cycles is not forecasted, only average annual changes over time.

Further detail on the structure of the SWIM2 can be found in Appendix A. No significant changes to the SWIM2 structure were made for this analysis, only model input data were altered.

[2] http://www.oregon.gov/DAS/OEA/docs/economic/forecast0309.pdf
[3] http://www.oregon.gov/ODOT/TD/FREIGHT/docs/CF_TM_1.pdf
[4] "real" in this sense means inflation adjusted

Industry Employment and Output

Table 1 illustrates employment shares by industry category across the state. Personal & Other Services cover the largest proportion of jobs across the state, with Retail Trade coming in at a close second. These two industries plus Finance, Insurance, Real Estate (FIRE), Business & Professional Services; and Health Services include over half of the state employment. Over eighty-five percent of the total state employment falls into the top 11 industry categories presented in Table 1. The statewide share of employment remains fairly stable over time across the industries; with the exception of Personal & Other Services increasing from 17% in year 2015 to 24% in 2035. Retail Trade has a slightly reduced proportion of employment over time, changing from 18% in year 2015 to 15% in year 2030.

Table 1. Statewide Employment by Industry: Percent of Total Employment

	Standard Industry Classification (SIC)	2015	2025	2035
1	Personal & Other Services & Amusements	17%	21%	24%
2	Retail Trade	18%	16%	15%
3	FIRE, Business & Professional Services	10%	10%	11%
4	Health Services	7%	6%	6%
5	Government	6%	6%	5%
6	Agriculture & Mining	6%	5%	5%
7	Other Durables	4%	5%	5%
8	Construction	6%	5%	5%
9	Lower Education	5%	5%	5%
10	Wholesale Trade	4%	5%	4%
11	Transport	4%	4%	4%
12	Electronics & Instruments	3%	2%	2%
13	Other Non-Durables	2%	2%	2%
14	Communications & Utilities	2%	2%	2%
15	Higher Education	2%	2%	1%
16	Accommodations	1%	1%	1%
17	Lumber & Wood Products	2%	1%	1%
18	Food Products	1%	1%	1%
19	Home-based Services	<1%	1%	1%
20	Pulp & Paper	<1%	<1%	<1%
21	Forestry & Logging	<1%	<1%	<1%

Table 2 presents economic activity with respect to the value of industry output statewide.[5] Oregon economic activity by output value is fairly concentrated in the Wholesale Trade and Distribution industry. The share of this industry's output is expected to grow to nearly a fourth of the total value of output. The top three largest industries in terms of industry output: Wholesale Trade; FIRE, Business

[5] The value of industry output is a common measure of economic activity, more commonly referred to as gross state product. For purposes of this memo, the term "industry output" will be used to differentiate between SWIM2 forecast output and other state forecasts for gross state product.

& Professional Services; and Retail Trade, make up about half of the total value of industry output for Oregon.

Personal Services has a much larger share of the state's employment than the state's industry output. This indicates a more labor-intensive, lower wage sector. Conversely, Wholesale industry's labor has a higher proportional impact on the state economy per employee.

Table 2. Statewide Industry Output by Industry: Percent of Total Output Value

	Standard Industry Classification (SIC)	2015	2025	2035
1	Wholesale Trade	16%	21%	23%
2	FIRE, Business & Professional Services	15%	15%	15%
3	Retail Trade	17%	15%	14%
4	Electronics & Instruments	9%	9%	8%
5	Communications & Utilities	5%	5%	5%
6	Personal & Other Services & Amusements	5%	5%	5%
7	Construction	5%	5%	4%
8	Government	5%	4%	4%
9	Health Services	4%	4%	4%
10	Other Durables	4%	3%	3%
11	Transport	3%	3%	3%
12	Lower Education	2%	2%	3%
13	Other Non-Durables	2%	2%	2%
14	Agriculture & Mining	3%	2%	2%
15	Food Products	2%	2%	1%
16	Pulp & Paper	1%	1%	1%
17	Lumber & Wood Products	1%	1%	1%
18	Accommodations	1%	1%	1%
19	Higher Education	1%	<1%	<1%
20	Forestry & Logging	<1%	<1%	<1%
21	Home-based Services	<1%	<1%	<1%

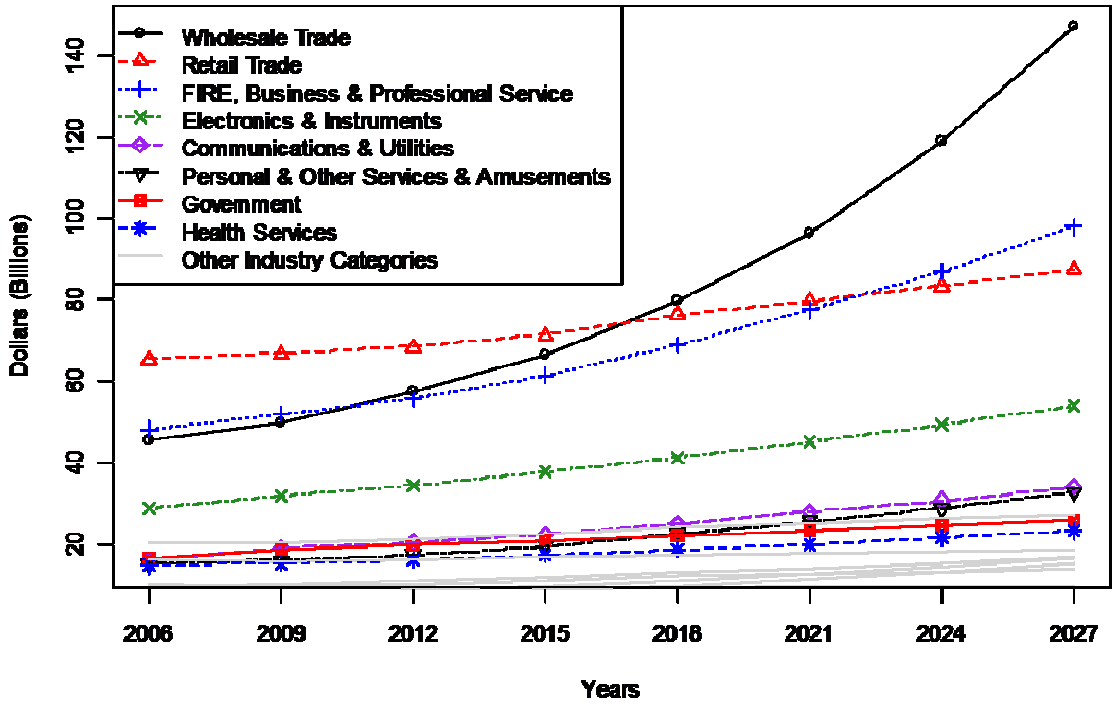
The next four largest industries include: Electronics & Instruments; Communications & Utilities; Personal & Other Services & Amusements; and Construction: which account for another 25% of total industry output value. The remaining fourteen industry groups account for the 25% of industry output by value.

Table 3 presents the top Oregon industries by employment and value of industry output for the state side-by-side. These eight industries represent over two thirds of the state employment and over three fourths of total industry output. These industries cover a broad set of freight needs, while the concentration of industries varies by Oregon location.

Table 3. Top Industries for Employment and Industry Output Value				
	Reference Scenario Year 2015			
	Share of State Employment	Rank	Share of Industry Output Value	Rank
Personal & Other Services & Amusements	17%	1	5%	6
Retail Trade	18%	2	17%	3
FIRE, Business & Professional Services	10%	3	15%	2
Health Services	7%	4	4%	9
Government	6%	5	5%	8
Wholesale Trade	4%	10	16%	1
Electronics & Instruments	3%	12	9%	4
Communications & Utilities	2%	14	5%	5
Total Statewide Share	67%		76%	

Figure 1 illustrates the change in the value of output by industry group over time for the largest industries of Oregon as presented in Table 3. These eight industry groups represent the top five industries by employment and industry output. The top three groups are Retail Trade; Wholesale Trade; and FIRE, Business and Professional Services. Retail Trade is expected to remain a large part of the Oregon economy into the future, but growth will be moderate. Wholesale Trade is expected to grow the fastest, and become the dominant industry in the future. FIRE, Business and Professional Services is expected to grow at a healthy rate and increase its future share of Oregon industry activity. Electronics and Instruments is expected to grow at a steady rate, similar to Retail Trade. The remaining four industries are expected to retain their share of activity into the future at moderate growth rates.

Figure 1. Industry Output Values Over Time



Some of these industries are more susceptible to business cycle fluctuations in industry output and employment than others. These patterns are revealed in the Optimistic and Pessimistic scenarios presented later in this memo, as well as at the regional level when results are reviewed for the ACTs.

Highway Travel Patterns

Table 4 presents the average truck travel times and distances reported out of SWIM2. Statewide travel patterns are expected to change, given the "business-as-usual" patterns continue into the future. Average truck tour[6] travel time is expected to increase about eight percent over the next twenty-five years, while tour travel distance is expected to decrease about ten percent. Congestion means truck tours are less efficient, serving fewer stops per tour, leading to larger than necessary increases in truck vehicle miles traveled (VMT) and vehicle hours traveled (VHT.) Auto travel patterns are expected to change as well. Average auto tour travel times are forecasted to increase thirteen percent, while average distance is expected to decrease about six percent. The rising travel times and decreasing distances indicate increasing congestion faced by highway users in the future, given Oregon continues with business-as-usual.

Table 4. Reference Scenario: Forecast Average Travel Times and Trip Distances

	Trucks		Autos	
	Average Tour Travel Time	Average Tour Distance	Average Tour Travel Time	Average Tour Distance
2012	12 hours	380 miles	30 minutes	15 miles
2027	13 hours	345 miles	34 minutes	14 miles
Change	8% increase	10% decrease	13% increase	6% decrease

Total statewide VMT are expected to rise at a CAGR of about two percent. Total statewide VHT are expected to rise at a CAGR of about three percent. Table 5 presents forecast growth for VMT and VHT along side major economic indicators Change in VMT closely follows economic activity, a pattern observed in past studies as well. The higher growth rate for hours traveled indicates the effect of increasing congestion.

Table 5. "Business-As-Usual" Forecast Compound Annual Growth Rates 2010 – 2035

	Statewide	Trucks	Autos
Vehicle Miles Traveled	2.0%	2.3%	1.9%
Vehicle Hours Traveled	3.1%	3.1%	3.1%
Industry Output	2.0%		
Employment	1.4%		
Population	1.4%		

Statewide VMT for trucks are expected to increase faster than auto VMT (2.3% vs. 1.9%), while VHT are forecasted to increase at a CAGR of 3.1% for trucks and autos alike. The difference in growth rates between miles traveled and travel time reveal the effects of increasing congestion.

[6] Travel is modeled as "tours" instead of trips to reflect the logistic behavior of trucks and autos. A tour starts at "home base," includes trips that start and stop within the tour, ending back at home base.

Reference Scenario Commodity Flow

Figure 2 illustrates commodity movement from, to and within Oregon for all freight modes, including exchanges with both foreign and domestic trade partners. Commodities outbound are produced in Oregon for sale elsewhere. Inbound commodities represent commodities used on Oregon production activity as well as goods for final sale. The largest commodity group by value is the Machinery, Instruments, Transportation Equipment and Metals category, for all three directions of movement. Outbound and internal flows of Food and Kindred Products are expected to maintain a steady rate over time, but inbound flows will increase. Other Miscellaneous goods include textiles, leather, furniture, mattresses, and miscellaneous manufactured products. This commodity group is expected to increase in the rate of inbound goods. Figure 2 reveals Oregon inbound goods are expected to grow faster than Oregon outbound goods. This may be caused by Oregon's relatively high level of economic activity in service industries relative to manufacturing.

Figure 2. Oregon Commodity Flow by Direction

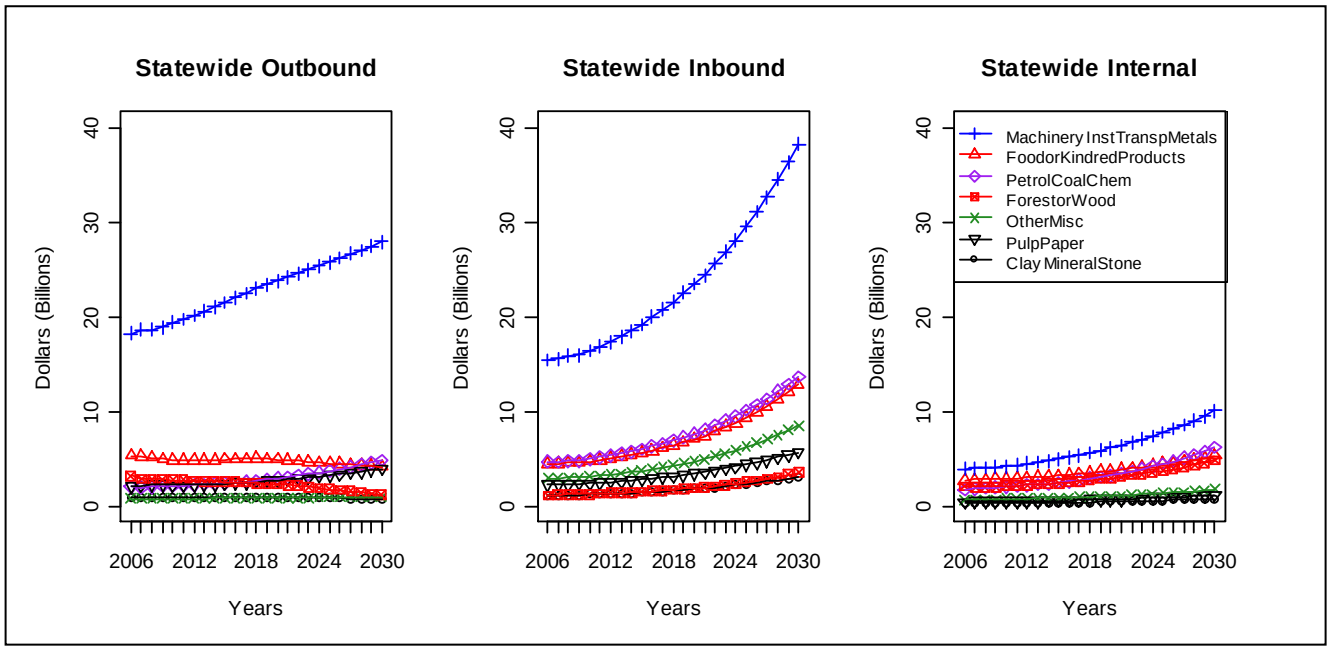
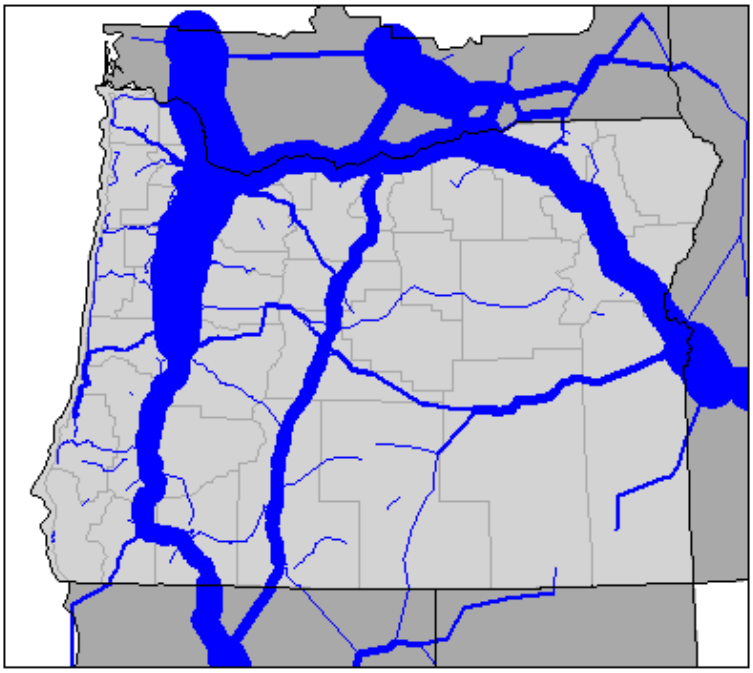


Figure 3 illustrates the relative flow of all commodities via highways in Oregon and into the bordering areas. The importance of the interstate corridors is evident. Figures 4 through 10 show average daily statewide highway (trucks) commodity flow by value and tonnage for years 2012 and 2027 for each of the seven commodity groups. Over three-fourths of commodity flow is via truck. Detailed description of commodity flows by truck and other freight modes, such as rail, air and water are provided in the Commodity Flow Forecast Update. Detailed listing of how commodities are classified and grouped is provided in Appendix B.[7] Note that the figures are not scaled relative to each other. Doing so conceals activity in the lower volume commodities.

Figure 3. Highway Commodity Flows

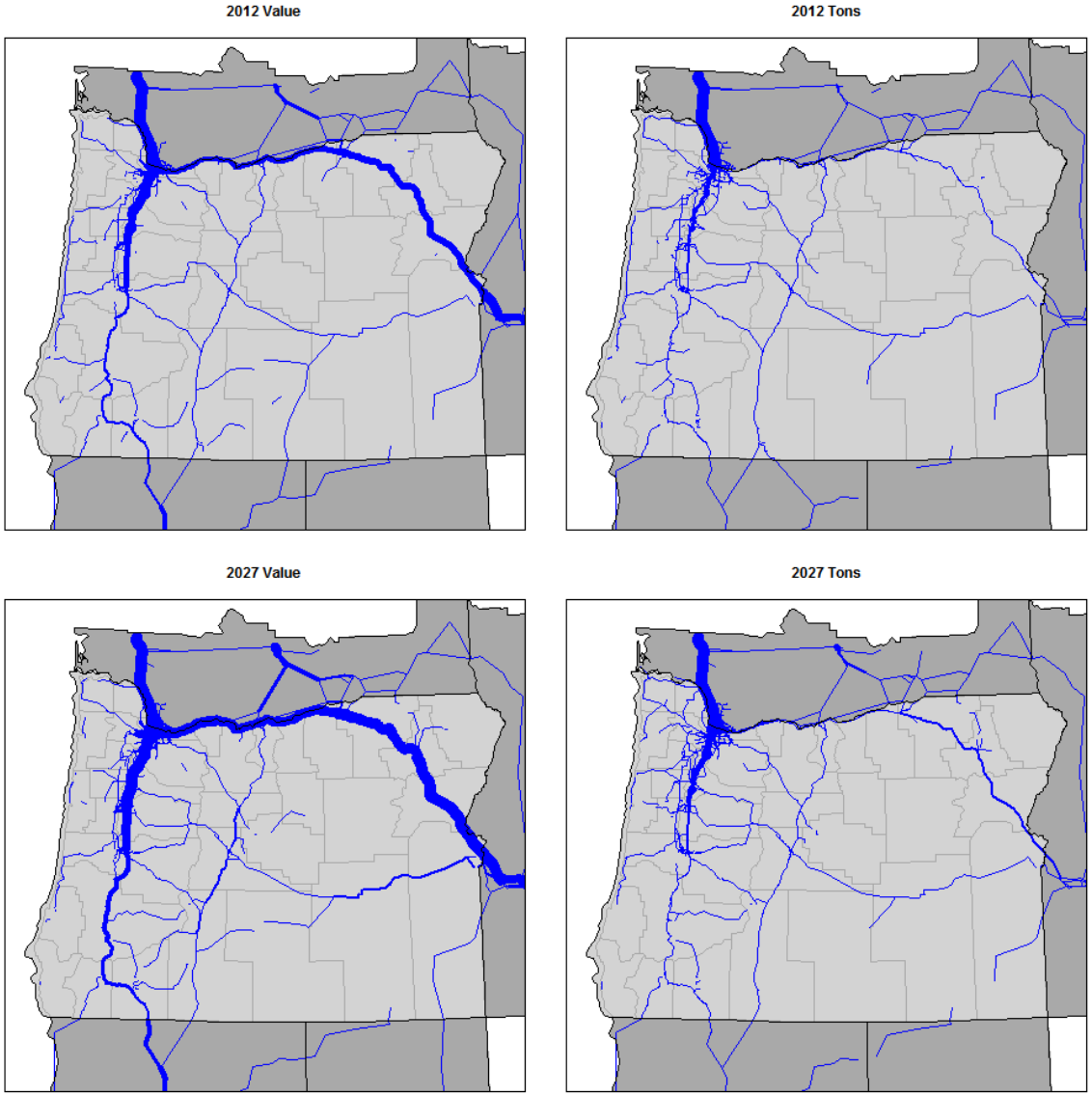


[7] SWIM2 uses the SCTG commodity classification, which is a little different from the STCC commodity classification used for the CFF. This report often uses 7 Commodity Groups, which are can be compared across classification systems. Further detailed description of the codes can be found in :SCTG Commodity Codes" booklet, 2007 Commodity Flow Survey, USDOT
http://www.bts.gov/publications/commodity_flow_survey/survey_materials/pdf/sctg_booklet.pdf

Figure 4 presents highway flows for the Machinery, Instruments, Transportation Equipment and Metals commodity group. Commodities within this category include base metal in primary or semi-finished form; articles of base metal; machinery; electronic and other electrical equipment; motorized and other vehicles (including parts); transportation equipment; precision instruments and apparatus. This commodity group is the largest group by value for flows outbound, inbound and internal to the state (as previously shown in Table 2).

The value maps illustrate commodity flow in terms of total value of goods moving on an average day. The tons maps illustrate this same movement but in terms of weight in tons. The industries producing these commodities are predominantly located in the urban areas of the Willamette Valley, with some located in Bend, Astoria, and Medford. These goods are primarily trucked to Washington and Eastern states. It is evident in these flow maps the Machinery, Instruments, Transportation Equipment and Metals commodity group tends to be higher in value and lower in weight. Commodity flows by value predominantly move in the Willamette Valley corridor and on I-84. However, the heavier goods movement within this commodity group tends to flow in the Willamette Valley I-5 corridor and north of Portland. Future flows magnify this pattern, with the addition of a notable amount of additional flows on the southern portion of the I-5 corridor and I-84. Also evident is an overall increase in forecast

Figure 4. Machinery, Instruments, Transportation Equipment, Highway Flows

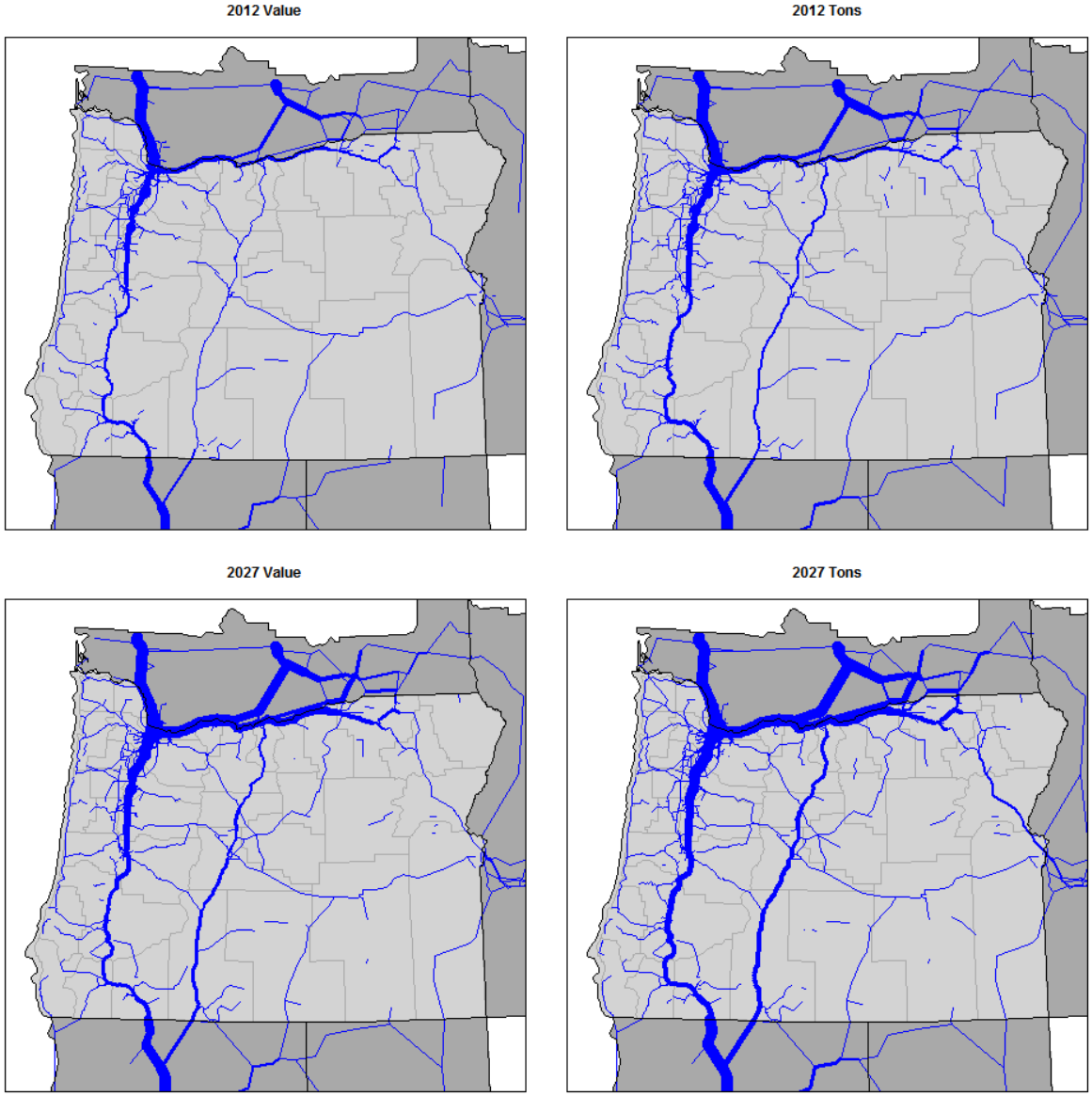


flows on the non-interstate highway system. These flows are forecast to increase in all three directions – outbound, inbound and internal.

Figure 5 presents highway flows for the Food and Kindred Products commodity group. Commodities within this category include live animals and fish; cereal grains; animal feed; meat, seafood; milled grain products; alcoholic beverages; and tobacco products. This group represents a wide range of products in terms of value and weight. As a group, the commodity represents a mid-range value per unit weight. Food and Kindred products are the second highest commodity group in terms of value for Oregon after Machinery.

Dominant production of these agriculture and food products is in the eastern and central areas of the state, as well as northwest Willamette Valley to Astoria. The flow maps reveal the most active highway corridors include the north-south I-5 corridor, particularly in the Willamette Valley area and southern central Washington State. However, there is considerable flow toward California from I-5 and US-97, as well as movement from the Portland area on I-84 to I-82 heading north into Washington. This pattern holds into the future and reveals even more commodity flows are forecast for this industry

Figure 5. Food and Kindred Products Highway Flows



in Oregon. Outbound flows are expected to remain the same level into the future, while inbound and internal flows are expected to increase a little in the future.

Figure 6 presents highway flows for the Petroleum, Coal, and Chemicals commodity group. Goods classified in this group include crude petroleum; gasoline and aviation fuel; fuel oils; pharmaceutical products; fertilizers; and plastics and rubber. This commodity group represents a mix of goods, and is characterized as a medium value-to-weight commodity. Commodity flow is predominantly from outside the state and flows in from the north on I-5 to the Willamette Valley corridor. There are flows east of Portland on I-84 and heading north into Washington State via US-97 and I-82.

Forecast flows for this commodity group appear to follow the current patterns of flow, with more flows moving south on I-5 from the Medford area into California as well as the southern portion of the Willamette Valley I-5 corridor between Salem and Eugene. The flows between Salem and Eugene show up on the value map and less on the tonnage map, implying the increased commodity flows are likely from the higher value, lower weight categories within the commodity group, such as pharmaceutical products. Statewide flows are expected to increase in the future at fairly low rates for outbound and internal, but inbound flows are expected to increase noticeably, at the same rate as Food and Kindred Products.

Figure 6. Petroleum, Coal and Chemicals Highway Flows

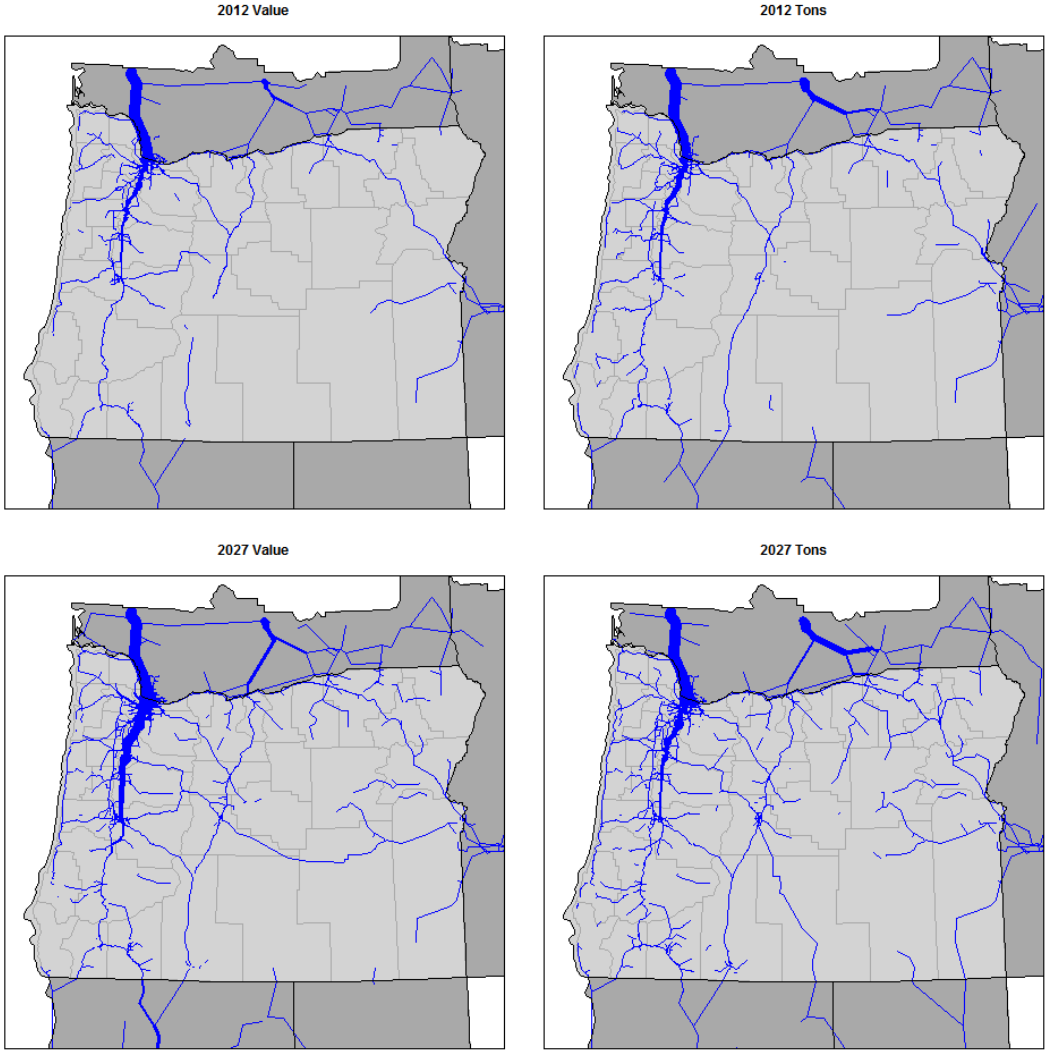


Figure 7 presents highway flows for the Other/Miscellaneous commodity group. Goods classified within this group include textiles; leather, articles of textiles or leather; furniture; mattresses; and miscellaneous manufactured products. Flows of this commodity group range across the entire state. More flows are concentrated in the Willamette Valley corridor of I-5. There is a notable high-value flow of this commodity on I-84. Lower value flows occur within the southern half of the I-5 corridor. Large lower value flows are forecast for this commodity group on the entire I-5 corridor, especially the southern portion. Significantly more high-value flow is forecast on the I-84 corridor, especially between the I-82 connection and Oregon/Idaho boundary. Statewide this commodity group is not expected to increase in outbound flows. However, inbound and internal flows are forecast to increase across the state.

Figure 7. Other Miscellaneous Goods Highway Flows

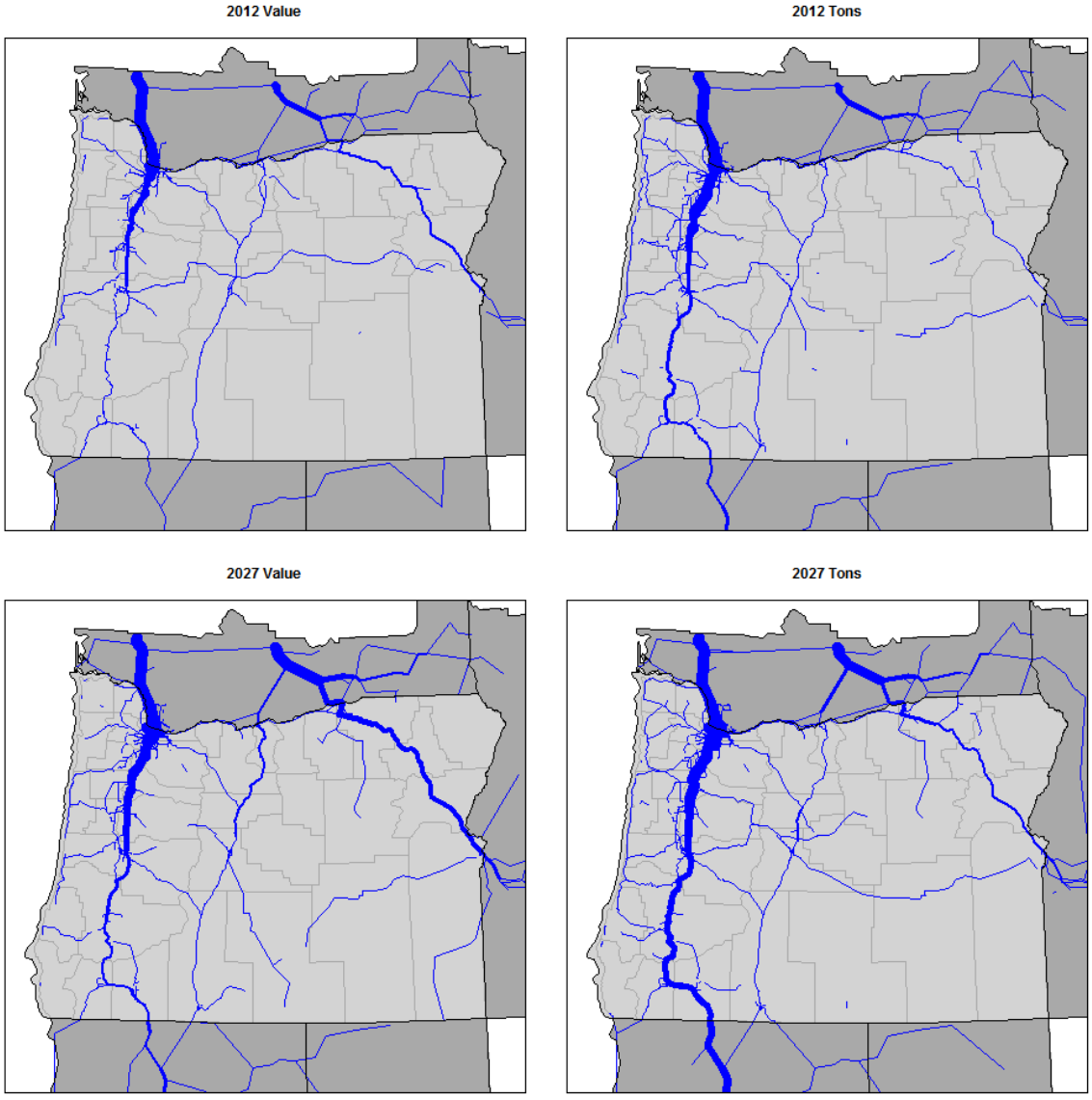


Figure 8 presents truck flows for the Pulp and Paper Products commodity group. Goods classified in this group include newsprint; paperboard; paper or paperboard products; and printed products. Northwest Oregon is a heavy production area for these products. Truck flows of this commodity group are concentrated in the upper Willamette Valley corridor of I-5 and further north into Washington State. The value maps reveal there is movement for this commodity dispersed across a wide range of locations in the state. Less movement is revealed when viewing flows by weight, as indicative of low value-to-weight goods. However, southern I-5 reveals some lower value-to-weight flows, while I-84 exhibits some higher value-to-weight flows in this commodity group. The central and southern ACTs have notable flows related to this commodity group, which is carried across the state. Statewide growth in this commodity category is expected to grow a little, although this is one of the more slowly growing groups. Flow is expected for grow for all directions of movement, outbound, inbound and internal.

Figure 8. Pulp and Paper Products Highway Flows

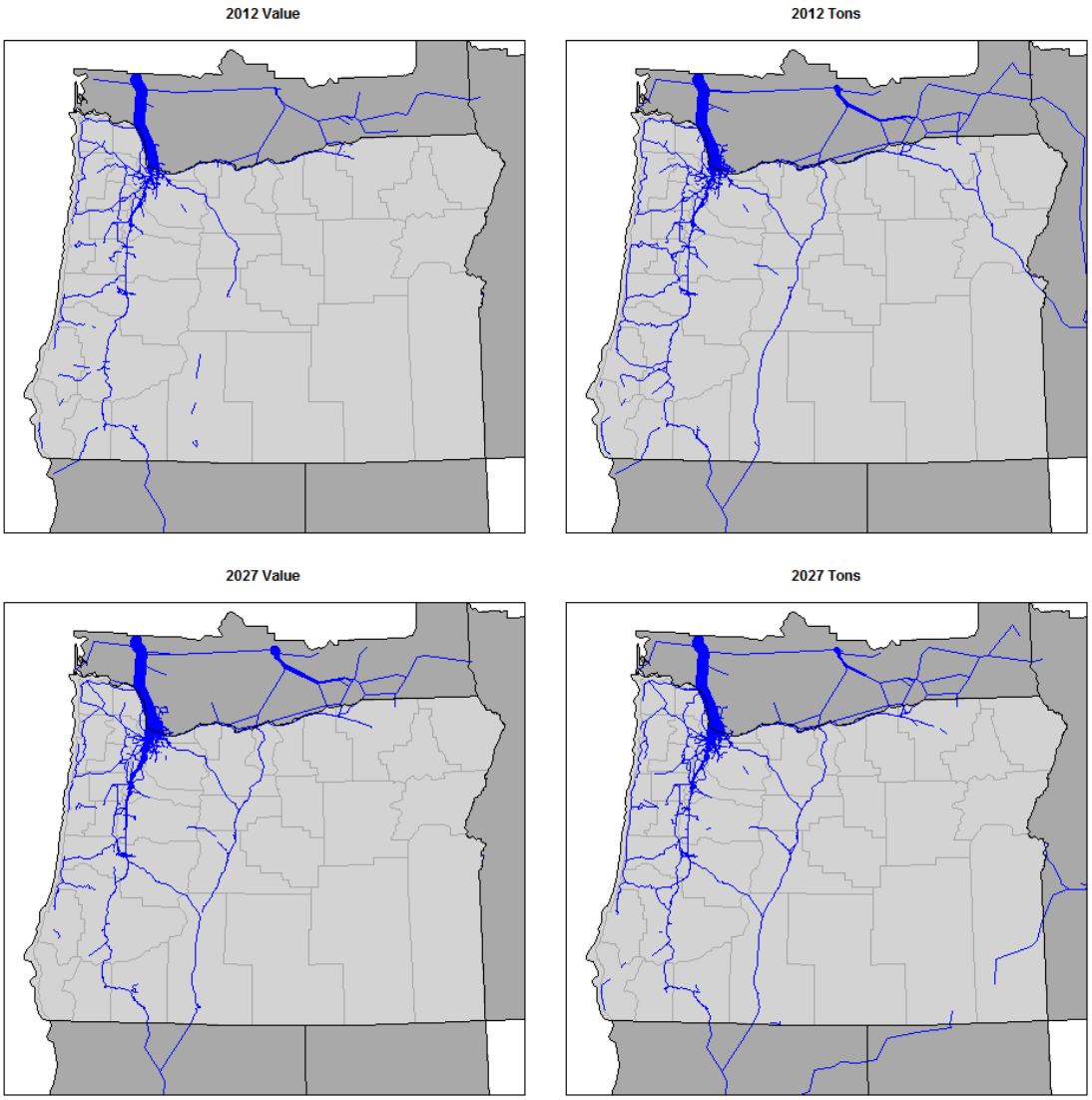


Figure 9 presents flows for the Forest or Wood Products commodity group. Goods classified within this group include logs and other wood in the rough and wood products. Production of these goods is concentrated in the southeast corner of the state. Whether you view this commodity by value or weight, the corridor of I-5 between Roseburg and Portland accommodates a large proportion of the daily flows for this commodity group, with links to the coast and the west side of the Cascades. There is significant amount of flow from the Cascades on US-20 toward Salem. The flow is more pronounced when looking at movement in tons, since this commodity group typically has a low value-to-weight ratio. Outbound flows are expected to remain about the same over time. Some increase in inbound flows is expected, but internal flows are anticipated to significantly increase at rates similar to Food and Kindred Products. This forecast flow is evident in the year 2027 flow maps which illustrate increased flows in the Willamette Valley corridor and continuing south on I-5 to the city of Roseburg. Flows between Salem and the Cascades increase in magnitude on the US-22 corridor, as well as on a segment of US-26 linking US-97 to the Portland area. There are noticeable increases in flows from several corridors leading to I-5 from the Coast Range, including US-26 west of Portland and OR-18 through Yamhill county.

Figure 9. Forest or Wood Products Highway Flows

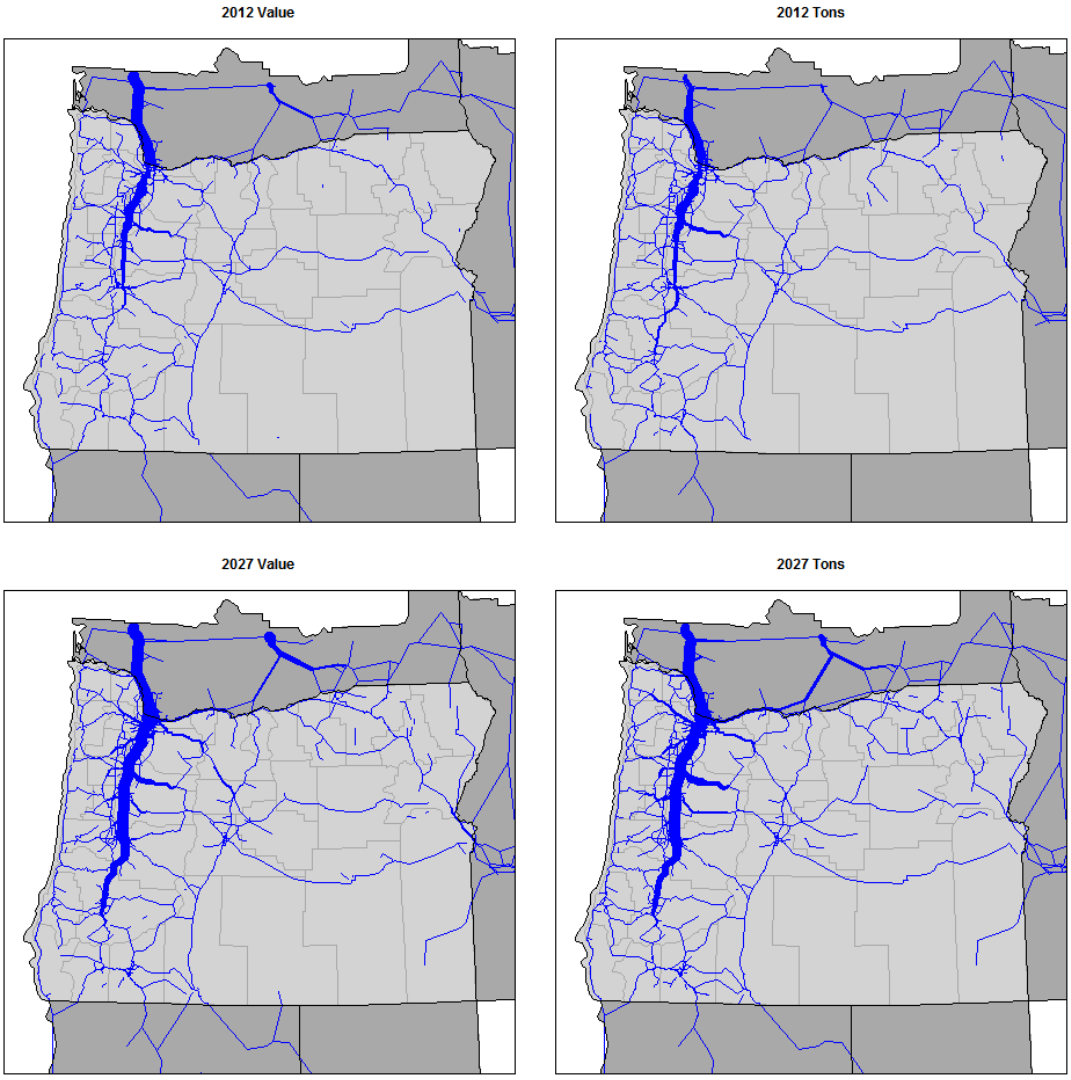
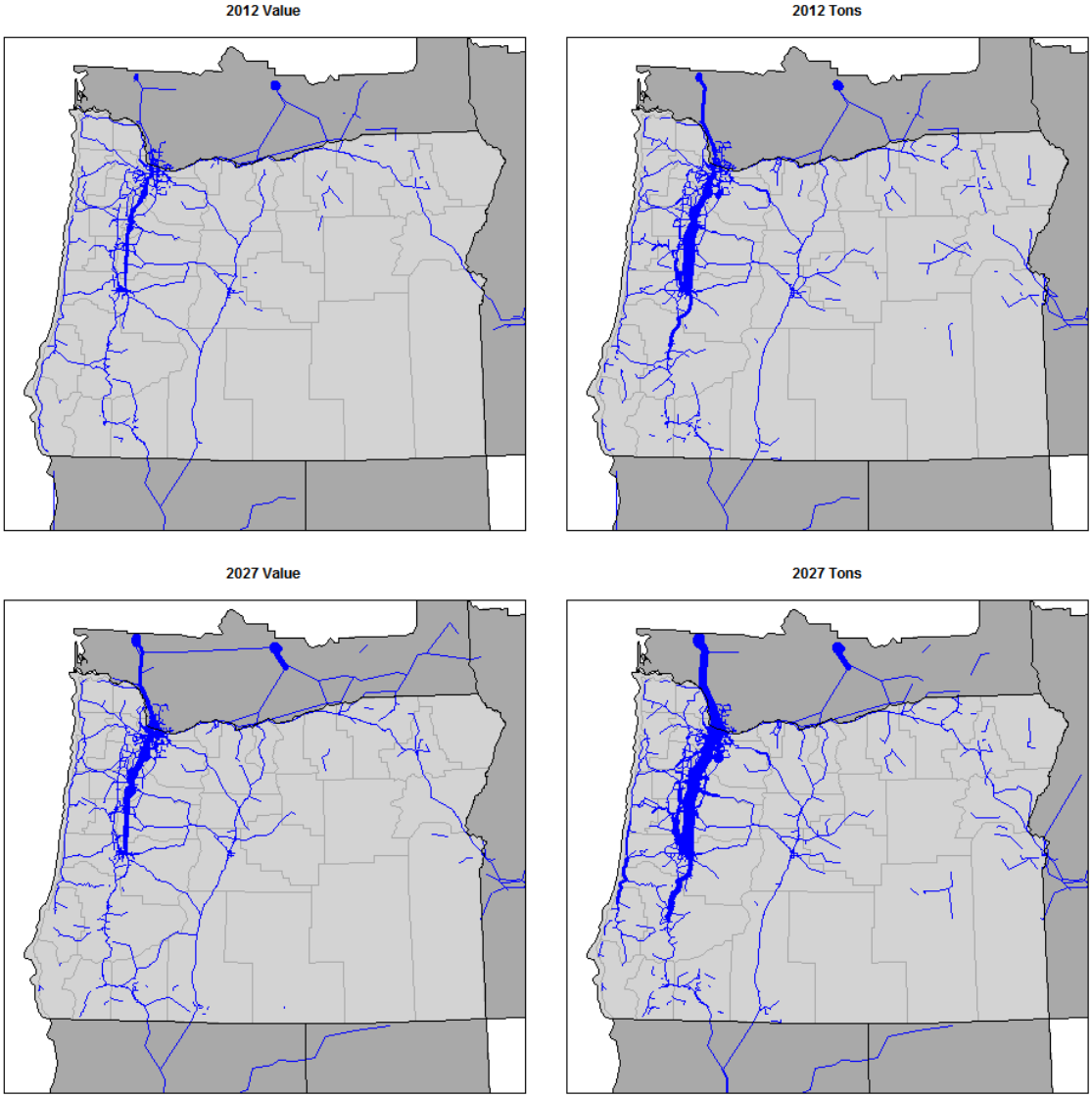


Figure 10 presents flows for the Clay, Mineral and Stone commodity group. Goods classified within this group include monument or building stone; natural sands; gravel and crushed stone; nonmetallic minerals; metallic ores and concentrates; and nonmetallic mineral products. This commodity group overall is a low-value high-weight group. This has pavement maintenance and preservation implications as the number of heavy trucks increases on specific highway segments, as well as the need for awareness of the effects of weight restrictions on bridges that could disrupt commodity movement and transport costs. Very little is outbound flow, of which the higher value, lower weight goods appear to dominate. The greatest share of flows is in the Willamette Valley corridor, although there is measurable flow on the southern half of I-5 between Eugene and Roseburg. These patterns are expected to hold into the future, revealing overall increases in forecast commodity flow for this group. The year 2027 map reveals increased flow by weight for sections of US-26, US-22, OR-99, and US-101.

Figure 10. Clay, Mineral and Stone Highway Flows



Oregon Freight Plan Analysis Scenarios

Freight is the Oregon economy in motion. In order to evaluate future risk to the freight system, several scenarios were created to observe regional differences and statewide patterns associated with future economic unknowns. SWIM2 was altered to create hypothetical future conditions in order to create analytical "bookends," from which to evaluate a range of reasonably possible long-run conditions. The purpose of these scenarios is to provide information to decision makers formulating freight policy to serve the needs of Oregon freight movement now and into the future. It should be noted that the model results do not reflect the impact of the economy and high transport costs on mode split. Estimating these impacts requires additional analysis.

Three hypothetical scenarios were produced using SWIM2, in addition to the Reference scenario:[8]

- Optimistic economic forecast
- Pessimistic economic forecast
- High transport costs

The Optimistic and Pessimistic forecasts provide a reasonable range of economic conditions that Oregon could experience over the next twenty-five years. Oregon industries rely on the transportation system for obtaining the factors of production needed to do business and get their goods to market. When economic activity changes, so do the demands placed on the transportation system. The High Cost scenario adds additional transportation costs to the Pessimistic scenario to reveal the long-range implications associated with this area of risk.

Several evaluation metrics were formulated to reveal the effects of changing underlying economic conditions at the statewide and regional level. These metrics were used to compare conditions in the analysis scenarios relative to the Reference scenario. Performance was evaluated with respect to:

- Transportation System – miles traveled, hours traveled, trip costs, commodity flow
- Economic Welfare – industry output, commodity value, and production costs

Analysis results were evaluated statewide as well as regionally, based on the twelve Oregon Area Commissions on Transportation (ACT) geographic boundaries. Variations in national and statewide economic conditions result in different regional conditions. Such differences arise from unique regional industry mix and commodity flows, which can be obscured when conditions are evaluated at the statewide level. Results at the ACT level are presented in a section after the statewide results.

Industry Employment and Output

Figure 11 illustrates statewide employment growth from all four scenarios. As with industry output, the blue x's representing results from the High Cost scenario are hidden under the red crosses of the Pessimistic scenario, indicating little statewide change despite regional differences. Oregon industries with employment most affected by economic uncertainty are discretionary services (Personal and Other Services; Accommodations) and some manufacturing (Other Durables; Other Non-Durables).

[8] A fourth scenario to evaluate growth in key Oregon industries was planned for this analysis. However, after reviewing the Optimistic forecast data, the differences between the planned industry scenario and the Optimistic scenario were too slight to warrant a separate SWIM2 scenario run. The information desired for the industry scenario is provided by the Optimistic scenario.

The employment levels of Electronics and Instruments; Communications and Utilities; Lumber and Wood Products; Food Products; Forestry and Logging, and Government and Education sectors are more stable amidst economic uncertainty.

Figure 11. Percent Change in State Employment by Industry from 2006 to 2027, All Scenarios (including percent of total employment by industry)

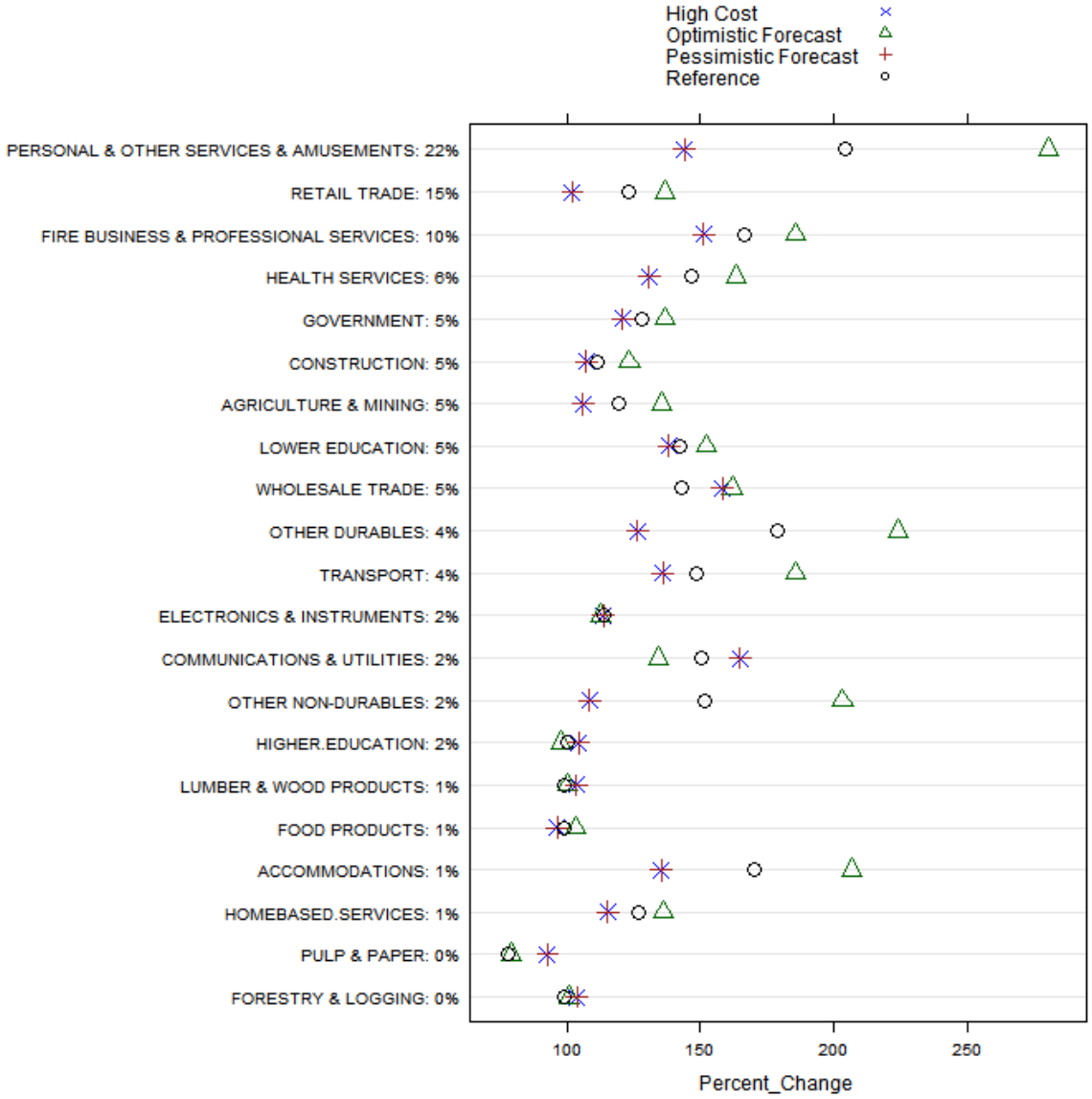
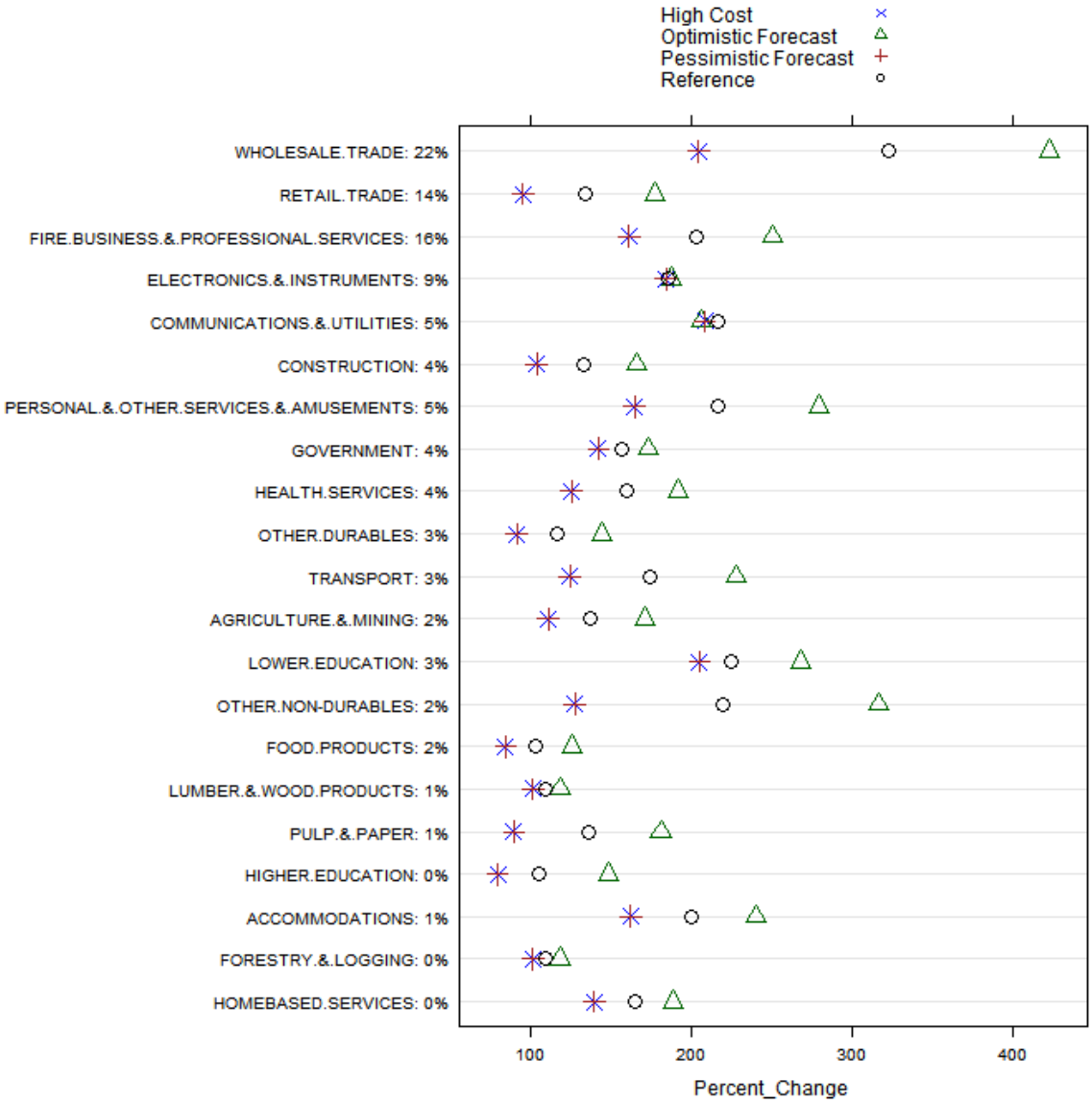


Figure 12 illustrates statewide industry output growth for all four scenarios. The blue x's representing results from the High Cost scenario are hidden under the red crosses of the Pessimistic scenario. This indicates higher transportation costs do not significantly affect statewide industry output relative to the underlying economic conditions, although region allocation of these industries across the state varies somewhat as higher travel costs lead to activity concentrations. Oregon industries most affected by economic uncertainty are Wholesale Trade, Other Non-Durables; Personal and Other Services, and Transport Services. In contrast, Electronics and Instruments; Communications and Utilities; Lumber and Wood Products; Forestry and Logging; and Food Products industry output are very stable in the midst of economic uncertainty.

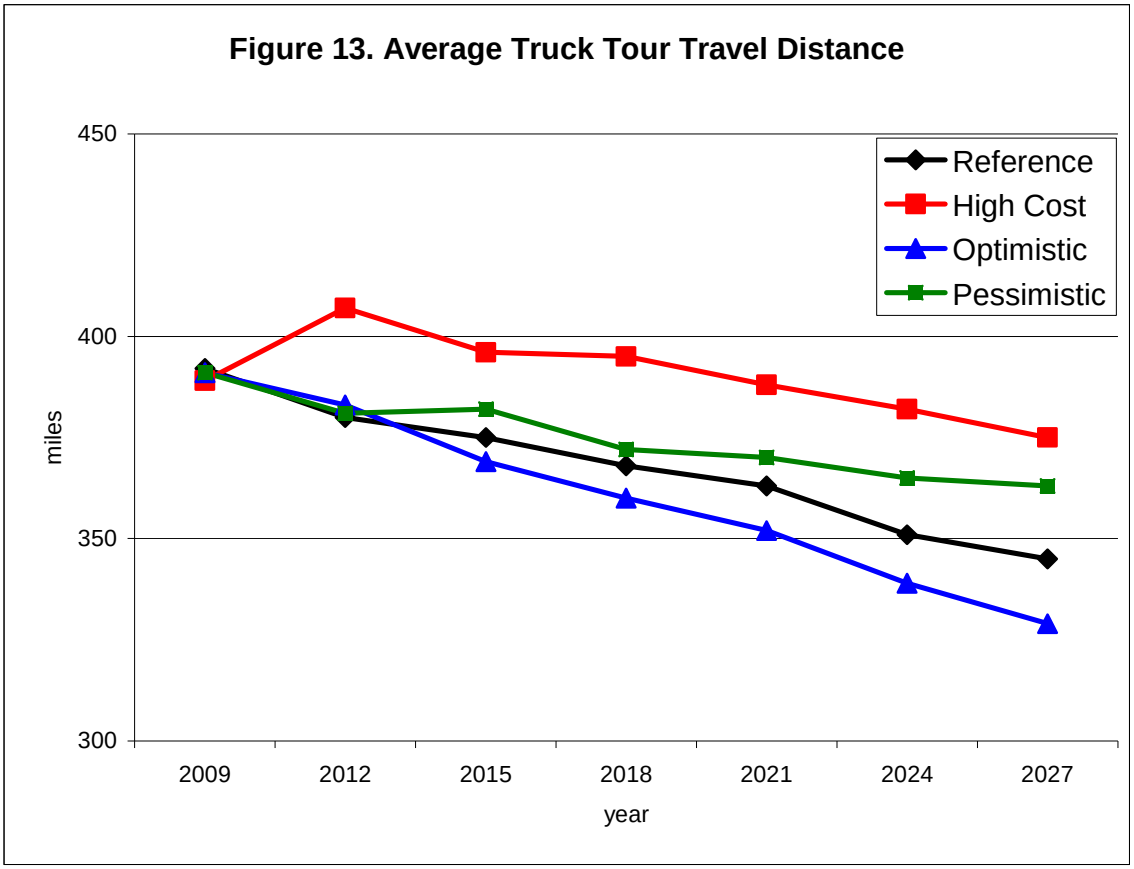
Figure 12. Percent Change in Industry Output by Industry from 2006 to 2027, All Scenarios (including percent of statewide output by industry)



Highway Travel Patterns

Truck movements within SWIM2 represent how trucks link trips over the course of a typical day, loading and off-loading cargo at several stops that are linked together as tours. We find that average truck tour distances decrease over time as congestion increases. The rate at which the decline occurs is affected by economic conditions. Figure 13 presents the forecast average truck tour distances for all four scenarios. The Reference scenario reveals the current average tour distance of 390 miles is expected to decline about twelve percent, to 345 miles. When the economy is strong, the average decline is larger, about sixteen percent. When the economy is slower, the average truck tour distances do not decline as quickly, especially when additional transportation costs are imposed on highway users, the distances are more stable over time. This illustrates how firms adapt to increasing congestion. When congestion is present, more trucks are put on the road in order to deliver the same quantity of goods within reliable delivery times to meet customer needs. While additional trucks improve service to customers, it exacerbates congested conditions and leads to overall increases in VMT. Indeed, looking at the VMT growth rates by scenarios, the lowest overall VMT growth occurs under the High Transport cost scenario. The limited congestion in this scenario allows longer and fewer tours, delivering more cargo per tour, meeting delivery times using fewer trucks, leading to the lowest overall VMT growth. Conversely, congestion leads to shorter tours to meet delivery times on a less reliable system, number of trucks used increases as well, resulting in higher total truck VMT.

Figure 13. Average Truck Tour Travel Distance



Truck travel time also changes under different economic conditions. Figure 14 illustrates forecasted average truck tour travel times for all four analysis scenarios. Under the "business-as-usual" Reference scenario, the average travel time is expected to increase about twelve percent, from about 11.6 hours to 13 hours. This pattern is more pronounced when the economy is strong, with expected travel times increasing eighteen percent, to 13.8 hours. When the economy is muted, travel times do not change as much. Travel times are forecast to increase about seven percent over twenty years in the Pessimistic scenario. The High Cost scenario, average tour time is forecasted to rise less, about three percent. Truck hours of travel are reduced when economic activity is lighter and even more so when the transport costs per mile are higher. VHT increases the least over time in the High Transport Cost scenario, where longer tours/fewer trucks more efficiently serve the demand for moving goods. In the more congested Optimistic and Reference scenarios, VHT increases significantly more than VMT.

Figure 14. Average Truck Tour Travel Time

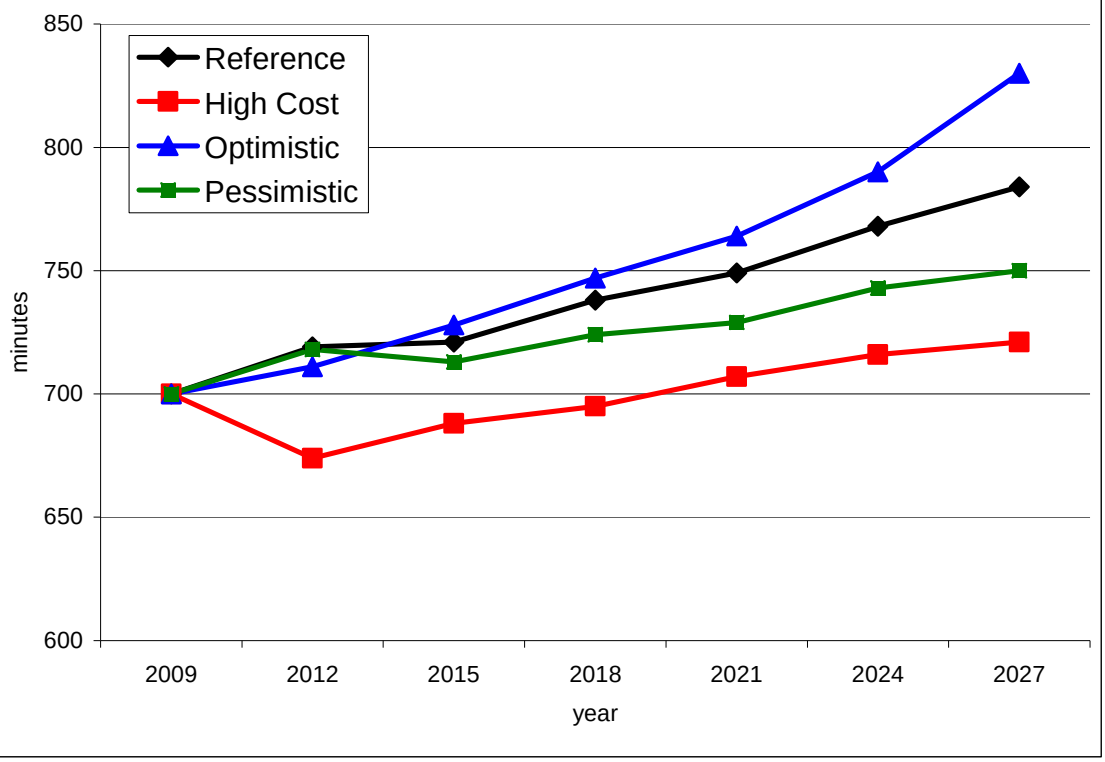


Table 6 illustrates the difference in compound average growth rates for VMT and VMT for all four scenarios. The relationship between economic growth and congestion is evident, as is the effect of higher transportation costs.

Table 6. Compound Average Growth Rates for Truck Vehicle Miles Traveled and Vehicle Hours Traveled: All Scenarios

Scenario	Truck Vehicle Hours Traveled	Truck Vehicle Miles Traveled
High Cost	1.4%	1.1%
Pessimistic	1.7%	1.3%
Reference	3.1%	2.3%
Optimistic	1.2%	3.0%

Auto tour distances and travel times are also responsive to different economic conditions. Table 7 provides auto tour travel statistics for all four scenarios. Auto tours show little variation in length among the four scenarios, with the exception of the High Cost scenario. Average auto tour distance starts out at 15 miles and is forecasted to be 14 miles by 2027 for the Reference, Optimistic, and Pessimistic scenarios. Auto tour distance is significantly reduced when there are higher transport costs, dropping to an average of 11 miles per tour.

Auto tour travel time does change. Table 7 reveals auto tour travel time increases when the economy is strong and decreases when economic activity is more muted, as observed with trucks. Increased per-mile transport costs combined with slower economic conditions result in a noticeable drop in travel times. Total VMT drops when the economy is slower, freeing up capacity and reducing congestion, resulting in faster travel times.

Table 7. Auto Tour Travel Statistics: Distance, Time, Compound Average Growth Rates (CAGR) of Auto VMT and VHT - All Scenarios

		Year 2027 by Scenario			
	Year 2010	Reference	Optimistic	Pessimistic	High Cost
Tour Distance	15 miles	14 miles	14 miles	14 miles	11 miles
Tour Travel Time	30 minutes	34 minutes	36 minutes	32 minutes	25 minutes
VMT CAGR	-	3.1%	4.3%	2.0%	0.6%
VHT CAGR	-	1.9%	2.8%	1.2%	-0.1%

Slower economic conditions alone have little effect on reducing average auto tour distance, but a measurable effect on travel time (half the increase in travel time of the Reference). Tour characteristics do not significantly change, but the number of tours drops due to decreased economic activity. Adding a three-fold increase in per-mile transport costs reduced tour distance, more than twenty percent below the Reference tour distance. Only a small portion of that reduction is attributable to reduced economic activity. Households and businesses are able to respond to changing economic conditions by relocating. This results in densification of urban areas as households choose homes closer to their workplaces and other areas of activity requiring travel, such as shopping.

As with trucks, change in overall auto VMT and VHT is reduced when per-mile transport costs increase. In the case of autos, the model suggests change in overall VMT and VHT could remain close to current levels with the introduction of a three-fold per-mile cost increase.

Analysis Scenarios Commodity Flow

The Optimistic and Pessimistic forecasts provide a reasonable range of economic conditions that Oregon could experience over the next twenty-five years. Oregon industries rely on the transportation system for obtaining the factors of production needed to do business and get their goods to market. When economic activity changes, demands placed on the transportation system change as a result. The High Cost scenario adds additional transportation costs to the Pessimistic scenario to reveal the long-range effects of this additional area of risk.

Figures 15, 16, and 17 illustrate the difference in highway commodity flows across the state for the three analysis scenarios compared to the Reference. The Reference scenario is represented by the blue layer.

Figure 15 presents the Optimistic scenario highway commodity flows in a green layer placed under the blue Reference flows in order to reveal the magnitude of the difference beween the two scenario flows. One can quickly see there is a noticeable difference between the two scenario flows in the I-84 corridor in terms of value and tonnage. Beyond that, the differences by value are spread across the state on highways from the coast and a few in southern Oregon. The differences between scenarios by weight are evident in the I-5 corridor south of Salem and a few state highways leading to the higher volume highways.

Figure 15. Commodity Flows for Optimistic Scenario Relative to Reference Scenario

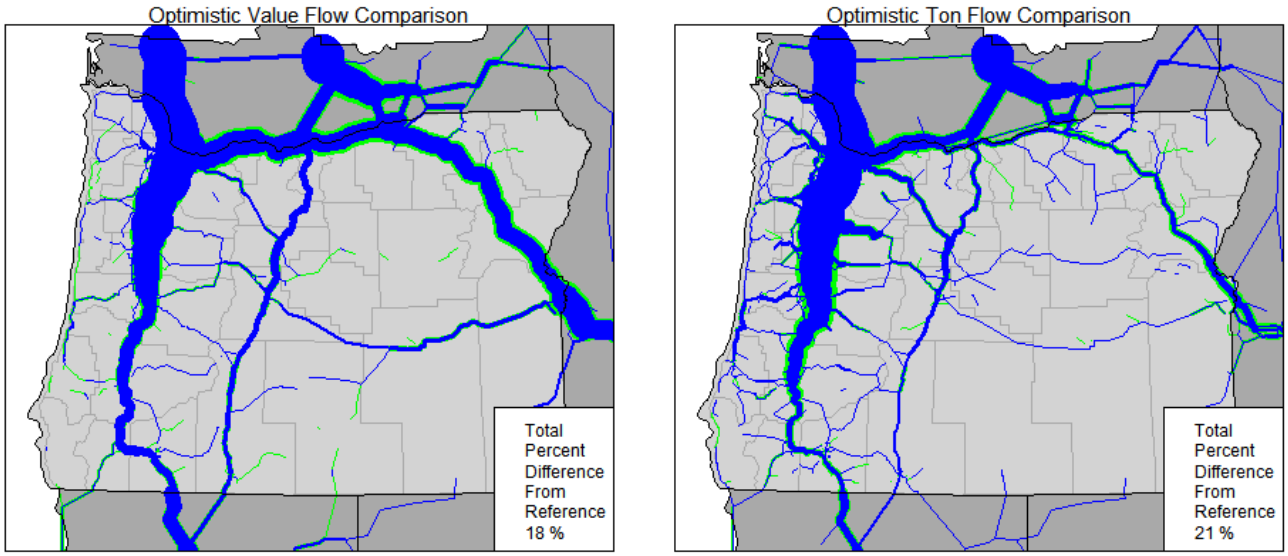


Figure 16 presents the Pessimistic scenario flows in a similar manner. Once again, blue represents the Reference scenario flows and red the Pessimistic scenario flows. Overall, the Pessimistic scenario shows slightly larger declines (-22% in value, -26% in tonnage) than the Optimistic scenario gains (18% in value, 21% in tonnage) in commodity flow. Looking at the difference in flows by commodity value, the greatest reduction in flows is on I-84 between Portland and The Dalles. Pessimistic scenario flow reductions become less pronounced as commodities disperse onto other highways into Washington State, further east on I-84 and onto US97 through central Oregon. The southern

Willamette Valley and further south on I-5 also reveal reduced flows by value under this Pessimistic scenario, which become more pronounced near the California border and on into California. When looking at flow differences by weight, the two most pronounced differences are on the mid-state section of I-5 between Salem and Roseburg and I-84 between Portland and the City of The Dalles, the same areas demonstrating increased flows in the Optimistic scenario. This indicates commodity flows on these sections are more responsive to economic conditions.

Figure 16. Commodity Flows for Pessimistic Scenario Relative to Reference Scenario by Value and Tonnage

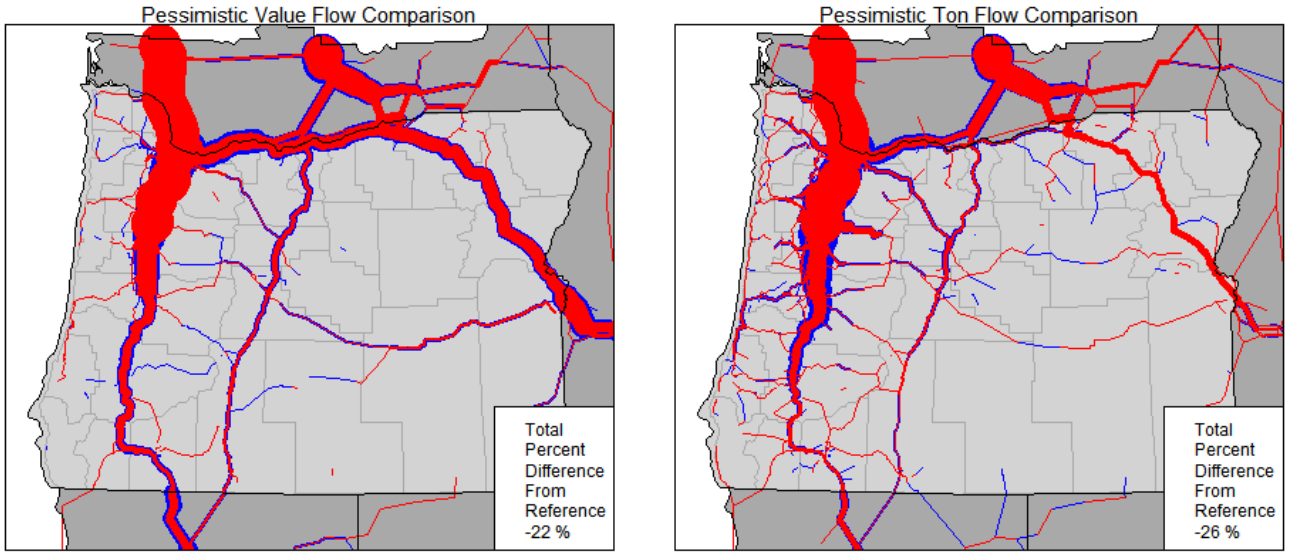


Figure 17 presents the High Cost scenario flows. This difference map looks very similar to the Pessimistic scenario map. The higher transport costs added to the slower economic conditions result in shifts in the location of economic activity, resulting in reduced flows in the I-84 corridor, US26 between Portland and US97, and US97 between I-84 and Bend. Higher transport costs induce higher concentrations of activity in the urban areas of the Willamette Valley. Clearly economic conditions affect commodity flow patterns. However, even when the economy slows, commodity flows are significant.

Tables 8 and 9 illustrate how the share of commodity flows by group may vary under different economic conditions statwide. The tables also reveal the relative rank of commodities in terms of value and weight. For example, Forest or Wood Products represent the largest commodity group by weight (37%), but has a small share of flows by value (5%.) Machinery, Instruments, Transportation Equipment, and Metals is the largest commodity group by value (49%), but has a small share of flows by weight (4%). Comparing the shares across all four scenarios reveals the commodity shares by weight are stable under different economic conditions, varying no more than one percentage point. The exception is Machinery & Instruments, which has a stable absolute value of flow under all scenarios, but the statewide share drops when the economy is strong as other commodity production picks up. When the economy is slower, this commodity group's share increases as other commodity activity drops. This is largely offset by slight declines in a number of other areas, particularly the large Forest or Wood Products commodity group, where a one-percent change translates into large tonnages, and the reduced demand for other largely inbound raw materials such as the Petroeum,Coal and Chemicals.

Figure 17. Commodity Flows for High Cost Scenario Relative to Reference Scenario by Value and Tonnage

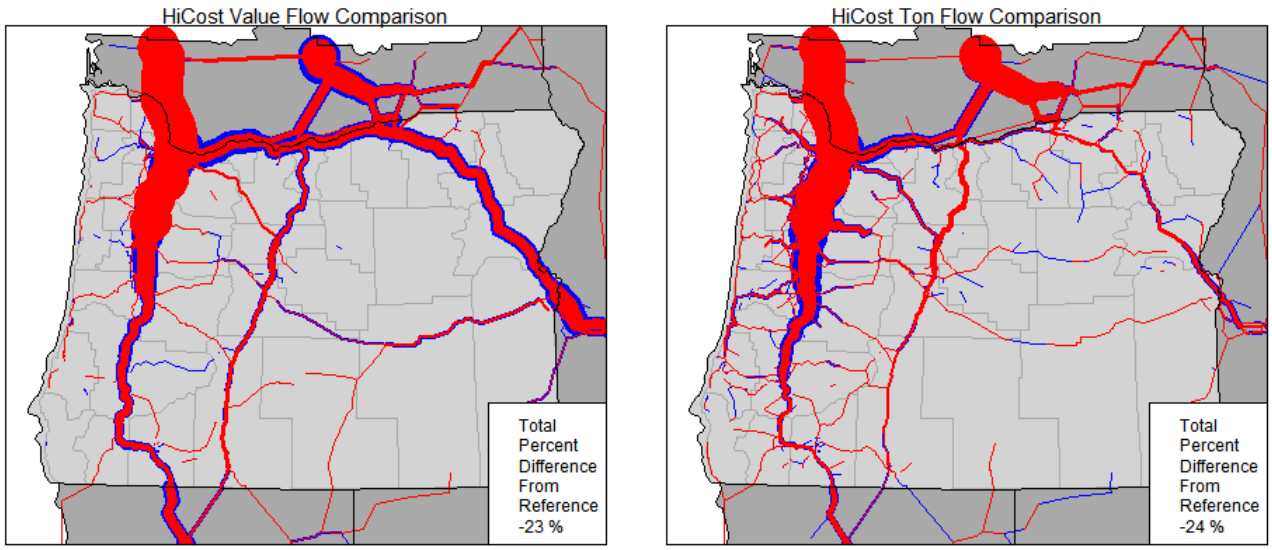


Table 8. Share of Total Statewide Commodity Flow by Weight for all Four Analysis Scenarios*

	Reference	High Cost	Pessimistic	Optimistic
Forest or Wood Products	37	36	37	36
Petroleum Coal Chemicals	25	26	24	25
Clay Minerals Stone	16	16	16	16
Food & Kindred Products	12	12	12	13
Machinery, Instruments, Transp Equip, Metals	4	5	5	4
Pulp Paper Products	4	3	3	4
Other Misc	2	2	2	2

* columns may not sum to 100 due to rounding

Table 9. Share of Total Statewide Commodity Flow by Value for all Four Analysis Scenarios*

	Reference	High Cost	Pessimistic	Optimistic
Machinery Instruments, Transp. Equip. Metals	49	55	54	46
Other Misc	17	14	14	18
Food & Kindred Products	12	12	12	13
Petroleum, Coal, Chemicals	10	8	9	11
Pulp, Paper Products	6	5	5	7
Forest, Wood Products	5	5	5	5
Clay, Minerals, Stone	1	1	1	1

* columns may not sum to 100 due to rounding

Figures 18 – 24 illustrate the differences in commodity flows on Oregon highways for seven commodity groups across the three analysis scenarios for year 2027. Each figure displays the difference from the Reference scenario for commodity value and tonnage. The first row of maps presents results for the High Cost scenario. The second row presents results for the Pessimistic scenario and the third row for the Optimistic scenario. Results in red indicate a reduction in flows compared to the Reference scenario, while green represents an increase in flows relative to the Reference scenario. The lower right corner of each map reports the statewide percent difference compared to the Reference scenario in terms of value adjusted by lane miles of travel and absolute valuel. This provides a sense of magnitude of the difference between scenarios.

Figure 18 presents commodity flows for Machinery, Instruments, Transportation Equipment and Metals for the three analysis scenarios. This commodity group is a high-value, low-weight group. For both the Pessimistic and High Cost scenarios, flows are reduced significantly, despite less decline in growth than other commodities as indicated by its ranking in Table 7. The decreased flows with respect to the Reference are illustrated in red. The greatest reduction in flows in terms of value is on I-5 north of Portland and in the Willamette Valley. But, there are also reductions along the I-84 corridor. I-5 North of Portland realizes the largest declines in terms of value in these scenarios. In absolute terms, the decreased commodity flow for this group is 14% less than the Reference flows for the Pessimistic scenario and 15% less for the High Cost scenario.

The differences between the Pessimistic and High Cost scenario are interesting to note. Added transportation costs results in greater reductions in commodity flow along the I-84 corridor, but less of a reduction in flows on I-5 south of the Willamette Valley. Higher transportation costs result in more flows on smaller interior state highways shown as green on the High Cost Value Flow Comparison map, but less of a difference from the Reference scenario in flow along the central US97 highway. A large segment of southern US97 has more commodity flow for this group relative to the Reference in terms of comodity value. There is a larger decline in tonnage flows along US20 running east of Bend when transport costs are higher. These changes likely reflect consolidation of shipping activity in urban areas, with less intercity flows, except between major urban centers, such as Bend and the Willamette Valley.

The Pessimistic scenario results indicate increased flow for this commodity group on US199 from Grants Pass to the California border and several state highways from I-5 to the coast as shown in green. A slower economy results in reduced flows for this commodity for all of US97 in central Oregon and several highways connecting to I-5, including US20 across the state toward Idaho.

Overall, commodity flows for this group increase by an absolute amount of 9% in the Optimistic scenario. There is increased commodity value on the I-84 corridor east of Portland and increased tonnage on I-5 north of Portland. There is a general pattern of increased commodity flow across Oregon highways, but there are some decreased flows relative to the Reference scenario. I-5 south of Salem realizes a small net reduction in flows all the way to the California border, indicating a shift from trade to South of the state to trade with Northern (low-value goods) and Eastern (high-value goods) markets. Flows also decrease on US26 west of Portland and east of Portland all the way to US97. Also, flows increase on US199, even more than they did in the Pessimistic scenario. On the I-84 corridor east of Hermiston, there are small decreases in commodity flow by weight, when the net difference by value is positive for the entire corridor.

Figure 18. Difference in Commodity Flow for Analysis Scenarios Compared to Reference Scenario: Machinery and Instruments, Transportation Equipment, and Metals

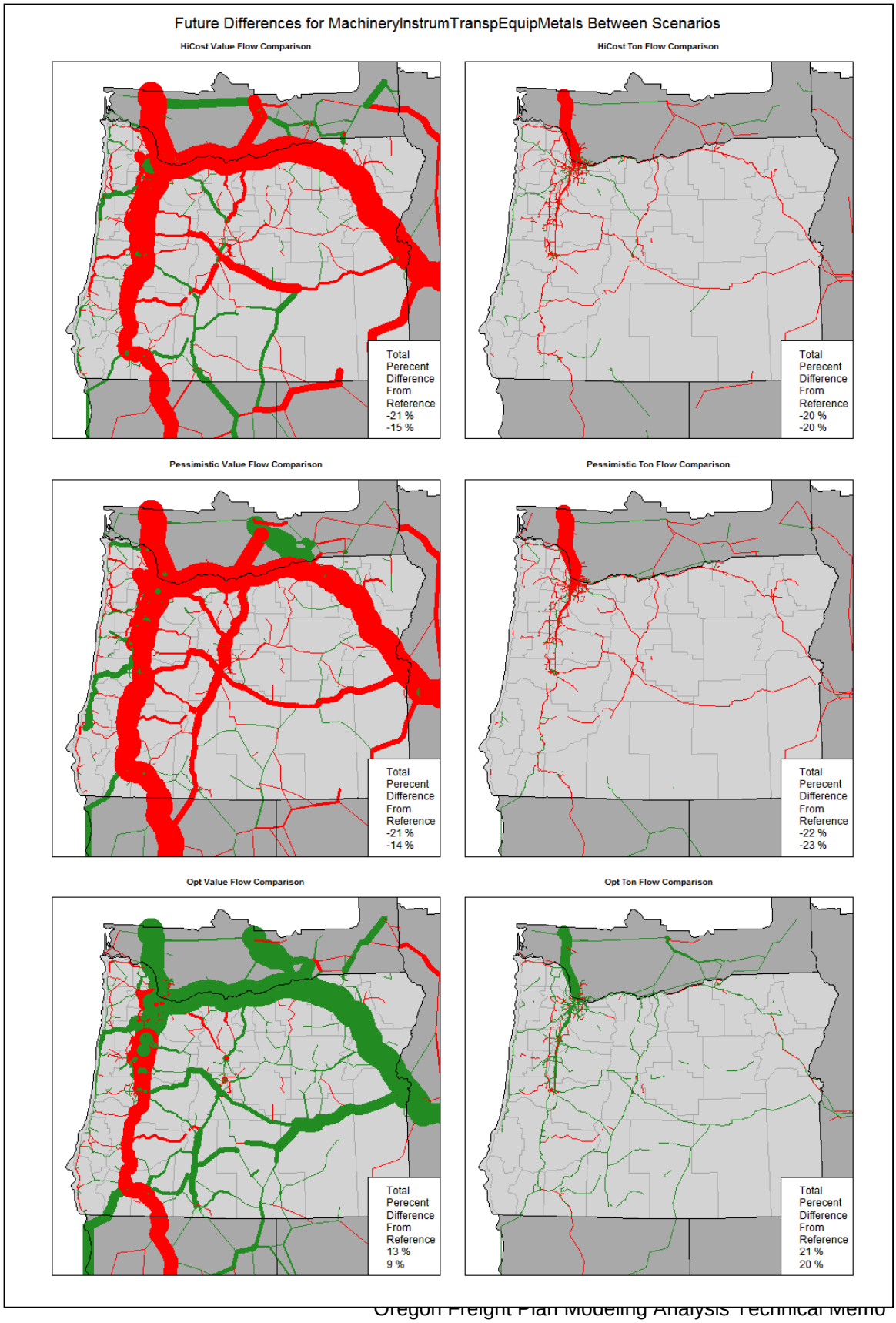


Figure 19 presents commodity flows for Food and Kindred Products for the three analysis scenarios. For both the High Cost and Pessimistic scenarios, flows are reduced across the state, although retaining its existing share of freight flows in the smaller economy. The greatest reduction in flow is on I-5 north of Portland and east of Portland on I-84 up to the Hermiston area, approaching the connection with I-82 heading north into Washington. There are also reductions in flow on US97 heading north toward I-82, as well as other routes, demonstrating some reduction in north-bound commodity flows for this group. These patterns are very similar in terms of commodity value and weight, with some greater reduction in flows on US97 by weight. Flows further south on I-5 and US97 show an larger reduction in flows relative to the Reference scenario. In terms of absolute value, the statewide reduction in flows for this commodity group is 24%.

There are no obvious differences in flow patterns for Food and Kindred Products when higher transport costs are included. This implies the greatest influence on this commodity group is economic conditions.

The results are quite the opposite for the Optimistic scenario, which represents a 27% increase in commodity flow in terms of absolute value with respect to the Reference scenario. Commodity flow increases on the main corridors of I-5 and I-84. The largest increases occur north of Portland on I-5, I-84 between Portland and I-82 via US 97 and the I-84/I-82 intersection at Hermiston. There are significantly more flows in the Willamette Valley I-5 corridor which continue further south and increase in size as the California border is approached. There are increased flows to a lesser extent on US20 east of Bend and US97 from I-84 to Bend, as well as highways connecting the Oregon coast to the I-5 corridor. The increased flows are noticeably greater in magnitude when looking at flows by weight on the I-5 corridor south of Portland. Interestingly, the Pessimistic scenario shows a decline on US97 that is not mirrored as gains in the Optimistic scenario.

Figure 19. Difference in Commodity Flow for Analysis Scenarios Compared to Reference Scenario: Food and Kindred Products

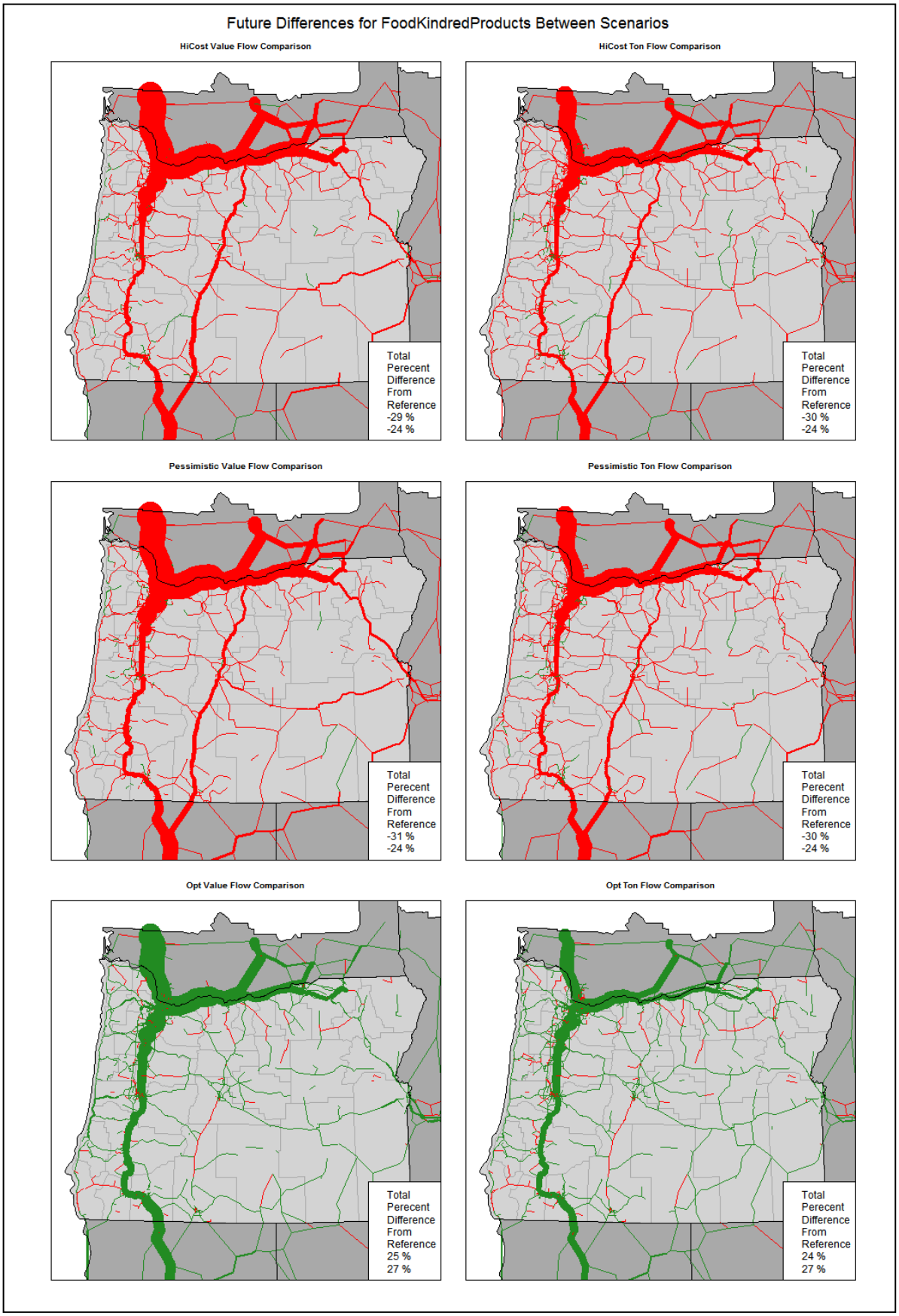


Figure 20 presents commodity flows for Other Miscellaneous Products for the three analysis scenarios. For the High Cost and Pessimistic scenarios, commodity flow is reduced across the state. The greatest reduction in flow is north of Woodburn on I-5 and into Washington State, with some reduction also on I-84 between the intersection with I-82 and the Idaho border. The reduction in flow is more pronounced by weight on the I-5 corridor in the upper Willamette Valley area starting in the vicinity of Salem. The addition of higher transport costs to a lagging economy resulted in greater reduction in flows on I-84 and US97 north of Bend and less reduction in flows on the I-5 corridor. Slower economic conditions do not alter the share of statewide commodity flows for this group; it remains 14% by value and 2% by weight (as presented earlier in Tables 6 and 7.) However, lane miles of commodity flow by value for the High Cost scenario is 37% lower than the Reference scenario, while the Pessimistic scenario is 30% lower. This demonstrates the freight consolidation effect, which reduces total truck VMT when transportation costs are higher.

The Optimistic scenario results in a greater share of commodity flows for this group in terms of value, rising to 18% of the statewide commodity flows. The most significant increased flows are on the I-5 corridor starting near Salem and continuing north to Portland and into Washington State. There are large increases in flows in terms of weight on the entire I-5 corridor. There is some additional flow on I-84, but the greatest increase in terms of value is between I-82 and LaGrande and in terms of weight between Portland and I-82. This commodity group represents a range of products in terms of value and weight which creates this variation in the weight and value flow patterns. Further insight on these patterns will be provided in the ACT profiles.

Figure 20. Difference in Commodity Flow for Analysis Scenarios Compared to Reference Scenario: Other Miscellaneous Goods

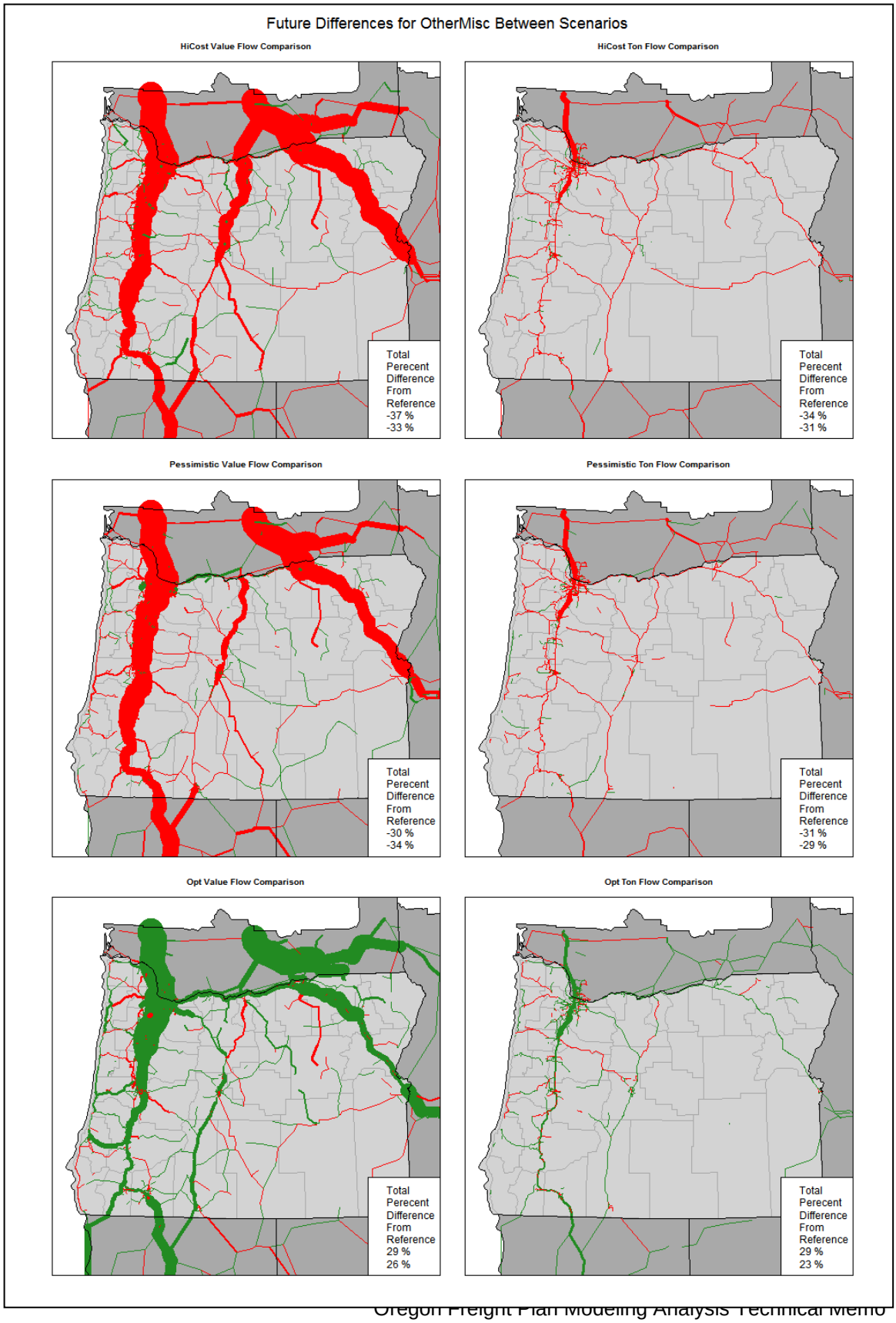


Figure 21 presents commodity flow for the Petroleum, Coal and Chemicals group. The fuels component of this commodity group is largely inbound flows, rising and falling in step with the overall economy, and higher-value chemicals. Evaluating this group in terms of value reveals flows are reduced on the I-5 corridor, especially in the Willamette Valley corridor when the economy contracts. The addition of higher transport costs reduces flows north of Portland on I-5 even more than reduced economic activity alone. The results are different when evaluating this group in terms of weight.

Reduced economic activity, as represented in the Pessimistic scenario, results in significant reduction of flow by weight north of Portland on I-5 and some reduction on I-5 in the Willamette Valley and further south. However, there is increase flow by weight on the I-84 corridor between the I-82 intersection near Hermiston and the Idaho border. When higher transport costs are added to a slow economy, as represented in the High Cost scenario, the results are quite different. Willamette Valley flows on I-5 are mostly higher than the Reference scenario, except for some segments within the corridor. The higher flows on I-84 are no longer present when higher transport costs exist, but US97 experiences increased commodity flow with higher transport costs.

Commodity flows from Idaho north to Washington via the I-84 corridor until intersecting with I-82. These flows increase somewhat for the heavier commodities within this group during slower economic times, likely reflecting the competitive advantage of other states relative to Oregon. Note that flows do not increase in terms of value on this corridor. For the purpose of the Freight Plan, the actual response of this commodity is less important than the realization that the freight plan strategies must support the economic resilience of Oregon firms and national freight flows.

The Optimistic scenario results in greater flows on I-5 north of Portland, with increased flows to a lesser extent on I-5 south of Portland for the Willamette Valley corridor both in terms of value and weight. The magnitude of flow increase is greater in terms of commodity value, than weight. In absolute terms, flows are 9% higher than the Reference scenario in terms of value and 20% higher in weight. Flow increases on the I-84 corridor between I-82 and Idaho in terms of weight, but very little in terms of value. Once again, this likely reflects activity of other states shipping relatively heavy, low value commodities within this group.

Figure 21. Difference in Commodity Flow for Analysis Scenarios Compared to Reference Scenario: Petroleum, Coal, and Chemicals

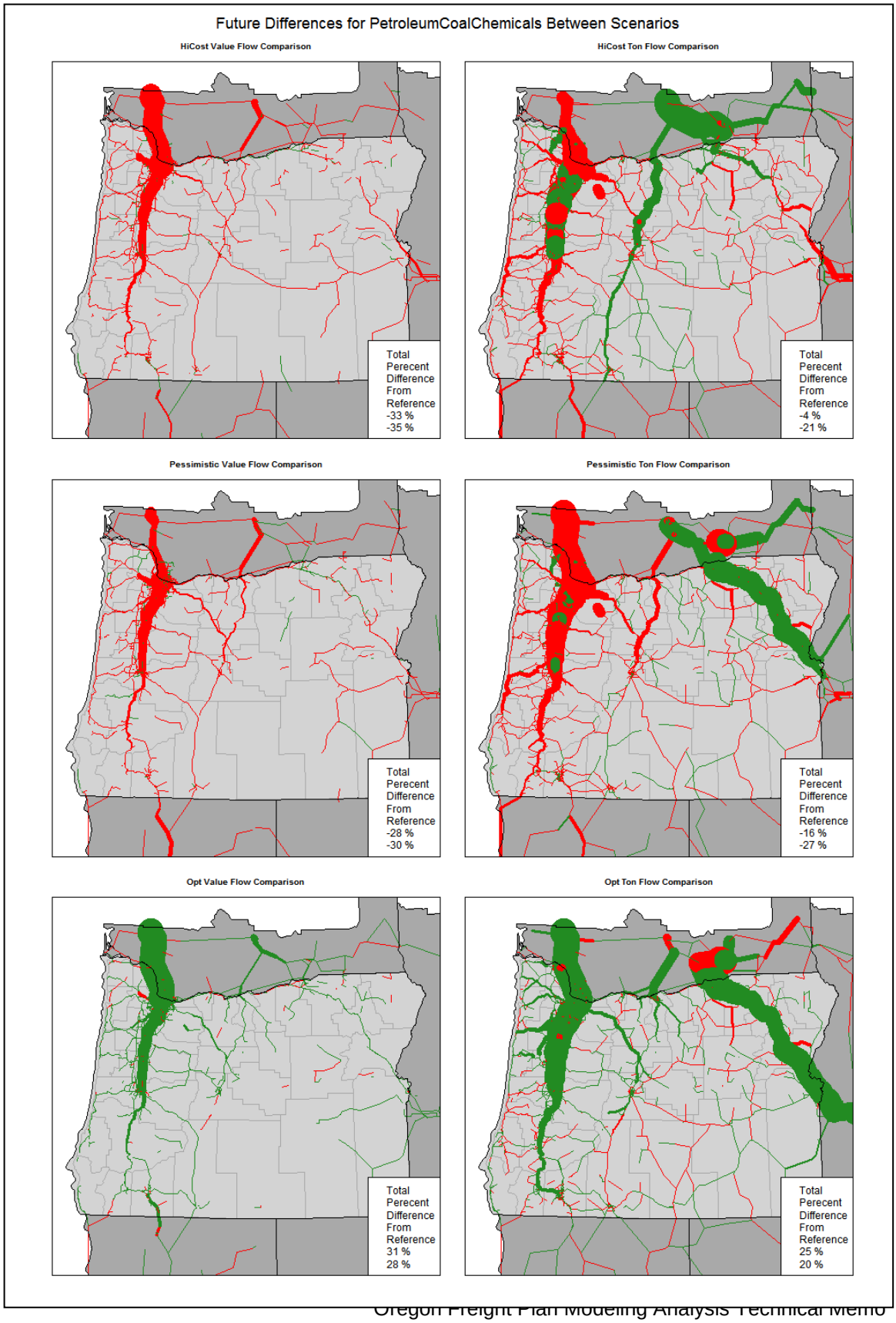


Figure 22 presents commodity flow for Pulp and Paper Products group. When economic activity slows, the greatest reduction in commodity flow for this group occurs north of Portland on the I-5 corridor. There is some reduction in flows on the I-5 corridor south of Portland to a lesser extent. Reductions can be seen on US 97, US 26 east of Portland and OR58 from Eugene to US97. A small increase in flow appears on OR31 in the Pessimistic scenario, but disappears when higher transportation costs are incurred. There are fairly small differences between the High Cost flows and the Pessimistic flows, indicating economic conditions have more influence on this particular commodity than transportation costs.

The Optimistic scenario mirrors the Pessimistic scenario. Additional flow occurs north of Portland on the I-5 corridor, with increases on the I-5 corridor south of Portland as well to a lesser extent. There is also more flow on US97 and US26 north of Bend in terms of weight, not so in terms of value. The source of such differences is illuminated further in the ACT Profile section, where production activity and flows are discussed by ACT.

Figure 22. Difference in Commodity Flow for Analysis Scenarios Compared to Reference Scenario: Pulp and Paper Products

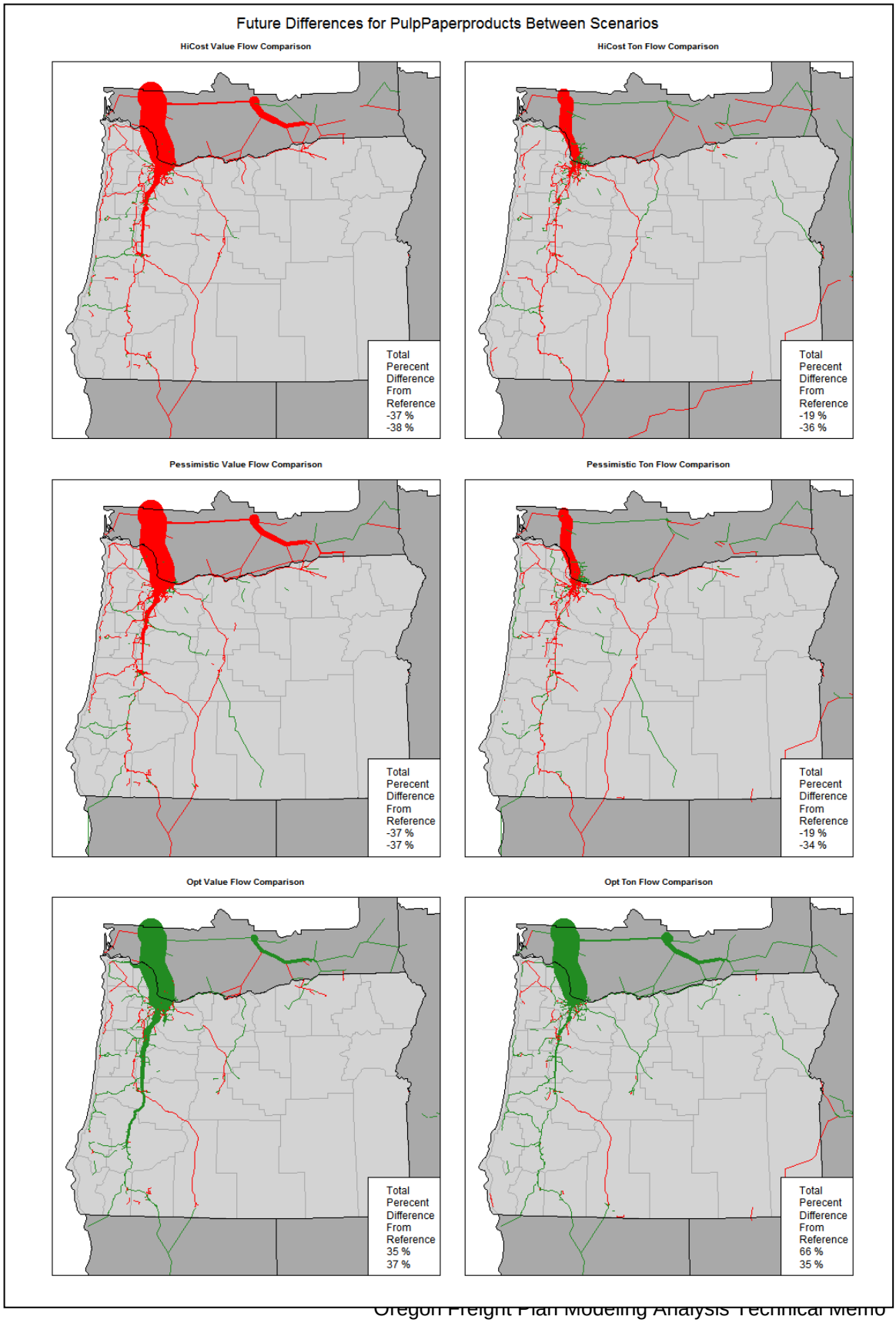


Figure 23 presents commodity flow for the Forest or Wood Products group. This commodity group is a relatively low-value, high-weight group. This group relies on the I-5 corridor for movement. When economic activity wanes, as represented in the Pessimistic scenario, flows are significantly reduced, 25% in absolute terms by weight and value. The greatest reduction in flow occurs on the I-5 corridor through the Willamette Valley south of Portland, with sizeable reduction in flows north of Portland and south of Eugene to Roseburg. There are further reductions in flow across the entire state. The addition of transportation costs do not appear to alter these results at the statewide level to a noticable extent.

A similar, yet opposite effect occurs for the Optimistic scenario. Flows increase on the I-5 corridor north of Portland, further south in the Willamette Valley and further down to Roseburg. The increase in flows are more pronounced in terms of value compared to weight. There are also notable increases in flows on I-84 and US26 east of Portland and US22 east of Salem.

Figure 23. Difference in Commodity Flow for Analysis Scenarios Compared to Reference Scenario: Forest or Wood Products

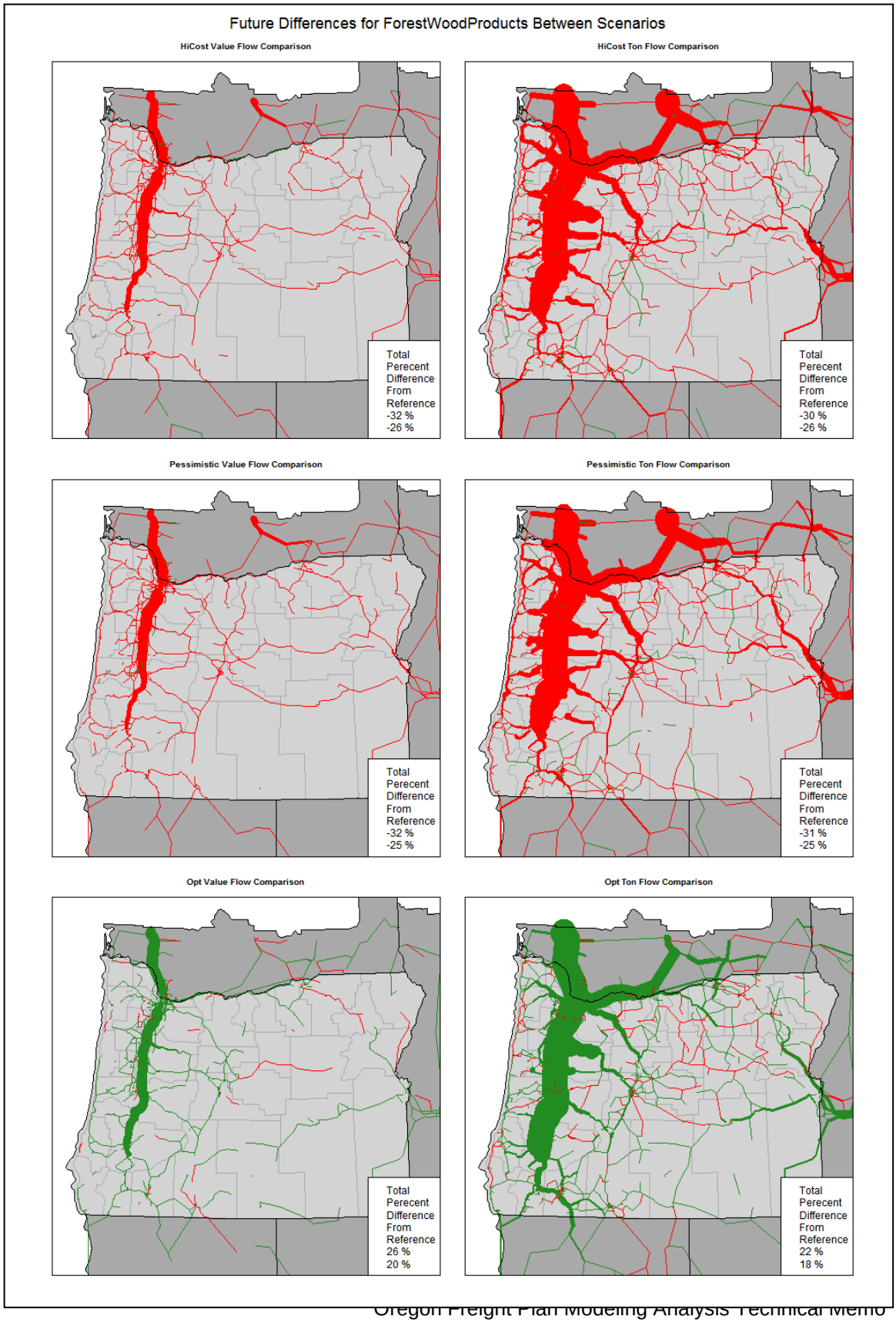
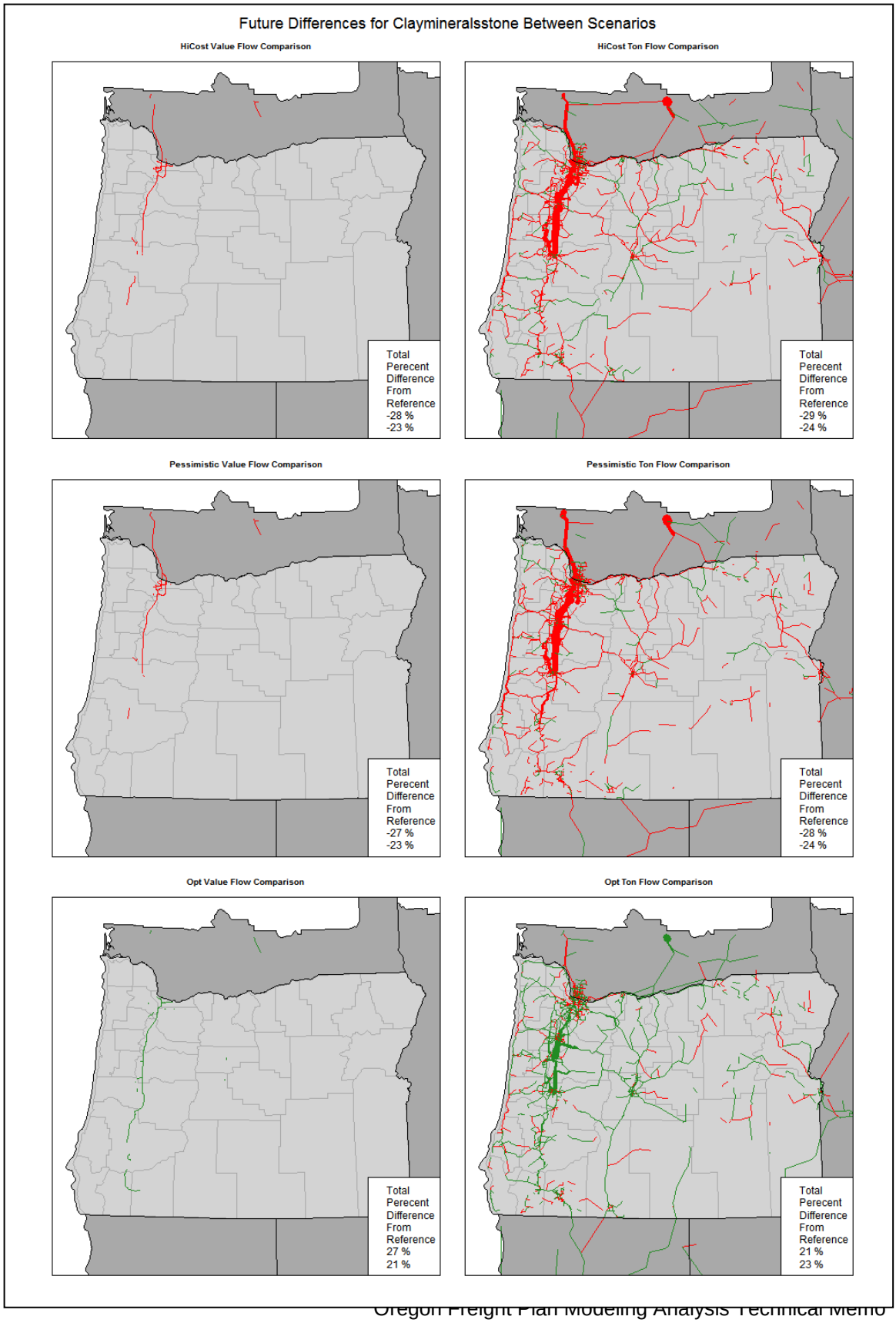


Figure 24 presents commodity flow for the Clay, Minerals and Stone group. This group is a low value, high weight group, representing one percent of statewide commodity flow in terms of value, and sixteen percent by weight. Thus, the change in flows are most evident when looking at tonnage flows. When economic activity wanes, as represented in the Pessimistic scenario, the bulk of flow reduction occurs in the Willamette Valley corridor. There is notable reduction in flows on the Oregon coast US 101 in the area of Coos Bay and Reedsport and some further north to Newport. US 97 north of Bend realized reduced flows as well. The addition of higher transportation costs results in similar patterns, but a net result of a little less reduction in flows compared to the Pessimistic scenario.

When the economy expands, as represented in the Optimistic scenario, flows for this group increase on the I-5 corridor predominantly in the Willamette Valley, notably in the vicinity of Salem and Eugene. Flows increase on US 97 north of Bend and OR 224 east of Portland. Flows north of Portland are less than the Reference scenario as the demands for this commodity change under new economic conditions.

Figure 24. Difference in Commodity Flow for Analysis Scenarios Compared to Reference Scenario: Clay, Minerals, and Stone

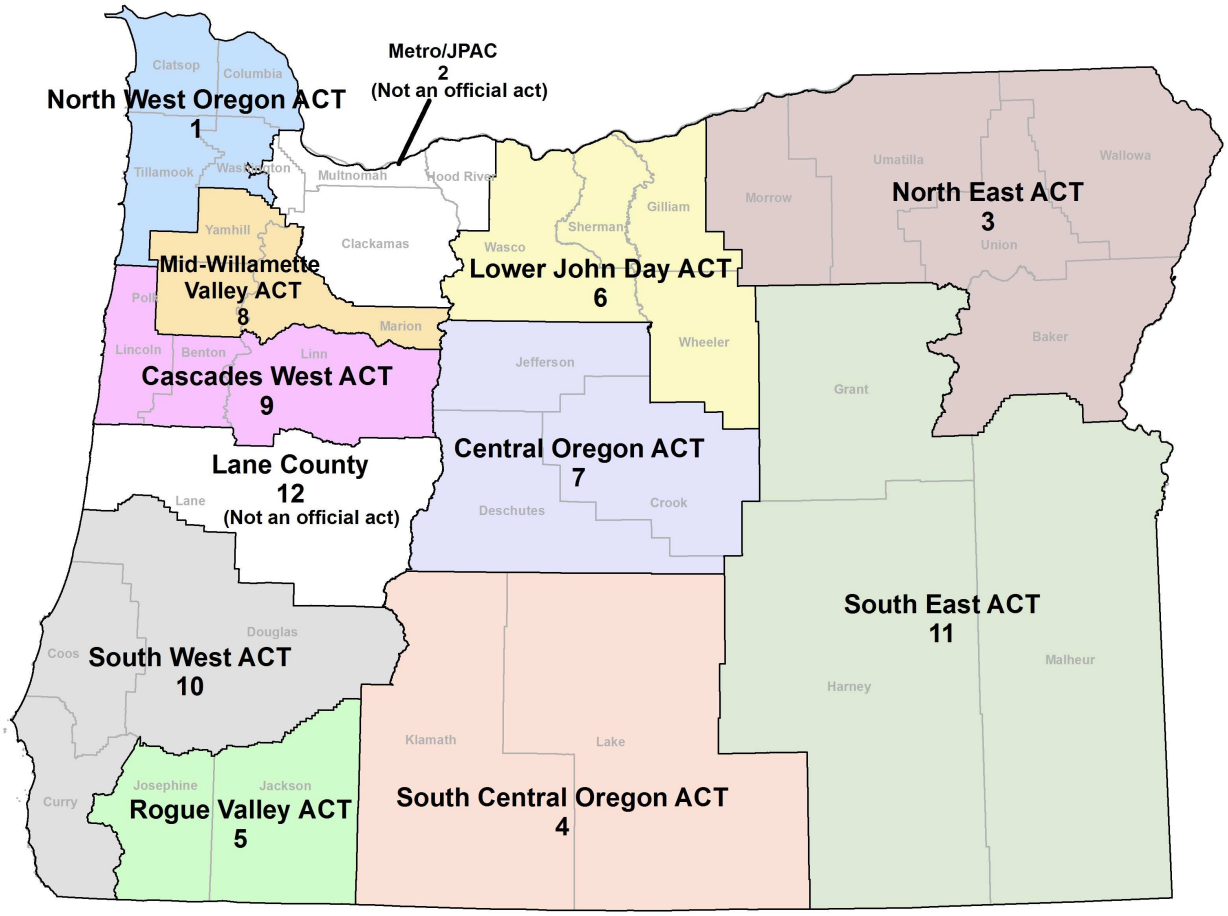


ACT Profiles

This section presents brief summaries of regional patterns in order to highlight the differences between areas of Oregon that may be obscured when reporting at the statewide level. The State of Oregon is divided into 12 Area Commissions on Transportation (ACTs) as illustrated in Figure 25. Regional patterns are evaluated at the ACT level for this analysis. For reporting purposes, several ACTs are grouped together because of the close regional economic interactions and similar use of highway corridors. ACT profiles are provided for the following:

- Northwest Oregon (ACT1)
- Willamette Valley (ACTs 8, 9, & 12)
- Central Oregon (ACTs 6 & 7)
- Portland Area (ACT2)
- Southwest Oregon (ACTs 4, 5, & 10)
- Eastern Oregon (ACTs 3 & 11)

Figure 25. Oregon Area Commissions on Transportation



For each of the six ACT groups profiled, four graphics will be presented to illustrate economic and freight activity for each area:

- Commodity production within the ACT group, indicated by the share of statewide production for each commodity group for each scenario
- Map of commodity flows produced by the ACT group destined to other ACTs and outside of the state [9]
- Table of highway corridors utilized to transport ACT goods to destination markets, i.e., the percentage of ton-miles for each commodity group produced by the ACT groups and moved by truck
- Forecast change in ACT group industry growth rates for output and employment, compared to the statewide rate for each scenario

ACT Profile Overview

ACT group profiles will also include commodity production levels for all four scenarios. Results are reported for seven commodity groups, presented in Table 10. Goods classified within the Machinery, Instruments, Transportation Equipment and Metals represent the largest share of statewide commodity flows by value, but very low in terms of weight. Forest and Wood Products represent the largest share of statewide commodity flows by weight, but very low in terms of flows by value. Figure 26 is provided as a reference of comparison for the ACT groups.

Table 10. Commodity Groups by Share of Statewide Production*

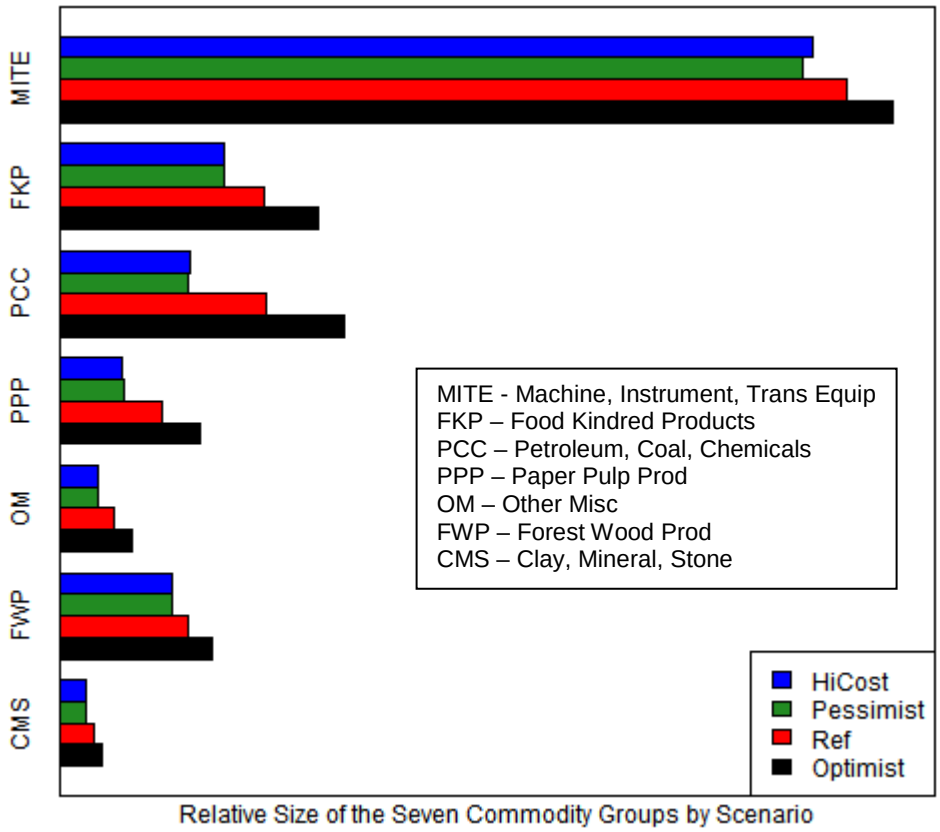
Commodity Group	Abbreviation	Statewide Share by Value	Statewide Share by Weight
Machinery, Instruments, Transport Equipment, and Metals	MITE	49	4
Other Miscellaneous	OM	17	2
Food & Kindred Products	FKP	12	12
Petroleum, Clay, Coal, & Chemicals	PCC	10	25
Paper & Pulp Products	PPP	6	4
Forest & Wood Products	FWP	5	37
Clay, Mineral & Stone	CMS	1	16

* Shares are from the Reference scenario. For more information on how the shares compare across all four scenarios, see Tables 6 and 7 in the previous section.

Figure 26 illustrates commodities produced and how they may vary under different economic conditions. This figure is provided for each ACT group. This can be used as a reference when evaluating ACT commodity production patterns. For example, the Northwest ACT's largest commodity group, Pulp and Paper Products, represents six percent of statewide commodity production by value, Over ten percent of this commodity group is produced within the Northwest ACT, making it a significant industry for the Northwest ACT, while remaining a relatively small sector for Oregon as a whole.

[9] Commodity consumption by ACT was evaluated. The ACTs followed similar consumption patterns to that of the state; no distinct differences were evident at the ACT level.

Figure 26. Range of Oregon Commodity Production Value: All Scenarios



Each ACT group profile includes a map of production flows destined to locations outside of the ACT. These maps allow the reader to quickly gauge the relative importance of other ACTs as destination markets, as well as export markets outside of Oregon. The relative importance of each commodity group to an ACT is evident by observing the relative size of the commodity pie pieces. Variation in commodity share of the ACT production across the four scenarios is also provided. The relative highway network flows for commodities transported by truck are also shown on the map to illustrate relative importance of corridors.[10]

A table reporting the share of commodity flows by ton-miles across Oregon's major corridors is presented for each ACT group. Each ACT has unique production activity and critical routes. However, the need to get goods to markets outside of Oregon is clearly needed by all areas of the state. Oregon is projected to ship approximately 60 percent of the value of goods it produces, out side state borders. On the other hand, Oregon is projected to ship roughly 70 percent of the value of goods consumed from outside of Oregon. This heavy global trading will require reliable highway, rail, and waterway networks. Table 11 illustrates the importance of the interstate corridors, since these corridors are used to move 53 to 73 percent of each commodity group flowing within Oregon.

Finally, each ACT profile will include industry growth figures similar to those presented earlier for the entire state. The ACT figures will be presented with the statewide figures to quickly reveal how the ACT differs from the state in general.

[10] To reduce the number of figures, network value flows are only shown for the Reference scenario. Flows for other scenarios are very similar to the Reference.

Table 11. Oregon Statewide Commodity Flow by Corridor, in Ton-Miles							
	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
I-5	37%	35%	40%	52%	54%	42%	46%
I-84	36%	29%	13%	8%	18%	9%	7%
US-97	3%	10%	9%	5%	7%	3%	3%
US-26	4%	4%	5%	6%	3%	7%	5%
US-20	4%	3%	3%	1%	2%	5%	4%
I-205	3%	2%	3%	5%	2%	2%	3%
US-101	1%	1%	3%	2%	1%	3%	5%
OR-30	2%	1%	2%	7%	1%	2%	1%
OR-22	1%	1%	1%	1%	1%	6%	3%
OR-126	1%	1%	1%	1%	1%	2%	2%
OR-99	1%	0%	1%	1%	0%	1%	2%
OTHER	7%	13%	19%	11%	10%	18%	19%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Northwest ACT (ACT 1)

The Northwest ACT includes Clatsop, Columbia, Tillamook and about two-thirds of Washington County. About 165,000 people currently reside in this area, representing 4% of Oregon's total population. Figure 27 presents a profile of the commodities produced in this ACT by value. There are large inventories of forested land in this ACT, supporting the Pulp and Paper Products (PPP) commodity production, a dominant area of activity for the Northwest ACT. While it may be small in terms of population, this ACT produces 11-13% of the Pulp and Paper Products produced in Oregon, with Pulp and Paper making up 12-18% of the Northwest ACT commodity production. It is important to note that demand for goods in this commodity group is affected by economic conditions, creating fluctuations in commodity production across scenarios. The other commodity groups remain fairly stable across scenarios for the Northwest ACT.

Figure 27. Northwest ACT Commodity Production by Value: All Scenarios

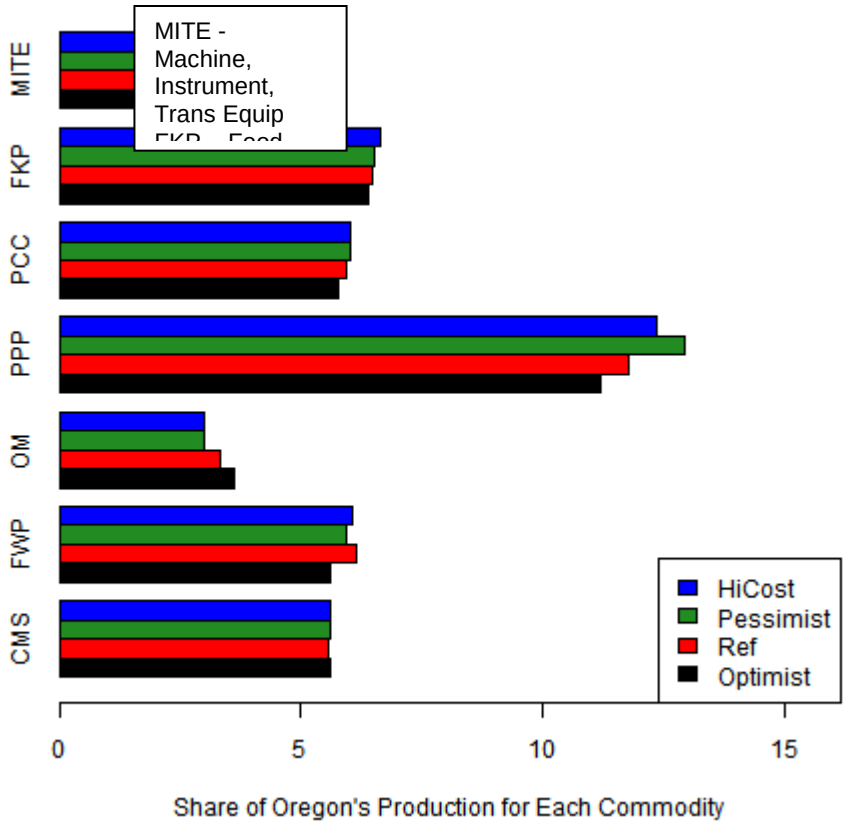


Figure 28 illustrates the destinations for commodities produced in the Northwest ACT. This ACT produces more than 4% of statewide commodities, with the exceptions of Other Miscellaneous Goods, and Machinery, Instruments, and Transportation Equipment. Since the ACT population share is 4%, this demonstrates the Northwest ACT is a relatively heavy producer of goods. The majority of Pulp and Paper products is shipped outside of Oregon. The Northwest ACT produces about 6% of Oregon's Forest and Wood Products, the majority of which is destined to the Portland area.

The upper right-hand corner of Figure 28 provides a table of shares by commodity group for the ACT economy, as well as the legend for the radar plot of commodity categories. The range of shares in this table reveals the variation in production shares across the four analysis scenarios. One can quickly see the most variation occurs in the production of the Machinery, Instruments, and Transportation Equipment group and Petroleum, Coal and Chemicals group. The lower right-hand corner of Figure 28 illustrates the relative shares of commodities destined outside of Oregon. One can quickly see that the largest export for the Northwest ACT in terms of value is Machinery and Instruments, followed by Food and Kindred Products.

Figure 28. Commodity Flow From Northwest ACT to All Destinations

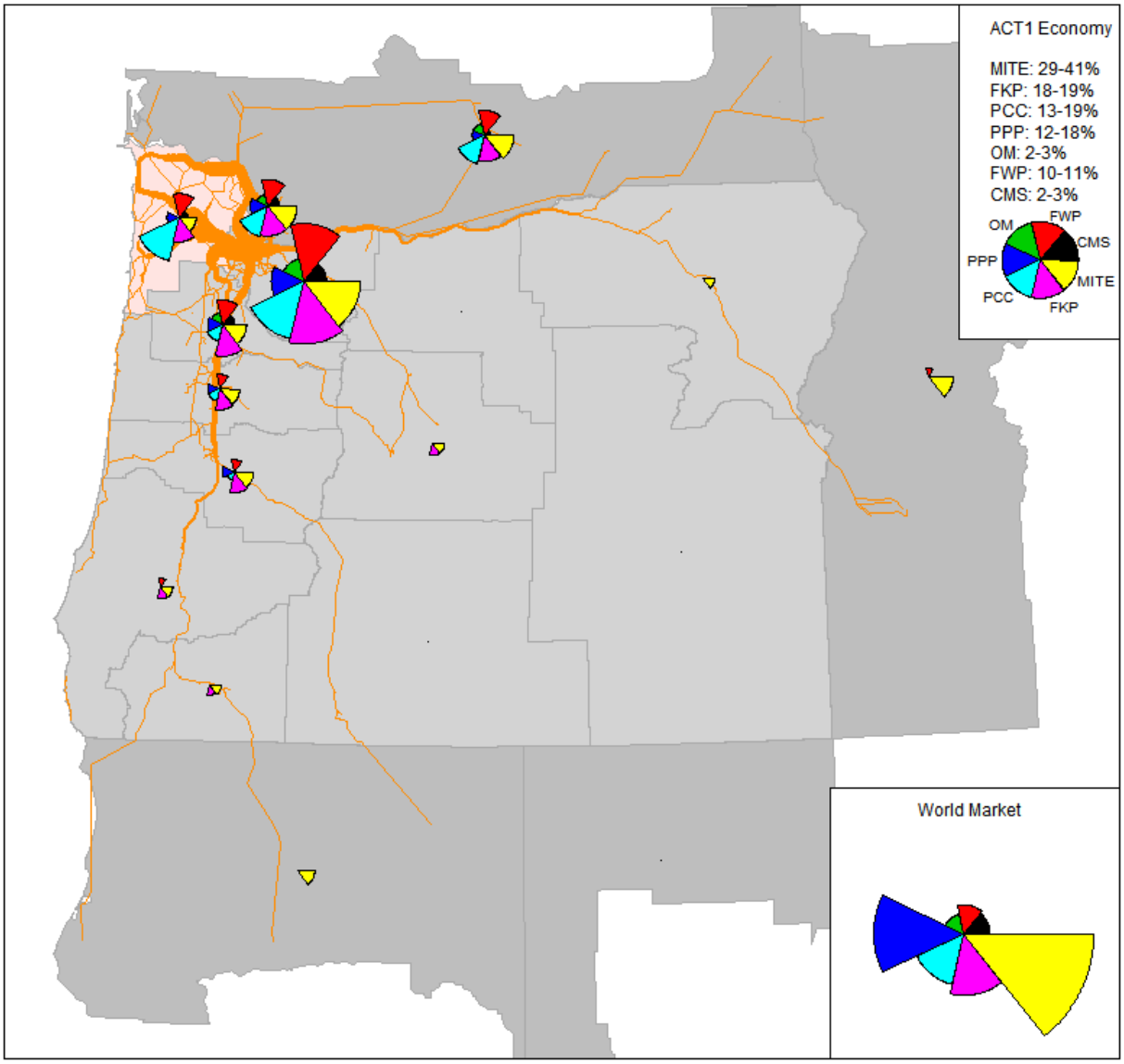


Figure 28 illustrates the relative destination flows of commodities produced in the Northwest ACT. This radar plot illustrates Northwest ACT commodity destinations for all 12 Oregon ACTs, as well as Vancouver, Washington and markets outside of Oregon to the north, south and east for all transportation modes. It is immediately apparent the top three commodities produced in the Northwest ACT, Machinery and Instruments; Food and Kindred Products; and Petroleum, Coal and Chemicals

are predominantly destined for the urban areas of Portland, Vancouver, Washington and the Willamette Valley ACTs. The remaining commodity sectors make up the balance of the ACT economy and are distributed fairly evenly across Oregon and the World Market based on relative size of these destination markets. The orange highway network flows represent commodities carried via truck only. To gain better insight into corridors of significance to each ACT, Table 12 provides the share of commodity ton-miles by highway corridor.

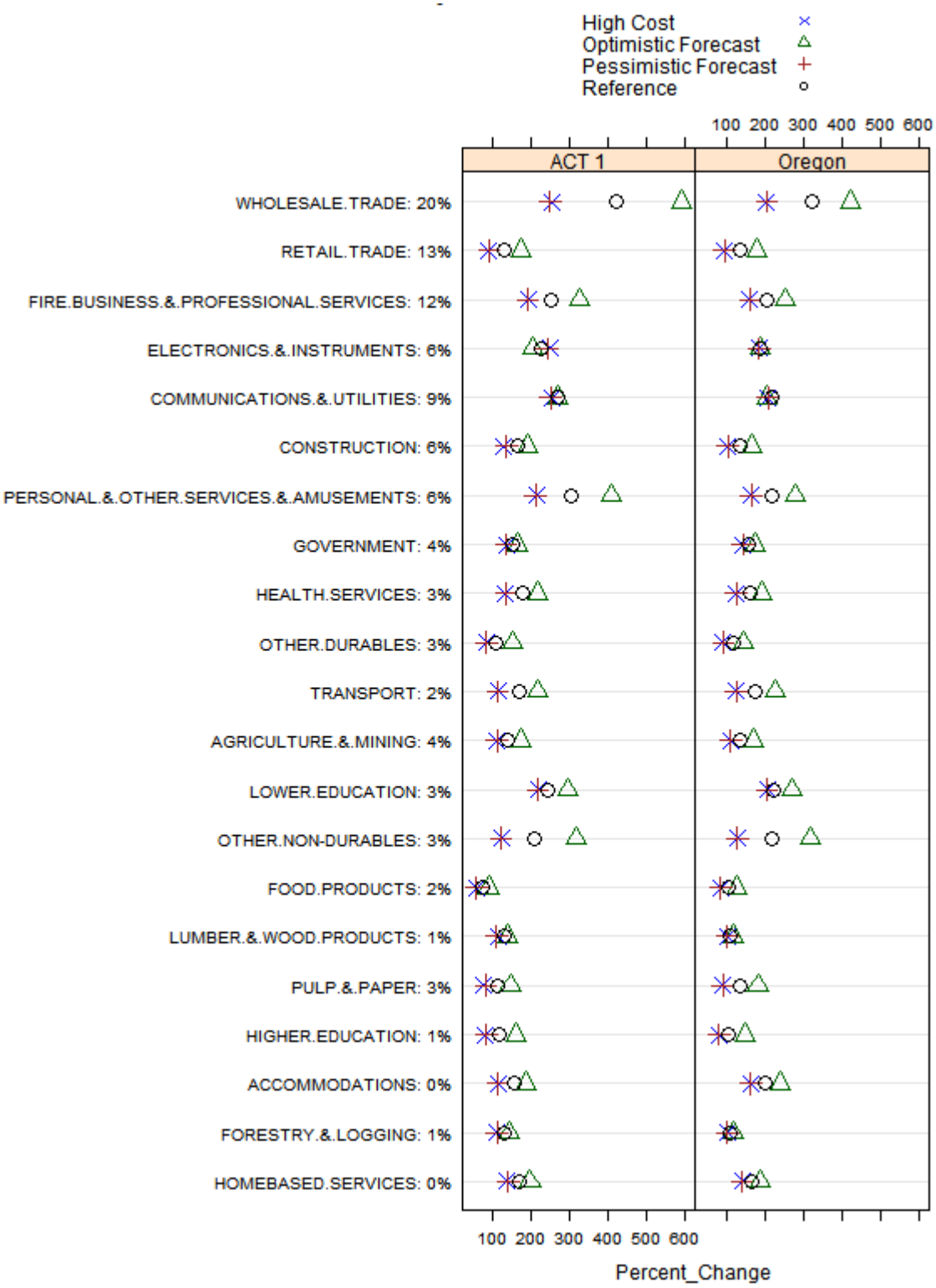
Given the location of the Northwest ACT, a relatively small number of corridors dominate commodity highway movement. The Northwest ACT relies on US-30, US-26 and US-101 to get goods to the interstate and other modes such as rail, air and water facilities. Table 12 illustrates the relative significance of the corridors utilized to transport goods to market from the Northwest ACT.

Table 12. Northwest ACT Commodity Flow by Corridor, in Ton-Miles

	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
I-5	25%	30%	13%	25%	30%	17%	21%
US-30	20%	11%	24%	41%	19%	14%	13%
US-26	14%	15%	22%	9%	15%	22%	14%
US-101	6%	8%	10%	5%	9%	9%	13%
OR-47	6%	4%	6%	3%	3%	8%	8%
I-84	11%	12%	1%	2%	5%	2%	2%
OR-6	3%	5%	9%	1%	3%	6%	3%
OR-22	2%	3%	2%	1%	5%	6%	5%
OR-103	1%	1%	1%	1%	1%	3%	4%
OTHER	12%	11%	12%	12%	10%	13%	17%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Twenty-year industry growth for the Northwest ACT is similar to that of the state as a whole. Figure 29 presents the percent change over twenty years of industry output for the ACT and state by industry group for all four scenarios. The industries are listed in order of ACT share of output and the shares are listed after the industry name. The top five industry groups represent sixty percent of total ACT industry output. The industries subject to the most economic volatility are Wholesale Trade; Personal and Other Services; and Other Non-Durables; combined they represent 29% of industry activity in the Northwest ACT. Growth in Wholesale Trade; FIRE, Business and Professional Services; Personal and Other Services is greater than the state as a whole.

Figure 29. Northwest ACT Percent Change in Output by Industry from 2006 to 2027, All Scenarios (including percent of statewide output by industry)



Portland Metro Area (ACT 2)

The Portland Metro Area contains the majority of Oregon's population, representing about 40% of statewide population. A large amount of commodity production for the state comes from the Portland Metro area: about sixty percent of statewide production of Machinery and Instruments and Other Miscellaneous goods and around fifty percent of Pulp and Paper Products, as illustrated in Figure 30. Production activity for Forestry or Wood Products is fairly low in this area. Growth rates for Other Miscellaneous, Pulp and Paper Products, and Petroleum, Coal and Chemicals are subject variation due to economic conditions.

Figure 30. Portland Metro Area Commodity Production by Value: All Scenarios

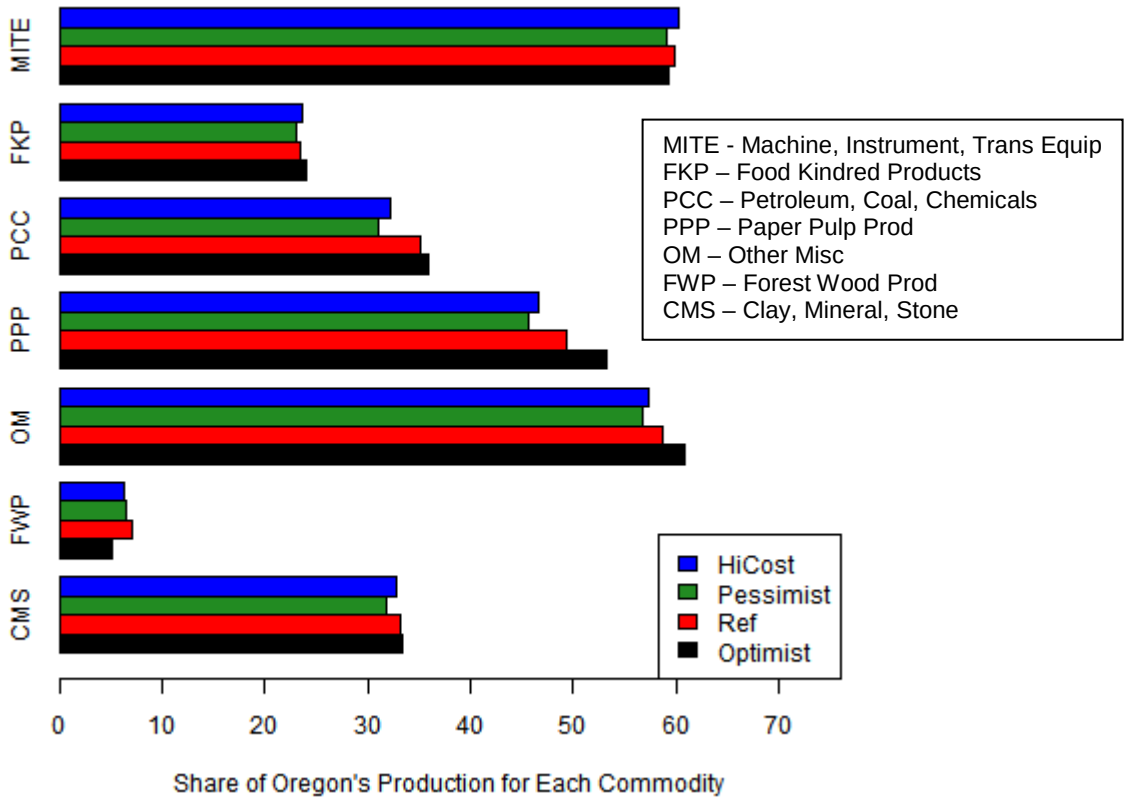


Figure 31 illustrates the destinations of commodities produced in the Portland Metro area for all transport modes. Sixty-two to seventy-six percent of the value of goods destined to market is Machinery and Instruments, which is predominantly destined to export markets, but consumed within the state as well. Other commodity production in Portland represent relatively small proportion of production in terms of value, none making up more than 15% of the Portland economy.

Figure 31. Commodity Flow From Portland Metro ACT to All Destinations

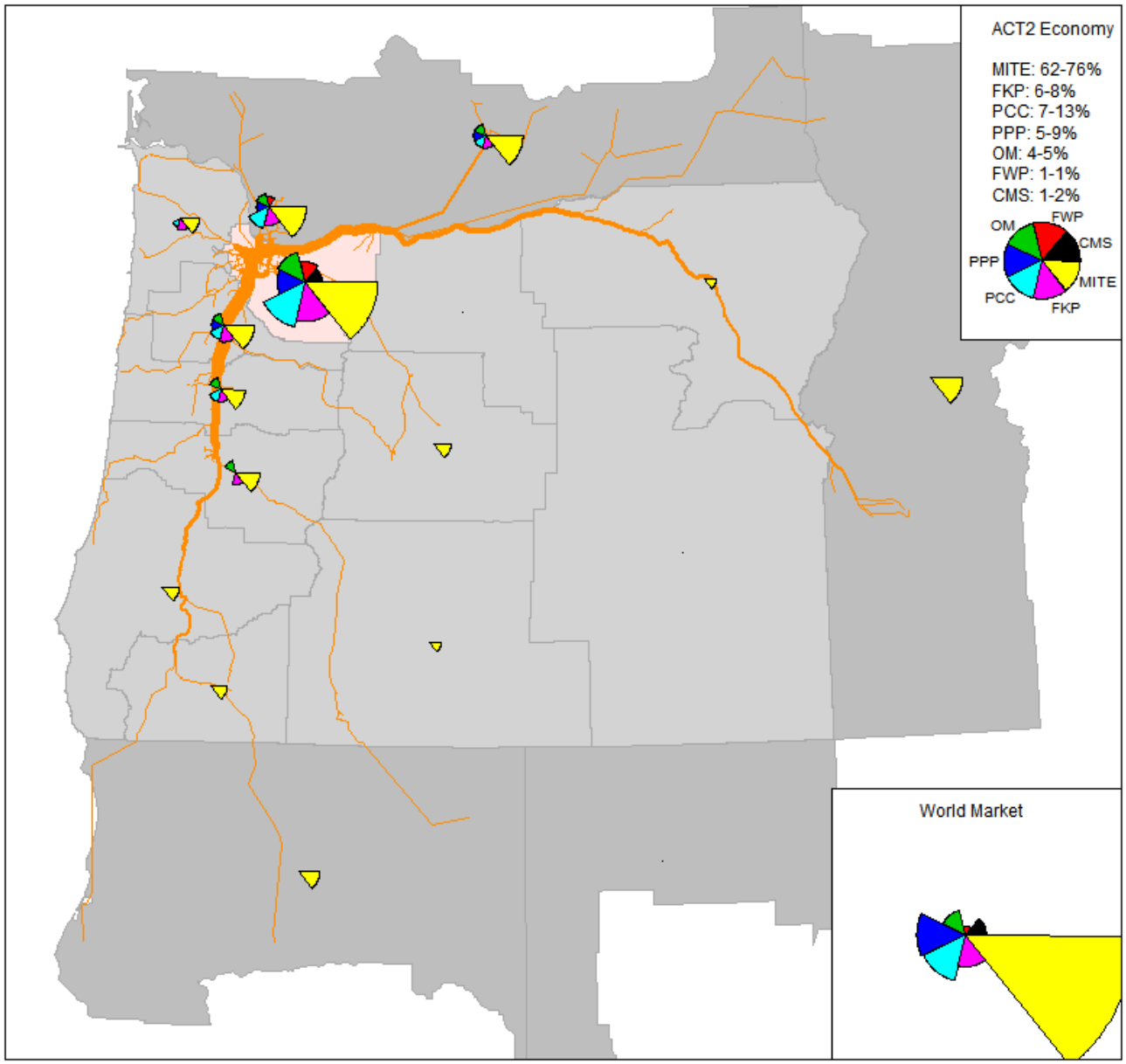


Table 13 presents the relative significance of highway corridors used to transport goods to market for the Portland Metro Area. The Portland Area relies significantly on US-26 and I-205, as well as throughways I-5 and I-84 for its highway commodity flows. Additionally, the Port of Portland and the rail network are critical to the area's (and State's) freight movement to markets. Depending on commodity group, between thirteen and twenty-eight percent of goods travel on other surrounding highways that flow into the main interstate corridors.

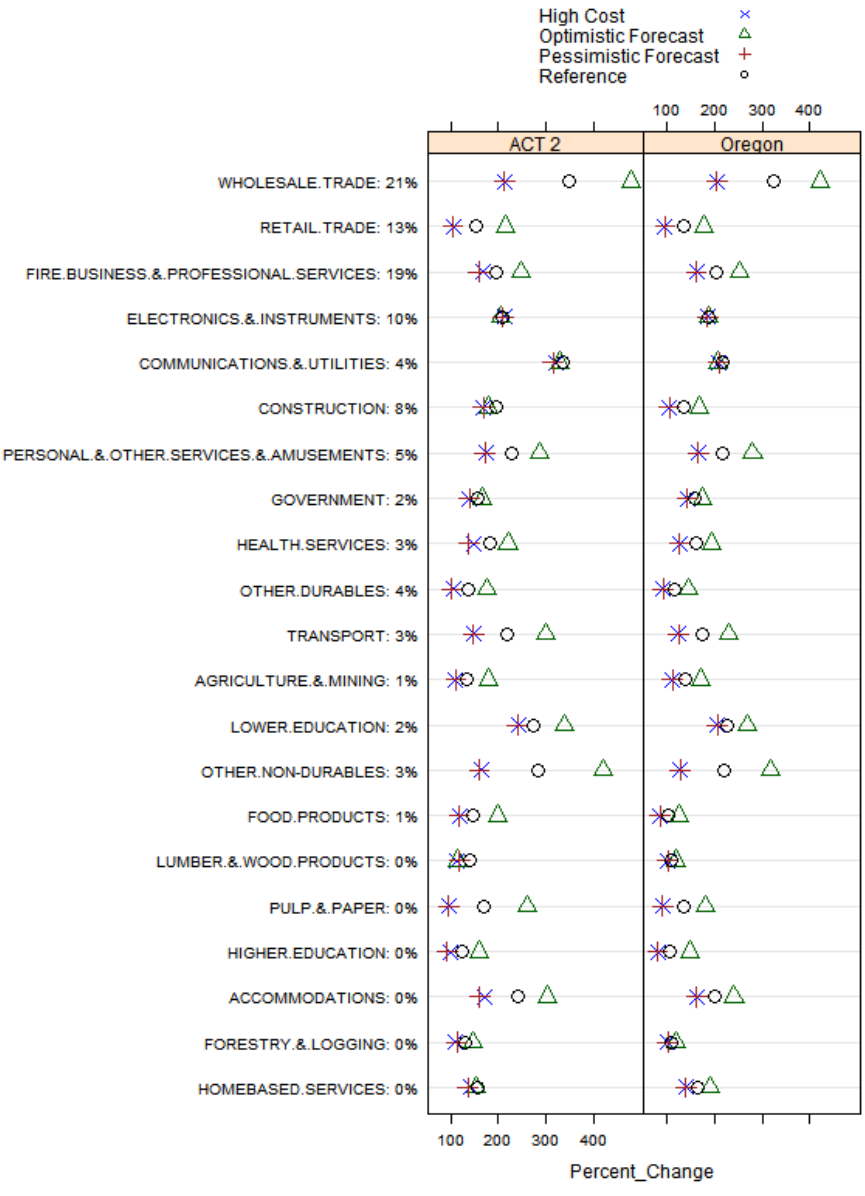
Figure 32 presents the percent change in output by industry over twenty years for all four scenarios. Over half of Portland's industry activity occurs within the industries of Wholesale Trade, Retail Trade and FIRE, Business and Professional Services (percentages are listed after the row's industry title).

Under the Optimistic scenario, the Wholesale Trade and Retail industries increase more than the state as a whole. Communications and Utilities, Transportation, Lower Education, Other Non-Durables, Food Products, Pulp and Paper, and Accommodations grow more over time than the state in its entirety.

Table 13. Portland Metro Commodity Flow by Corridor in Ton-Miles

	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
I-5	34%	33%	41%	46%	60%	47%	39%
I-84	38%	41%	9%	12%	12%	11%	12%
US-26	8%	6%	12%	8%	6%	11%	12%
I-205	7%	5%	10%	15%	9%	5%	10%
OTHER	13%	15%	28%	19%	13%	26%	27%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 32. Portland Metro Area Percent Change in Output by Industry from 2006 to 2027, All Scenarios (including percent of statewide output by industry)

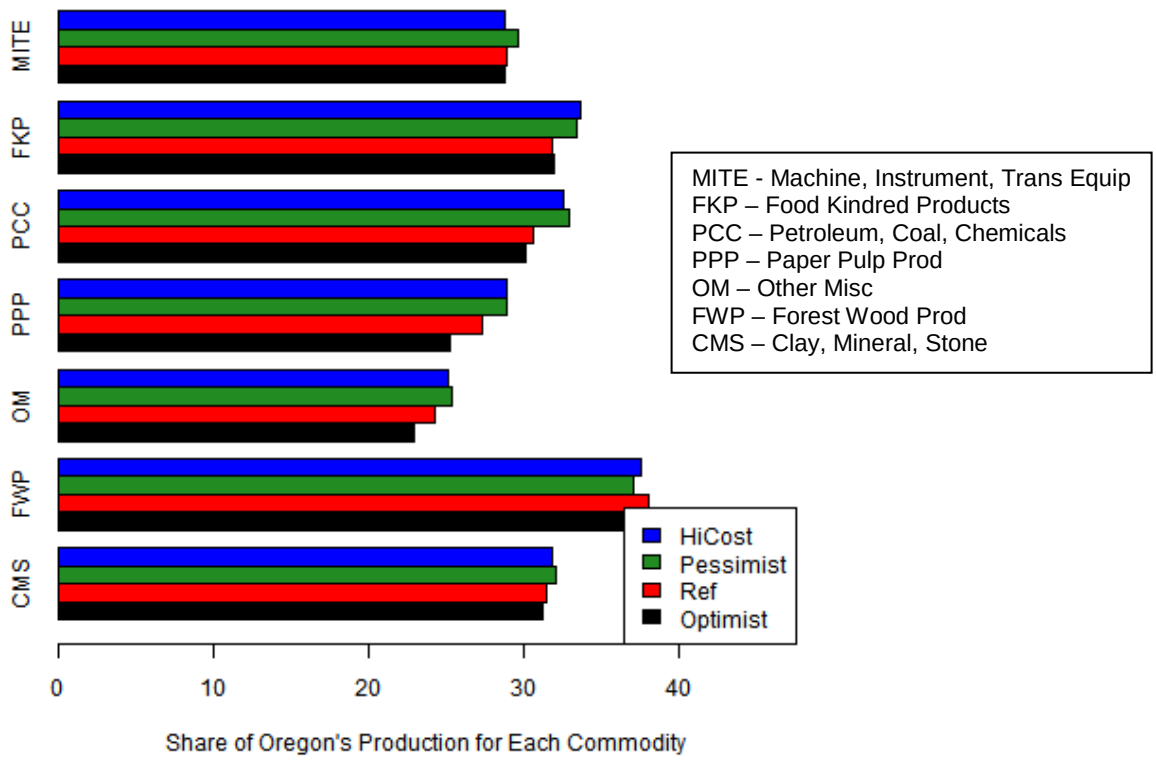


Willamette Valley Area (ACTs 8, 9, & 12)

The Willamette Valley area includes three ACTs: Mid-Willamette Valley, Cascades West, and Lane County, bound together by similar geography and use of the transportation network. All of these ACTs utilize I-5 as their major shipping artery along with the rail-line which runs alongside I-5. Direct access to these corridors enables Willamette Valley firms to quickly ship to areas along I-5 and to markets outside of Oregon. The Willamette Valley ACTs make up 28% of Oregon's Population (Mid-Willamette – 12%, Cascades West – 6%, and Lane County – 10%).

Figure 33 presents a profile of the commodities produced in the area by value. The magnitude of commodity production within these ACT's is consistent with its population share and balanced across many commodities. Production is somewhat pronounced in Forest and Wood Products, about thirty-five percent of state production, while Other Miscellaneous goods is less prominent. Willamette Valley is exposed to the effects of economic uncertainty given production shares for commodities sensitive to economic conditions, such as Pulp and Paper Products; Other Miscellaneous Goods; Petroleum, Coal and Chemicals; and Food and Kindred Products.

Figure 33. Willamette Valley Area Commodity Production by Value: All Scenarios



Figures 34, 35 and 36 map the destinations for commodities produced in the three Willamette Valley area ACTs. Unlike the rest of Oregon, nearly half of the goods produced in the Willamette Valley area are destined outside of the state, while close to half remains in the Willamette Valley and Portland Metro area. This pattern results in heavy reliance on the I-5 corridor for these ACTs, as well as OR18 and OR22 for the Mid-Willamette Valley ACT, US20, OR34 and OR58 for Cascades West ACT, and OR126 and US20 and OR58 for Lane County ACT. Detail regarding ACT reliance on specific highway corridors is provided in Tables 14, 15, and 16.

Figure 34. Commodity Flow From Mid-Willamette Valley ACT to All Destinations

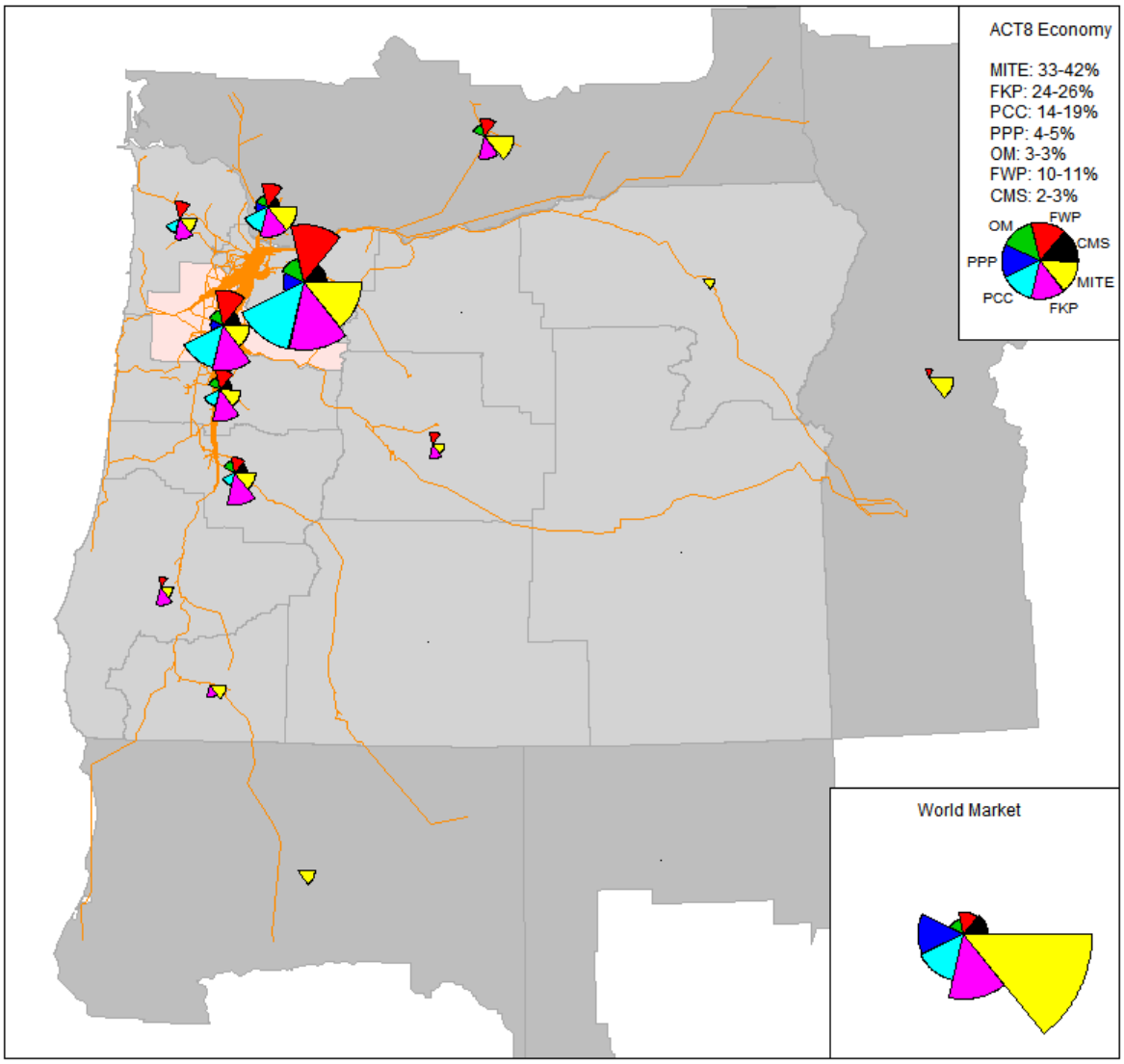


Table 14. Mid-Willamette Valley ACT Commodity Flow by Corridor in Ton-Miles

	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
I-5	55%	56%	63%	72%	67%	47%	57%
OR-22	3%	5%	7%	3%	5%	20%	9%
I-84	22%	17%	2%	3%	10%	2%	2%
OR-18	2%	2%	3%	1%	1%	5%	4%
US-20	1%	1%	2%	1%	1%	3%	2%
OR-223	1%	1%	1%	0%	0%	3%	2%
OTHER	16%	18%	22%	20%	16%	20%	24%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 35. Commodity Flow From Cascades West ACT to All Destinations

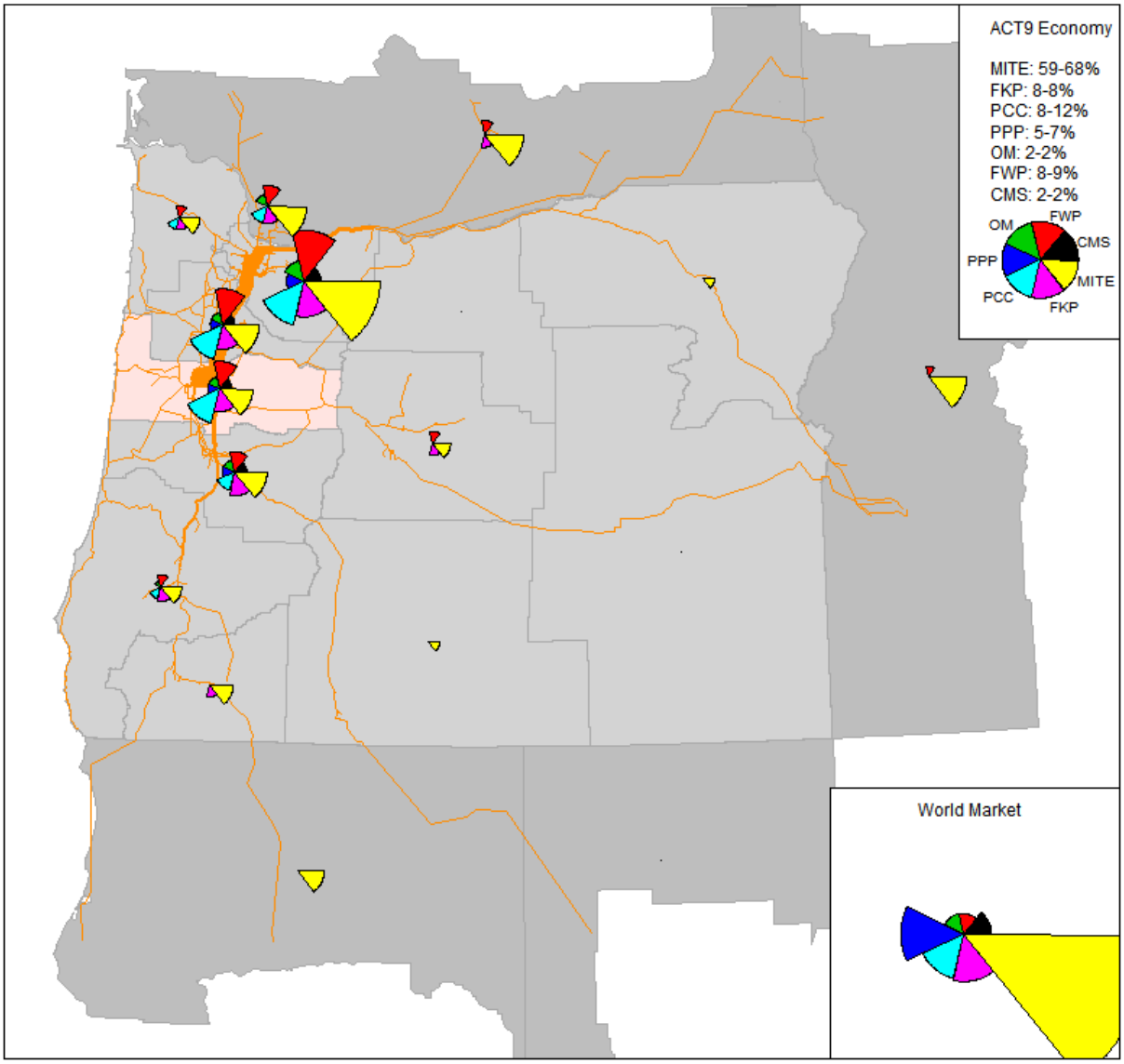


Table 15. Cascades West ACT Commodity Flow by Corridor in Ton-Miles

	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
I-5	52%	52%	60%	58%	68%	46%	47%
US20	8%	9%	7%	7%	7%	17%	12%
OR-22	1%	3%	3%	3%	2%	8%	4%
US-101	3%	5%	7%	5%	4%	4%	12%
OR-34	3%	3%	4%	6%	2%	6%	6%
I-84	25%	14%	1%	2%	5%	1%	0%
OTHER	8	14%	18%	19%	12%	18%	19%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 36. Commodity Flow From Lane County ACT to All Destinations

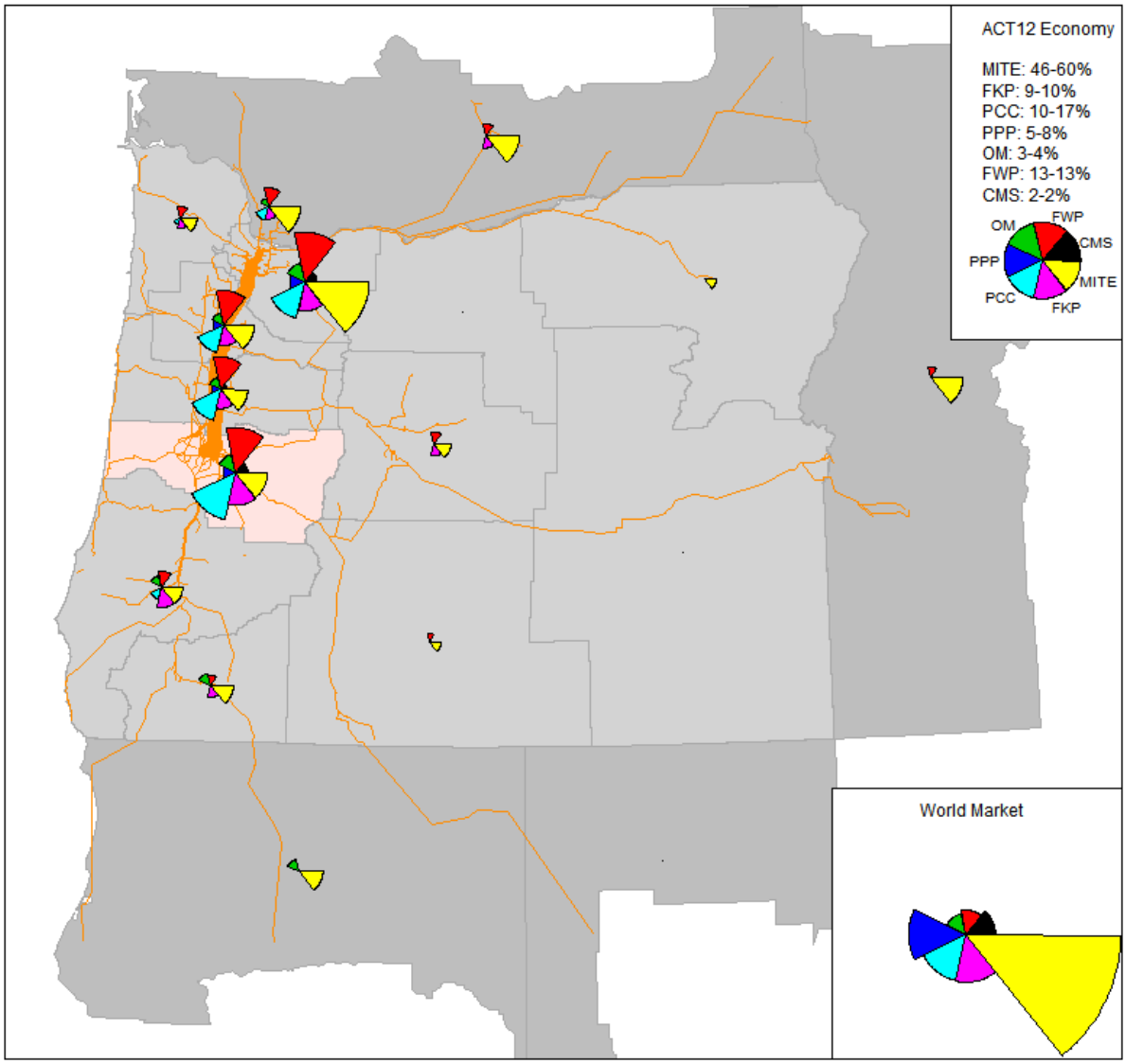
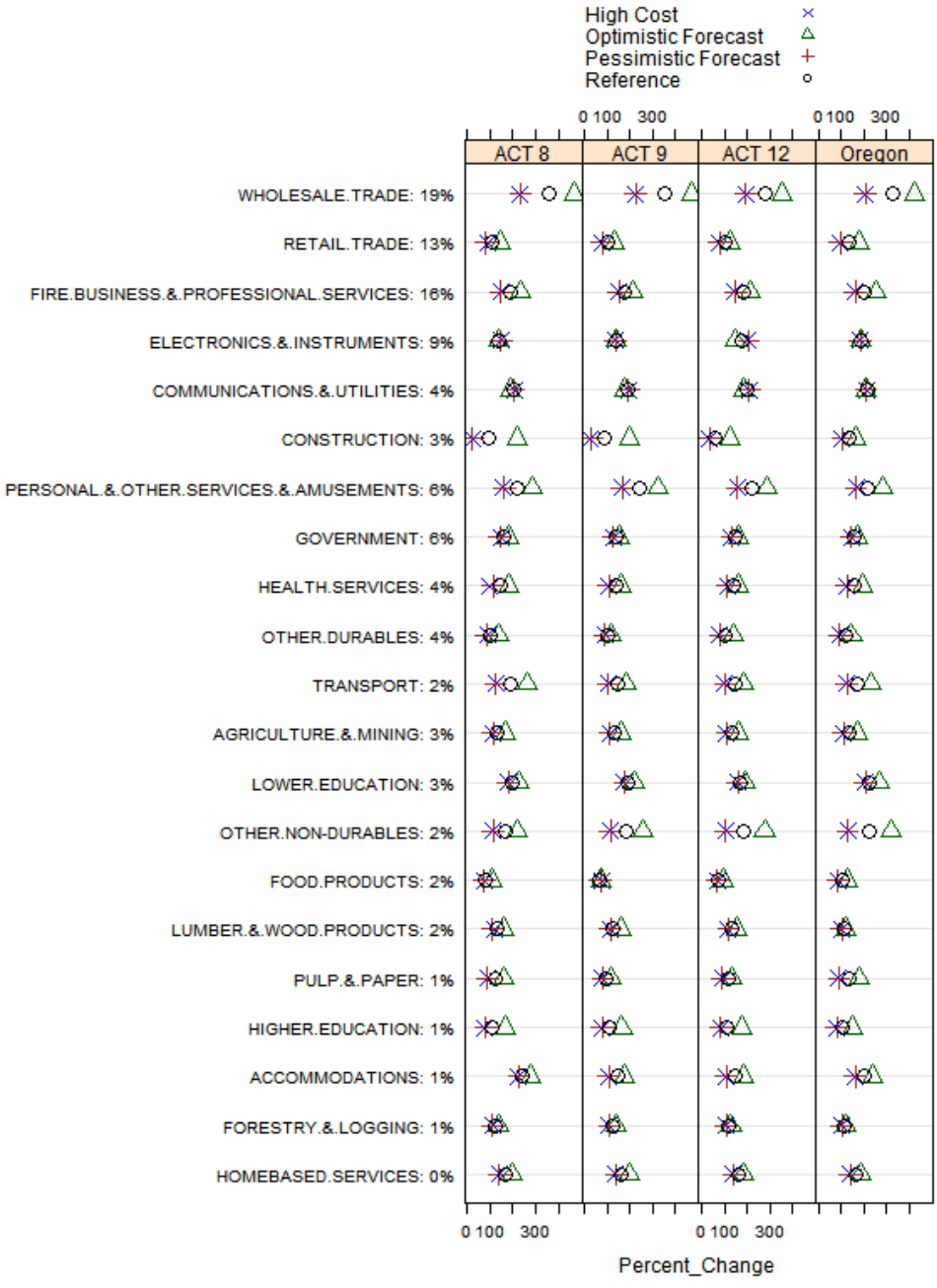


Table 16. Lane County ACT Commodity Flow by Corridor in Ton-Miles

	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
I-5	72%	70%	75%	81%	81%	63%	68%
OR-126	3%	3%	5%	4%	3%	8%	5%
OR-58	1%	2%	3%	1%	2%	5%	1%
US-20	10%	5%	2%	1%	3%	3%	3%
US-101	1%	1%	2%	2%	1%	2%	4%
OTHER	13%	19%	13%	11%	10%	19%	19%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 37 presents the percent change in industry output over twenty years for all four scenarios. There is more variation across scenarios in Wholesale Trade activity in the Mid-Willamette Valley and Cascades West ACTs than the Lane County ACT or the state. The Electronics and Instruments group varies very little across scenarios, with the exception of the Lane County ACT. Construction activity in the Mid-Willamette Valley and Cascades West ACTs vary more across scenarios than the state or Lane County ACT. Mid-Willamette Valley ACT Construction activity varies more across scenarios than the state or the other two Valley ACTs. On the other hand, there is less variation in Other Non-Durables in the Mid-Willamette Valley than Cascades West, Lane County ACT and the state. Finally, higher education grows more for the three Willamette Valley ACTs under strong economic conditions that the state as a whole, which is understandable considering the number of universities in the area.

Figure 37. Willamette Valley ACTs Percent Change in Output by Industry from 2006 to 2027, All Scenarios (including percent of statewide output by industry)

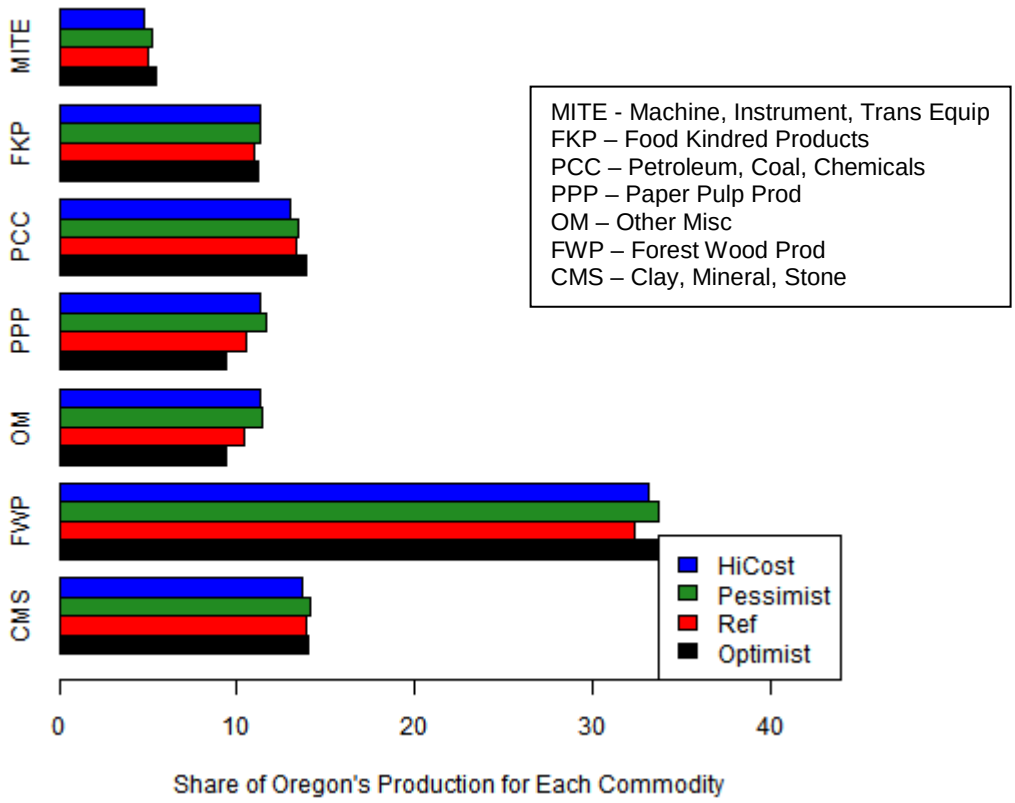


Southwest Oregon (ACTs 4, 5 & 10)

Southwest Oregon, consisting of Southwest ACT (10); Rogue Valley ACT (5); and South Central Oregon ACT (4), makes up about 15% of Oregon's population, including Rouge Valley MPO (RVMPO). Figure 38 provides a profile of the commodities produced in the area in terms of value. Southwest Oregon's economy is predominantly focused on Forest and Wood Products, with a full third of Oregon's statewide production coming out of this area.

Other commodity production shares more closely match the population share for the area, except for the relatively low share of Machinery and Instruments production, only five percent of Oregon's total production. However, this group is a high value commodity that represents a large proportion of the Southwest Oregon economy (South Central Oregon 12-18 percent; Rogue Valley ACT 32 – 41 percent; and South West ACT 18 to 22 percent of total commodity value produced).

Figure 38. Southwest Oregon Commodity Production by Value: All Scenarios



Figures 39, 40, and 41 map the destinations of commodities produced in the three Southwest ACTs. This area of the state requires well maintained local state routes to support access to the interstate routes to get commodities to distant markets. Machinery and Instruments; Food and Kindred Products; and Forest and Wood Products are primarily destined out of the immediate area to the World Market and larger population centers within Oregon.

Tables 17, 18 and 19 illustrate the relative importance of highway corridors used to transport goods to market for the Southwest Oregon area. To ship these commodities to destination markets, this area relies on Oregon routes (OR-140, OR-199, OR-126, and OR58,), as well as the interstate system (I-5, US-97, and US-101.)

Figure 39. Commodity Flow From South Central ACT to All Destinations

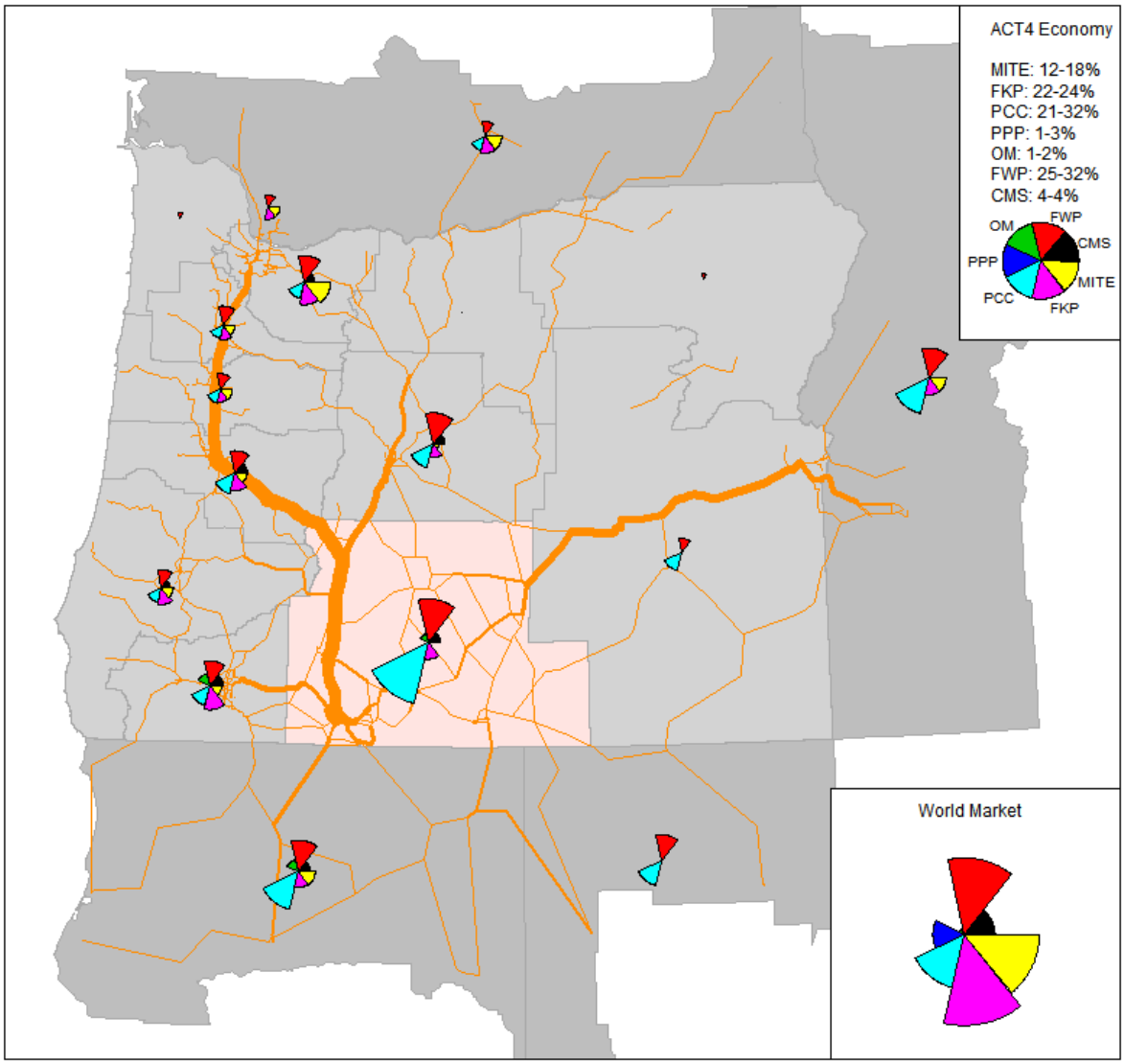


Table 17. South Central Oregon ACT Commodity Flow by Corridor in Ton-Miles

	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
US-97	36%	41%	56%	39%	43%	32%	42%
OR-140	8%	11%	12%	2%	13%	18%	23%
OR-58	16%	9%	6%	23%	11%	16%	10%
I-5	15%	9%	5%	28%	9%	11%	9%
US-20	11%	10%	3%	0%	2%	5%	2%
OR-395	6%	6%	6%	2%	4%	2%	3%
OTHER	8%	14%	12%	6%	18%	16%	11%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 40. Commodity Flow From Rogue Valley ACT to All Destinations

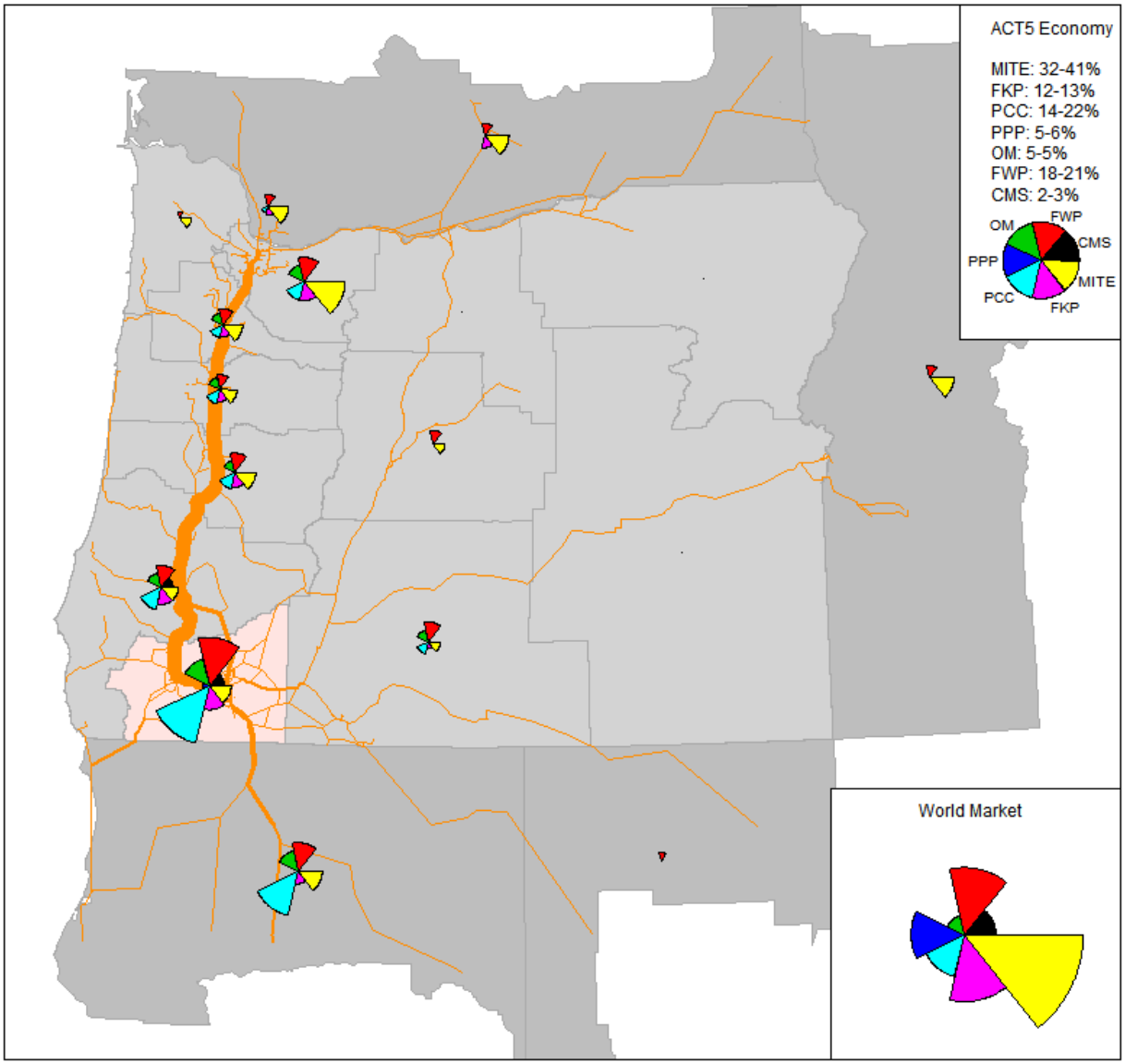


Table 18. Rogue Valley ACT Commodity Flow by Corridor in Ton-Miles							
	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
I-5	78%	76%	77%	88%	90%	64%	61%
OR-199	1%	2%	7%	1%	1%	5%	5%
OR-140	1%	2%	2%	0%	1%	6%	2%
US-97	4%	3%	2%	1%	2%	5%	4%
OR-62	2%	2%	3%	1%	1%	5%	2%
OTHER	14%	15%	9%	9%	5%	15%	26%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 41. Commodity Flow From South West ACT to All Destinations

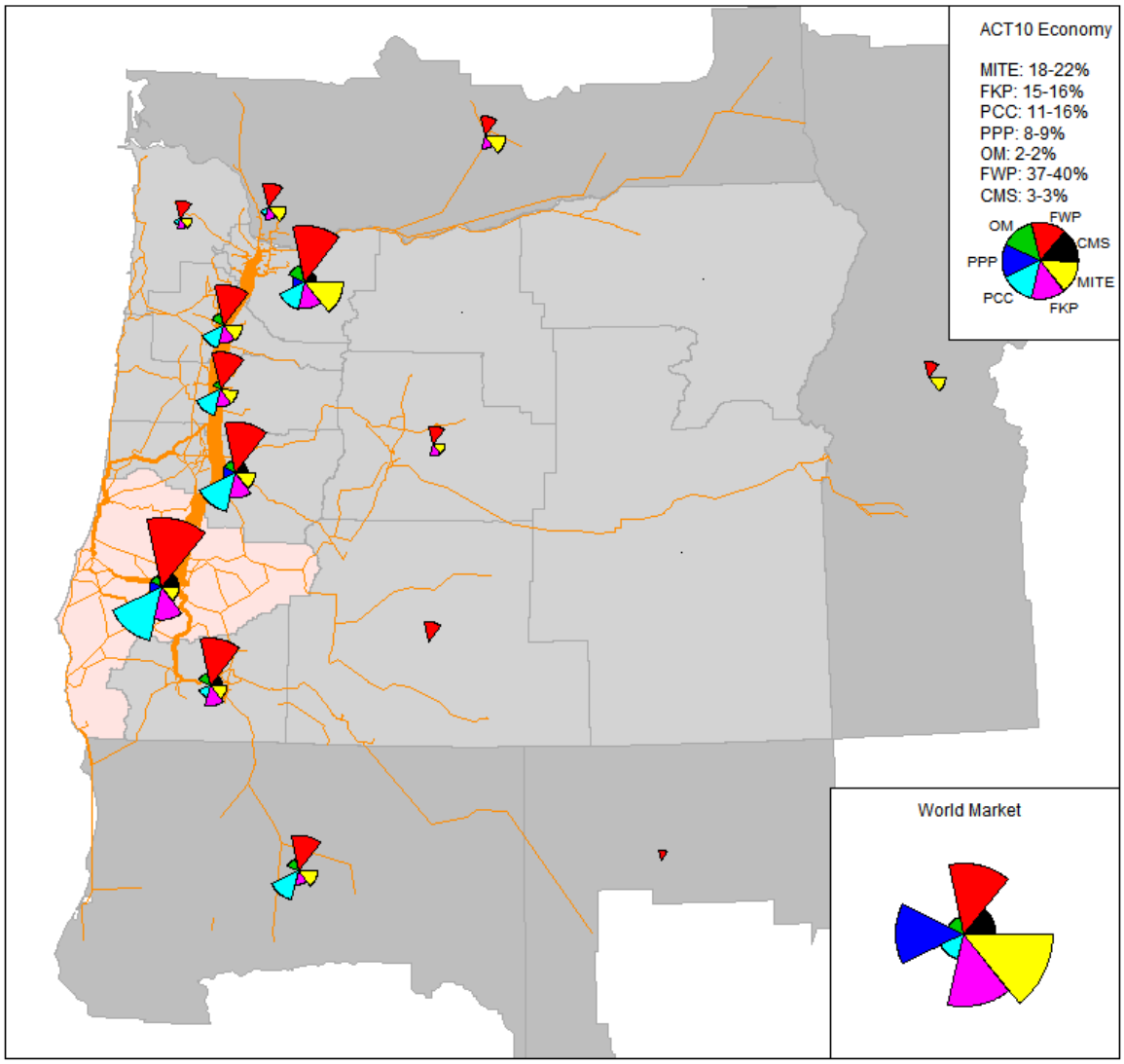
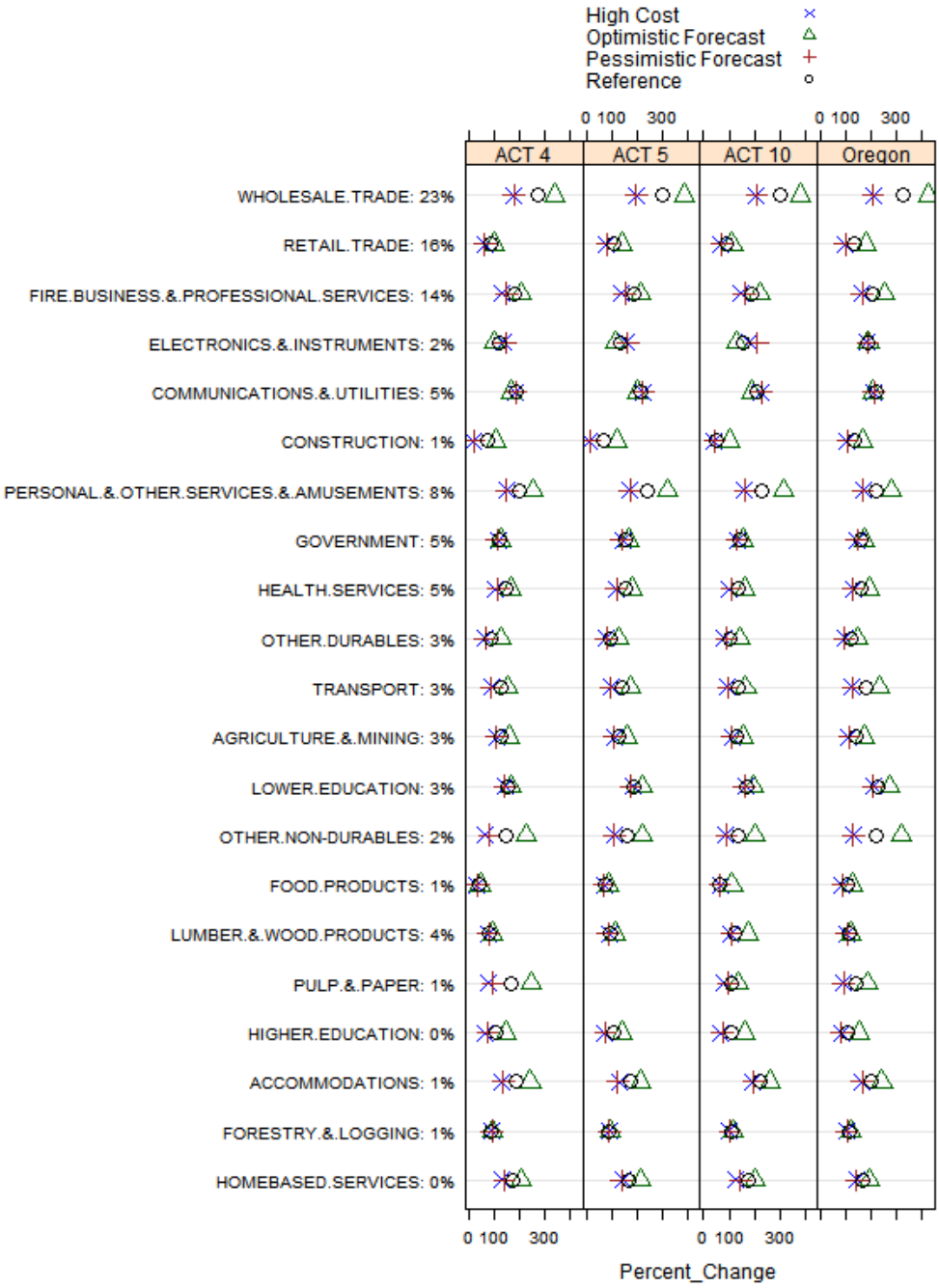


Table 19. South West ACT Commodity Flow by Corridor in Ton-Miles

	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
I-5	63%	72%	68%	60%	69%	67%	56%
US-101	11%	11%	14%	14%	11%	9%	25%
OR-126	6%	3%	6%	7%	6%	4%	4%
OR-42	1%	3%	3%	1%	2%	5%	4%
OR-38	0%	1%	1%	6%	2%	3%	1%
OTHER	19%	10%	8%	12%	10%	12%	10%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 42 presents the percent change in industry output over twenty years for all four scenarios. South West Oregon follows the state trends very closely. Two industries that vary under different economic conditions play a significant role in the South West economy: Wholesale Trade and Personal & Other Services & Amusements, making up over 30 percent of the regional economy. Fluctuations in these industries impact regional production and employment. Note that the South Central Oregon Act (4) realizes greater variability in the Pulp and Paper industry than the state in general.

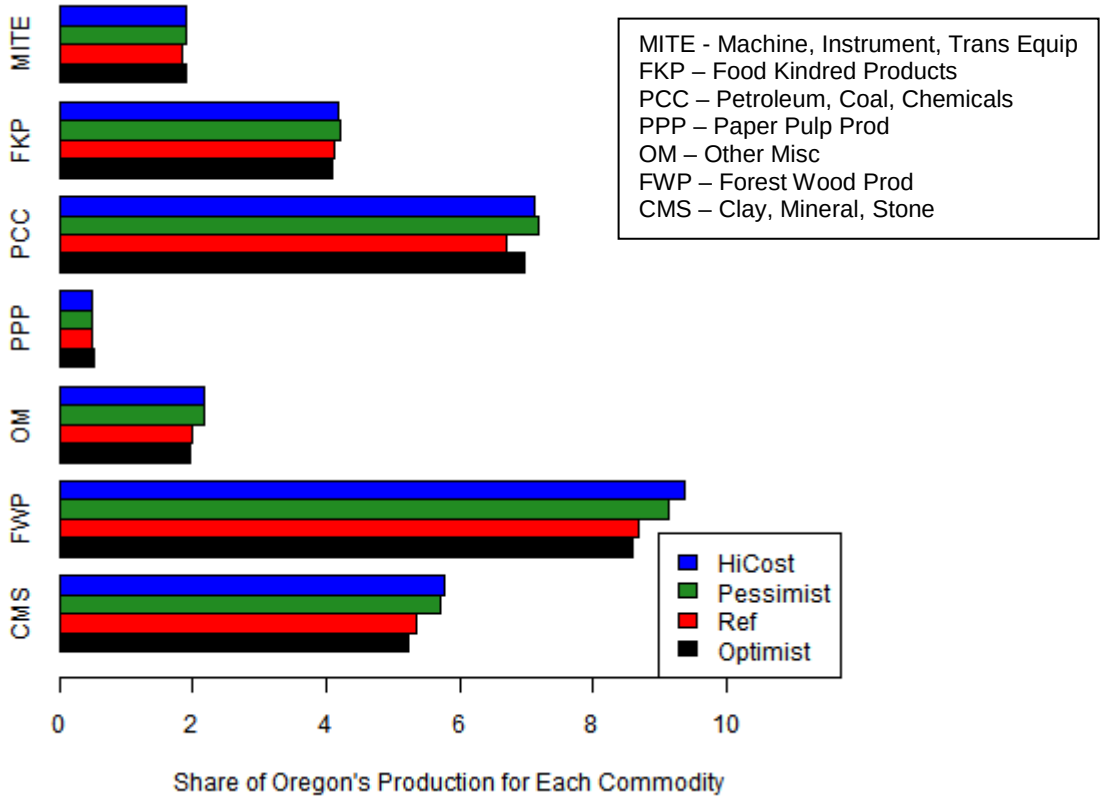
Figure 42. South West Oregon Percent Change in Output by Industry from 2006 to 2027, All Scenarios (including percent of statewide output by industry)



Central Oregon (ACTs 6 & 7)

Central Oregon includes two ACTs: Lower John Day (6) and Central Oregon (7.) Lower John Day ACT population center is the City of The Dalles along the Columbia Gorge. Central Oregon ACT includes the cities of Bend, Redmond and Prineville. Together, these two ACTs represent about 7% of Oregon's population, over eighty percent of which are located in the Central Oregon ACT. Figure 43 provides a profile of the commodities produced in the area in terms of value. Central Oregon's economy is predominantly focused on Forest and Wood Products and Petroleum, Coal and Chemicals group. This area produces a disproportionately high share of statewide production of Forest and Wood products. The share of commodity production remains fairly stable as economic conditions change, compared to other areas of Oregon.

Figure 43. Central Oregon Commodity Production by Value: All Scenarios



Figures 44 and 45 illustrate the destinations of commodities produced in the two Central Oregon ACTs. The Lower John Day ACT economy is dominated by production of Food and Kindred Products and Petroleum, Coal and Chemicals. Together these two groups cover between sixty and seventy percent of the commodity production in this ACT. Figure 44 includes commodity flows for all modes, so the port activity within the ACT is included. One can see the predominant destination for Petroleum, Coal and Chemicals is to the north, with internal destinations in the Portland area, internally within Lower John Day Act and to the east in the North East ACT. Food and Kindred Products are predominantly destined for the Portland and Vancouver area, and other population centers of the state. Machinery and Instruments group represents about twenty percent of the ACT economy, with destination markets to the north, Portland and Vancouver, and the Willamette Valley. Shipping via the Columbia River is important to the Lower John Day ACT, including the rail line. More

detail related to activity at the ports is available from other research done in support of the Oregon Freight Plan.

Several highway corridors are important for commodity flows for this area. Table 20 illustrates the relative importance of highway corridors used to transport goods to market for the Lower John Day ACT. A large share of goods are shipped to the Portland/Vancouver area and out of state, making both I-5 and I-84, US97, US26, US20 and US-197 important corridors for Central Oregon.

Figure 44. Commodity Flow From Lower John Day ACT to All Destinations

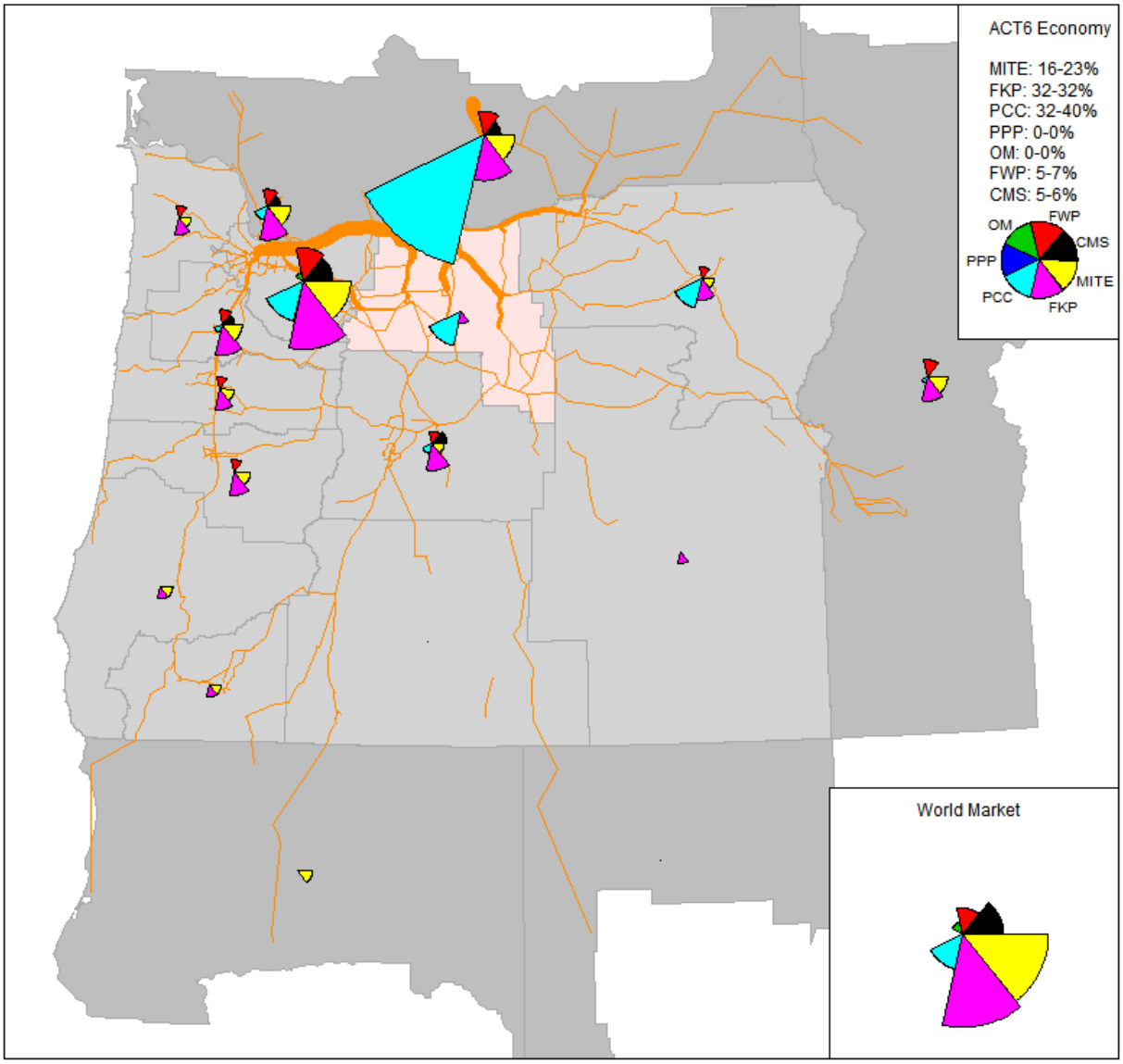


Table 20. Lower John Day ACT Commodity Flow by Corridor in Ton-Miles							
	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
I-84	70%	37%	29%	62%	47%	35%	19%
US-97	8%	17%	30%	21%	19%	10%	39%
US-26	2%	7%	9%	1%	1%	19%	22%
I-5	9%	14%	1%	7%	18%	8%	3%
US-197	6%	5%	10%	5%	6%	6%	9%
OR-206	1%	6%	7%	0%	3%	5%	1%
OR-19	1%	2%	5%	0%	1%	3%	1%
OTHER	3%	12%	9%	4%	5%	14%	6%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 45 illustrates the destinations of commodities produced in the Central Oregon ACT. The Central Oregon ACT economy is dominated by four commodity groups: Machinery and Instruments; Forest or Wood Products; Petroleum, Coal and Chemicals; and Food and Kindred Products. These four groups make up over eighty percent of the economy. Destination markets for Machinery and Instruments are mostly the Portland area and out of state, Forest or Wood Products and Petroleum, Coal and Chemicals are shipped within the Central Oregon ACT, Portland, and out of state. Food and Kindred Products are destined for Portland, the Willamette Valley region, within the ACT itself, as well as outside of the state.

Most goods are transported via truck, as can be seen in Figure 45 by the orange highway network flows. Table 21 illustrates the relative significance of highway corridors used to transport Central Oregon goods to destination markets. Significant corridors for this area include US-97, US-26, and US-20.

Table 21. Central Oregon ACT Commodity Flow by Corridor in Ton-Miles							
	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
US-97	29%	49%	62%	45%	48%	18%	34%
US-26	27%	14%	17%	36%	17%	33%	22%
US-20	21%	13%	6%	5%	13%	16%	17%
OR-126	4%	2%	2%	3%	3%	8%	7%
OR-22	5%	2%	2%	2%	8%	6%	4%
I-84	4%	8%	2%	4%	3%	3%	1%
OTHER	10%	12%	9%	5%	8%	16%	15%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 45. Commodity Flow From Central Oregon ACT to All Destinations

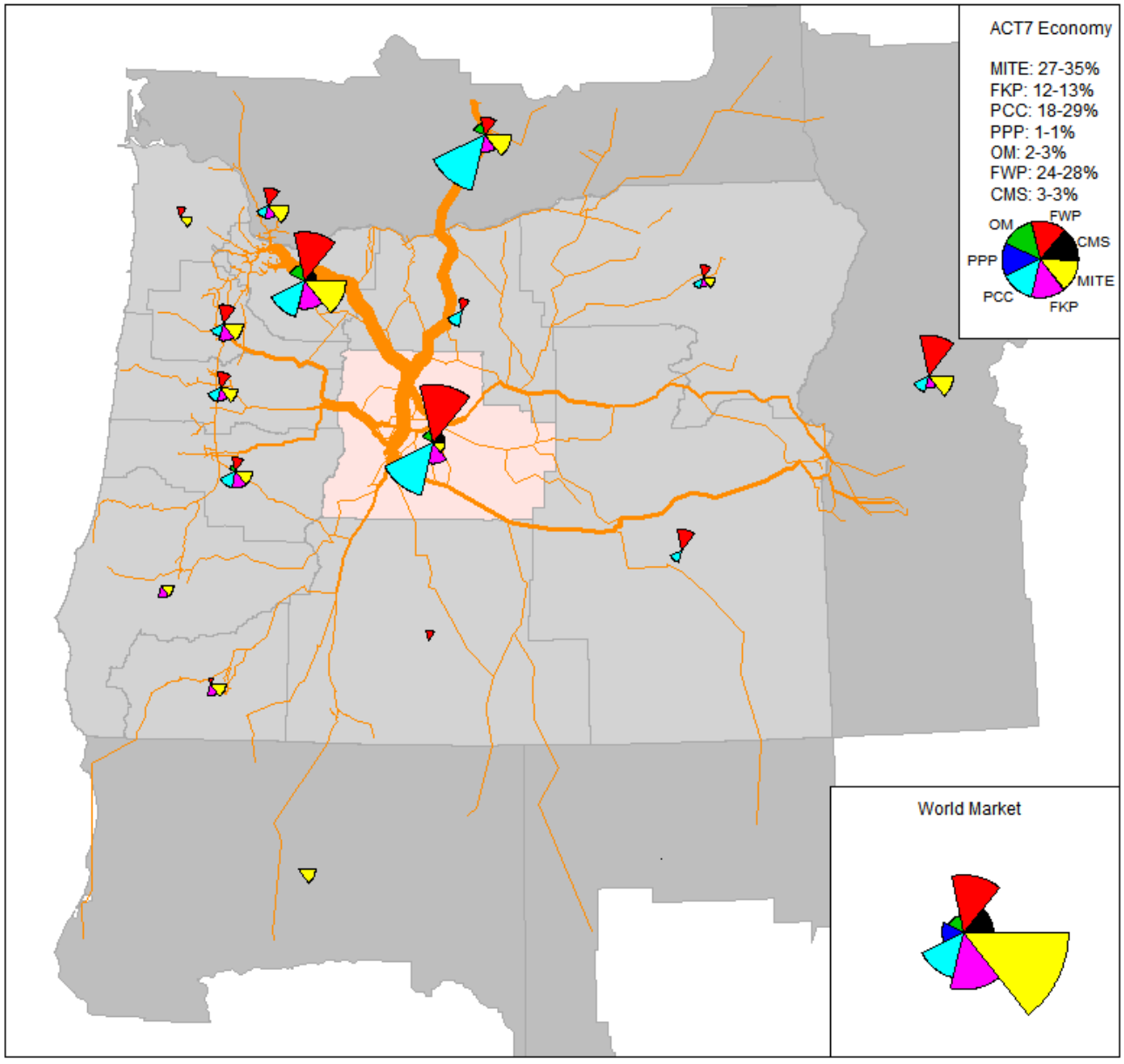
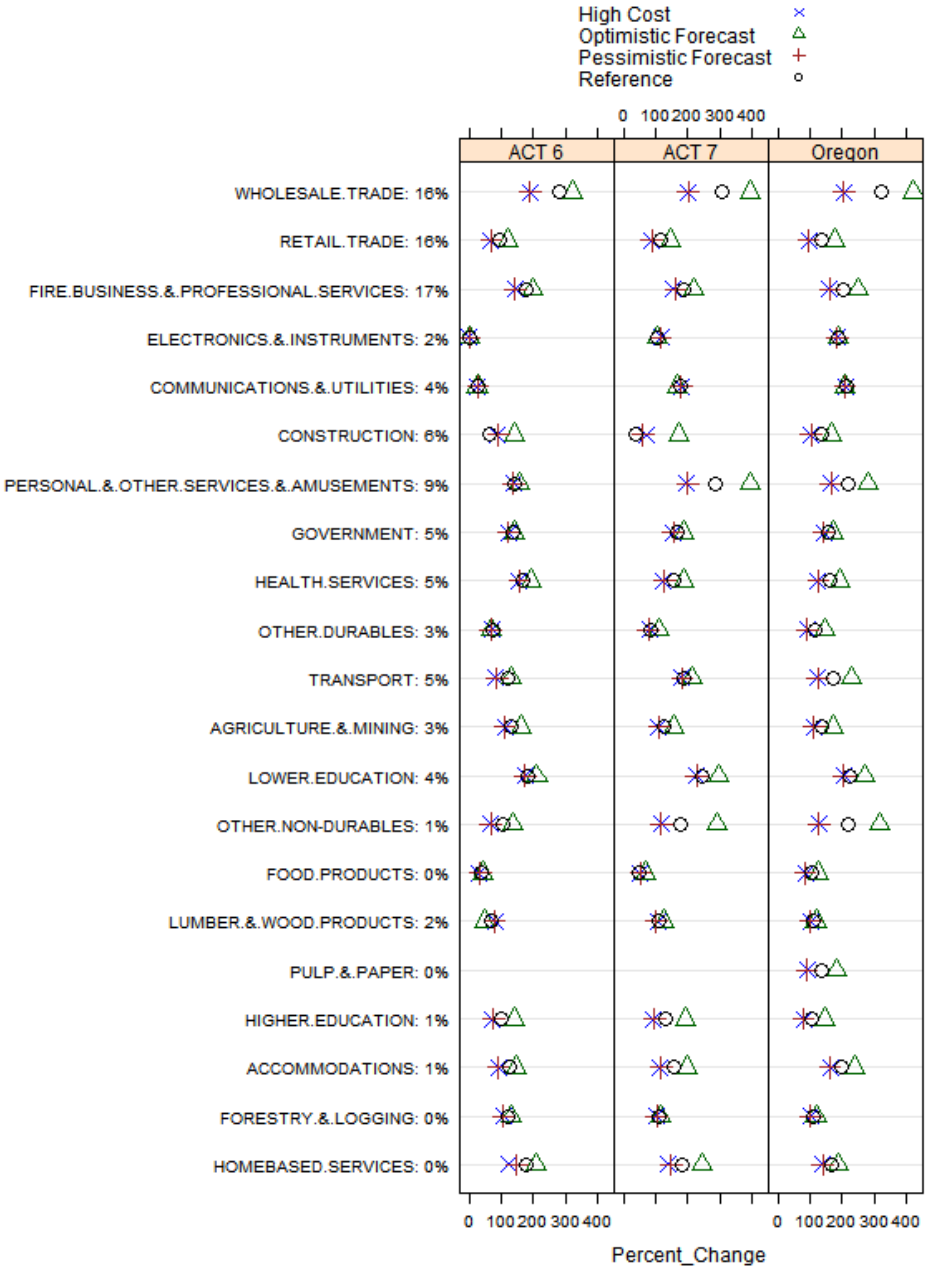


Figure 46 presents the change in industry output over twenty years for the Central Oregon ACTs and the state by industry group for all four scenarios. Central Oregon's Industry is more focused then Oregon as a whole, which exposes the region to economic variability. Wholesale Trade; Retail Trade; FIRE, Business and Professional Services; and Personal and Other Services make up nearly sixty percent of the industry output for the Central Oregon ACT. The variation in industry activity for this area is similar to the state as a whole, with a couple of exceptions. Wholesale Trade grows a little less that the state over the forecast twenty years. Change in Construction activity in the Central Oregon ACT (7) is higher than the entire state for the Optimistic Scenario. Personal and Other

Services, and Other Non-Durables industries are very stable in the Lower John Day ACT, but vary more for the Central Oregon ACT than the state as a whole.

Figure 46. Central Oregon Area Percent Change in Output by Industry from 2006 to 2027, All Scenarios (including percent of statewide output by industry)



Eastern Oregon (ACTs 3 & 11)

The Eastern Oregon area represents the least populous part of the state, less than four percent of state population, but more than one third of the area in land. Population centers include Pendleton, LaGrande and Baker City in the North East ACT (3), Ontario and Burns in the South East ACT (11.) A good deal of the land is used for agricultural production activity, such as producing Food and Kindred Products. Figure 47 illustrates the production shares for the state from Eastern Oregon. The Food and Kindred Products group produced in Eastern Oregon represents about 20 percent of the total statewide production. A relatively large share of Clay, Mineral and Stone; and Petroleum, Coal and Chemicals commodity groups are produced within this region as well.

Figure 47. Eastern Oregon Commodity Production by Value: All Scenarios

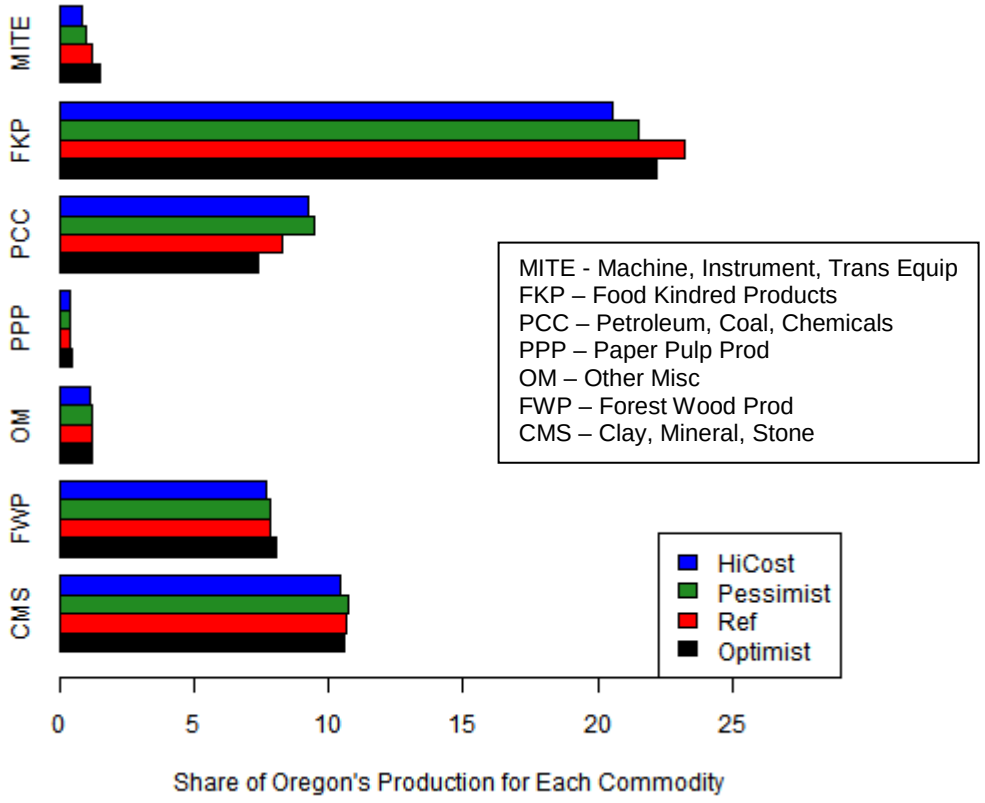


Figure 48 maps the destinations of commodities produced in the North East ACT. Food and Kindred Products make up over half of the ACT economy. A proportion of these goods are consumed within the ACT, but most are destined out of state or to the Portland/Willamette Valley area. The other commodities of regional significance are Petroleum, Coal and Chemicals; and Forest or Wood Products, most of which are destined outside of the state, within the ACT or to the Portland area. Machinery and Instruments represent more than ten percent of the regional economy, but this is a relatively small share in terms of statewide production (less than three percent.)

The Oregon highway flows illustrated in orange in Figure 48 demonstrate the relative significance of corridors on which ACT goods flow. Table 22 provides more detail by specific highways. I-84 (and I-82), along with US-97 and OR-11 are relied upon by the North East ACT to get goods to market destinations.

Figure 48. Commodity Flow From North East ACT to All Destinations

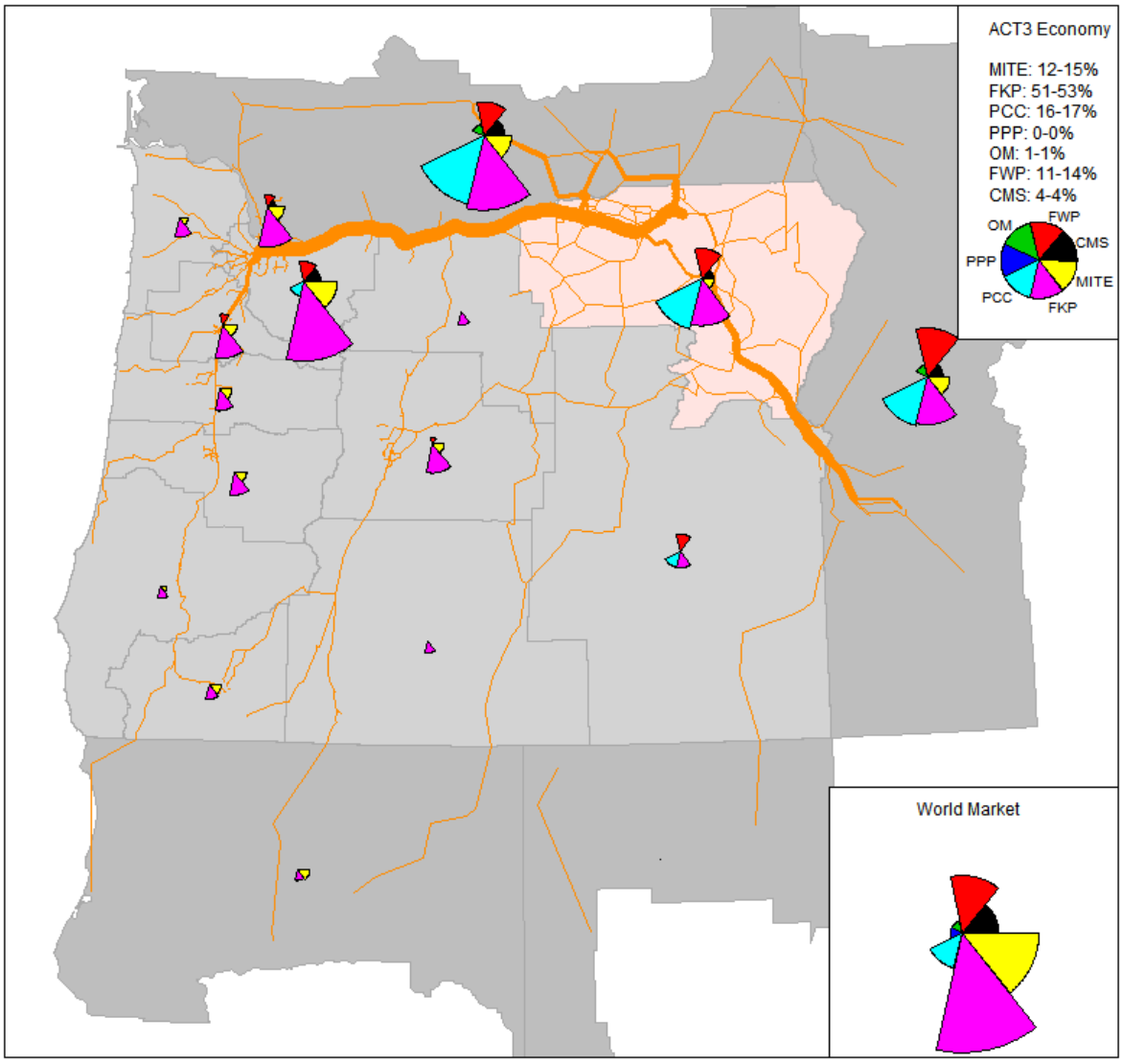


Table 22. North East ACT Commodity Flow by Corridor in Ton-Miles

	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
I-84	75%	67%	60%	64%	70%	55%	47%
I-82	5%	2%	7%	7%	5%	5%	2%
US-97	4%	6%	2%	3%	5%	2%	1%
OR-11	1%	8%	3%	5%	4%	4%	8%
OR-207	1%	2%	5%	1%	2%	7%	7%
OTHER	14%	15%	23%	20%	14%	27%	35%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 49 illustrates the destinations of commodities produced in the South East ACT. Food and Kindred Products play a dominant role in the South East ACT economy, representing over fifty percent of commodity production. This commodity group is predominantly destined to markets outside of Oregon, but Figure 49 demonstrates a significant amount is destined within the state. The second largest commodity group for the South East ACT is Petroleum, Coal and Chemicals group, which represents over twenty percent of the ACT commodity production. A large share of this commodity remains within the ACT, most of which destined out-of-state. Forest or Wood Products make up about ten percent of the ACT commodity production, destined to surrounding ACTs, but predominantly out-of-state.

The highway commodity flows illustrated in orange in Figure 49 reveal the relative significance of highway corridors on which South East ACT goods flow. Table 23 provides more detail by specific highways. I-84, US-20, US-26, and OR-395 are key facilities for getting goods to destination markets for this ACT.

Figure 49. Commodity Flow From South East ACT to All Destinations

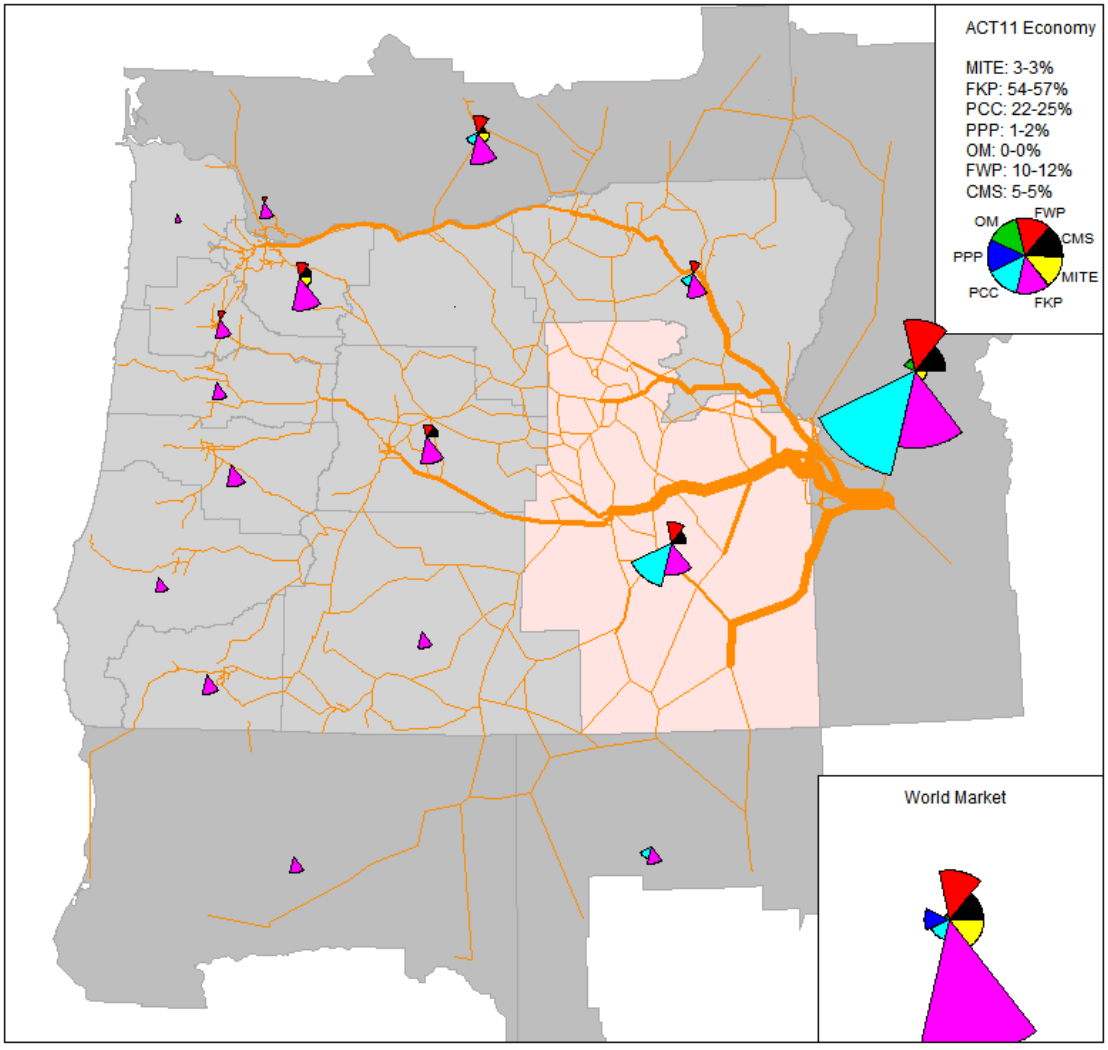
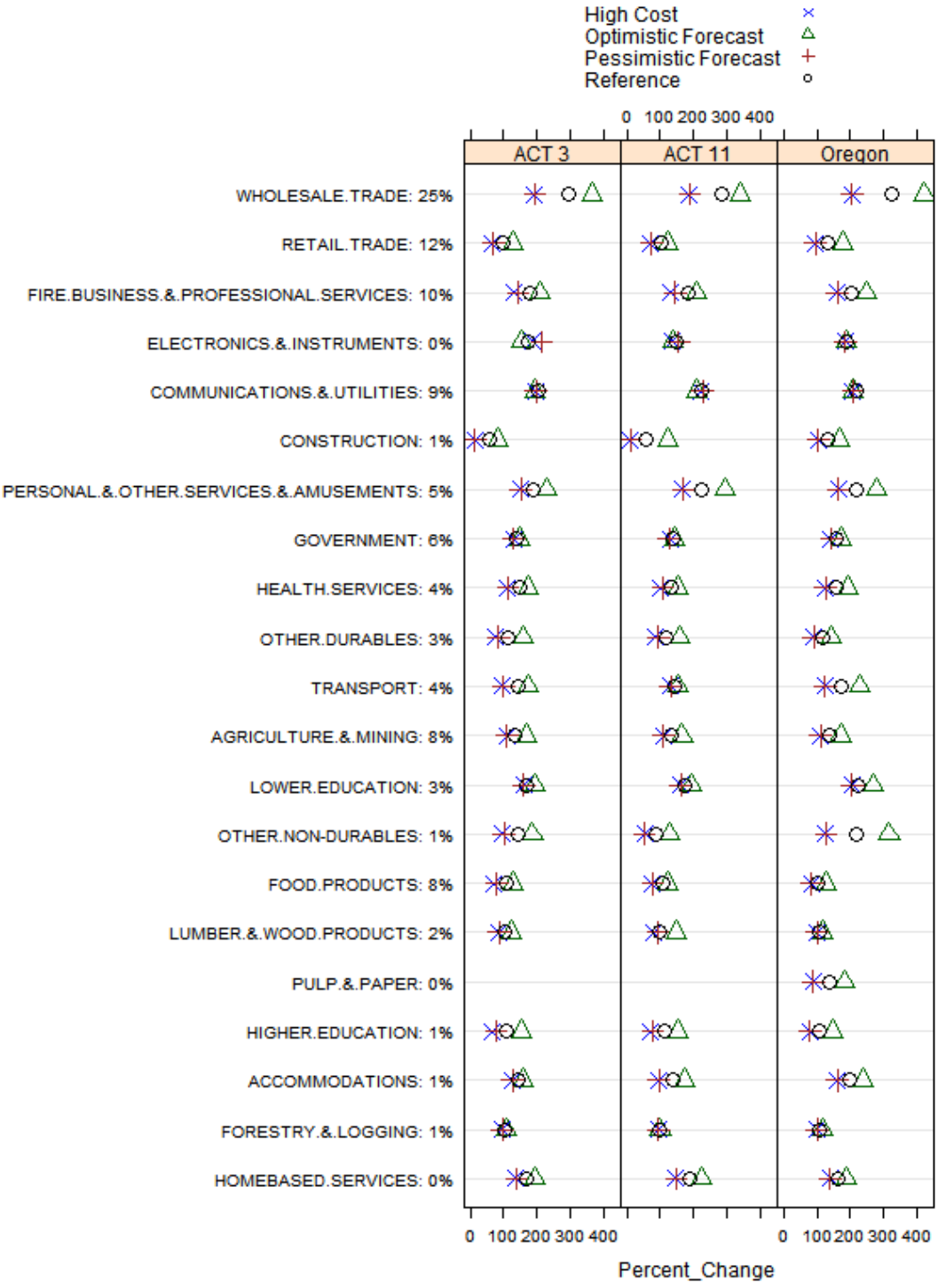


Table 23. South East ACT Commodity Flow by Corridor in Ton-Miles							
	Machine, Instrument, Trans Equip	Food Kindred Products	Petroleum, Coal, Chemicals	Paper Pulp Products	Other Misc	Forest or Wood Products	Clay, Mineral, Stone
US-20	44%	27%	30%	11%	10%	24%	32%
I-84	22%	31%	19%	36%	59%	24%	25%
US-26	11%	8%	7%	11%	7%	15%	23%
OR-395	9%	11%	15%	15%	12%	8%	3%
OR-95	0%	5%	9%	0%	0%	9%	0%
OTHER	14%	18%	20%	27%	12%	20%	17%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 50 presents the change in industry output over twenty years for Eastern Oregon ACTs and the state by industry group for all four scenarios. Eastern Oregon's Industry mix is dominated by three industries. Wholesale Trade (25%), Retail Trade (12%), and FIRE, Business and Professional Services (10%) make up nearly fifty percent of the industry output of Eastern Oregon. Variation in industry growth for these three sectors is dependent on economic conditions, similar to the state. Eastern Oregon industry growth is consistent with statewide patterns. Communications and Utilities, Agriculture and Mining, and Food Products represent another 25% of ACT production, with less growth variation under different economic conditions.

Figure 50. Eastern Oregon Percent Change in Output by Industry from 2006 to 2027, All Scenarios (including percent of statewide output by industry)



Conclusion

Oregon will realize significant increases in freight flows over the next thirty years. Even if the rate of growth is lower than current economic forecasts predict and the cost of transportation rises, the demands on the freight system will be great. While the precise mix of industry activity is challenging to predict, economic inertia causes the prevailing commodity mix and regional flow patterns to remain generally intact under different economic conditions. Oregon relies on a network of corridors to get goods to market. Many of Oregon goods are destined to locations within the state, while others are destined to markets beyond Oregon borders. These corridors also accommodate freight moving through the state

Oregon freight movement patterns result from the combined decisions and actions of thousands of "economic actors" – not only the buyers and sellers, but the links between them, such manufacturers, shippers, distribution centers, warehouses, distributers and consumers. Each industry follows a distinct logistics pattern, some requiring fast, reliable transportation of goods, while others look for the least expensive modes to take advantage of economies of scale. Some goods move via multiple freight modes, combinations of air and truck, or rail and truck, making adaptive changes to remain competitive as market conditions vary over time.

All this reveals the importance of creating a system that supports the activity of a variety of users, keeping in mind the facilities are shared with passenger transportation modes, as well as freight moving through the state. Not only does system use vary by industry and commodity, it also varies by region of the state.

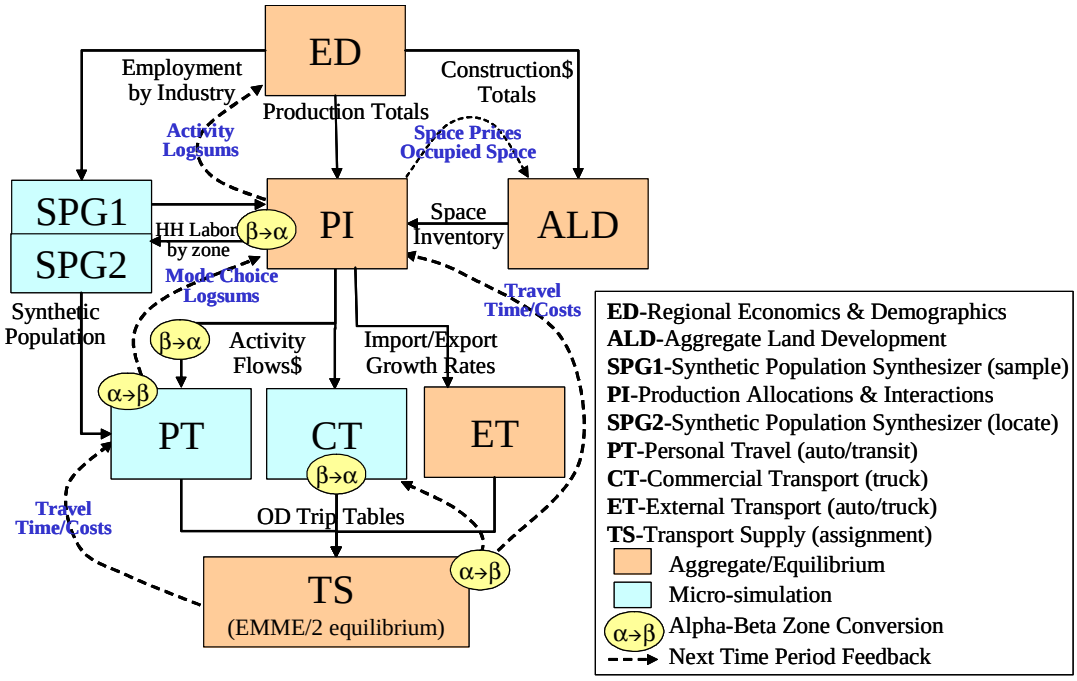
Appendix A – Oregon Statewide Integrated Model 2 (SWIM2) Overview

The Oregon Statewide Integrated Model (SWIM2) is an integrated land use transport model covering the entire State of Oregon. It is a second generation model, drawing on previous work done on the First Generation Statewide Model (SWIM1) and the Eugene-Springfield UrbanSim Model. The SWIM1 model was a customized version of the TRANUS software. SWIM2 is a more disaggregate and complex customized framework that combines a PECAS spatial model (Production, Exchange, and Consumption Allocation System) with activity-based transport models. SWIM2 augments the First Generation SWIM1 Model in more complex applications of Oregon statewide policy and investment decisions. Future SWIM2 model upgrades will be driven by policy application needs.

The development of both the first and second generation models was commissioned by the Oregon Department of Transportation as part of its Transportation and Land Use Model Improvement Program (TLUMIP) within the larger Oregon Model Improvement Program (OMIP). The model development has been undertaken by a series of teams led by Parsons Brinckerhoff, with Hunt Analytics, HBA Specto, EcoNorthwest and The University of Washington playing key roles as sub-contractors. The program has also been guided by an international Peer Panel.

SWIM2 contains nine modules as shown in Figure A.1. Each was developed and calibrated independently before proceeding with full system integration. The full model calibration of all modules in both a baseyear and trends over time was then completed and shared with the TLUMIP Peer Panel. The full model is run every 3 years, while the spatial-economic modules (ED-SPG1-ALD-PI) run every year.

Figure A.1. Modules and Flows in the Oregon Statewide Integrated Model (SWIM2)



SWIM2 operates at two geographic levels (Figure A.2). Both encompass 36 Oregon and 39 (Halo) adjacent state counties. The halo encompasses a roughly 50-mile buffer around Oregon. A system of alphazones (light and dark lines in Figure A.2) is the most disaggregate zone system. There are 2,950 alphazones within the model boundaries (2,575 zones in Oregon and 375 in the Halo) and 12 extermal stations (Table A.1 and Figure A.3). The External Stations serve as model area entry/exit points or gateways.

Figure A.2. SWIM2 alphazone and betazone Systems

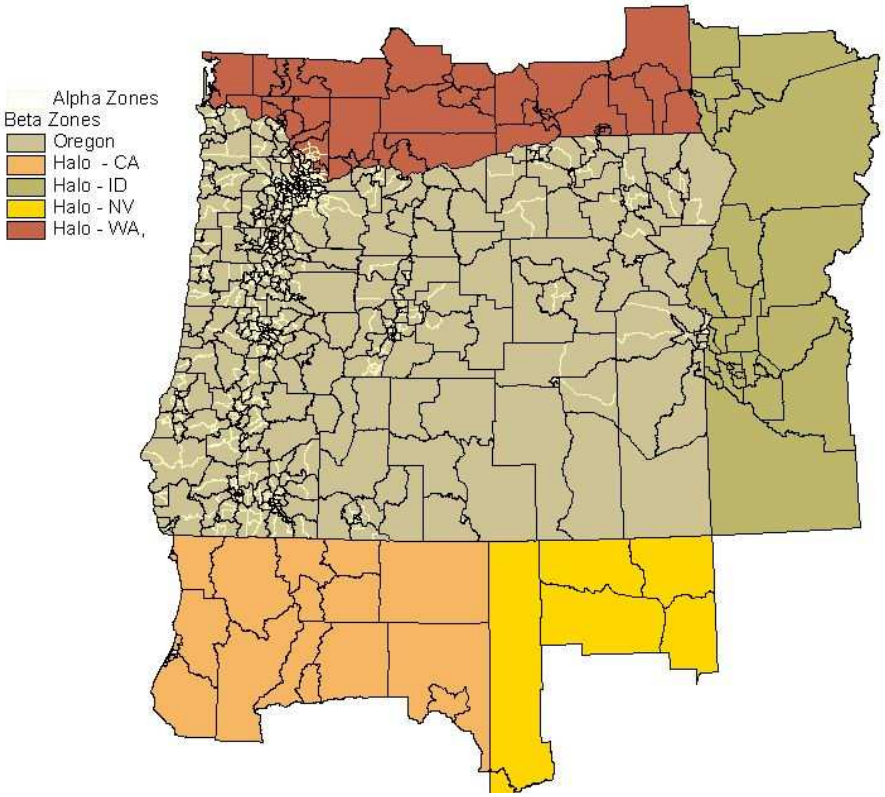
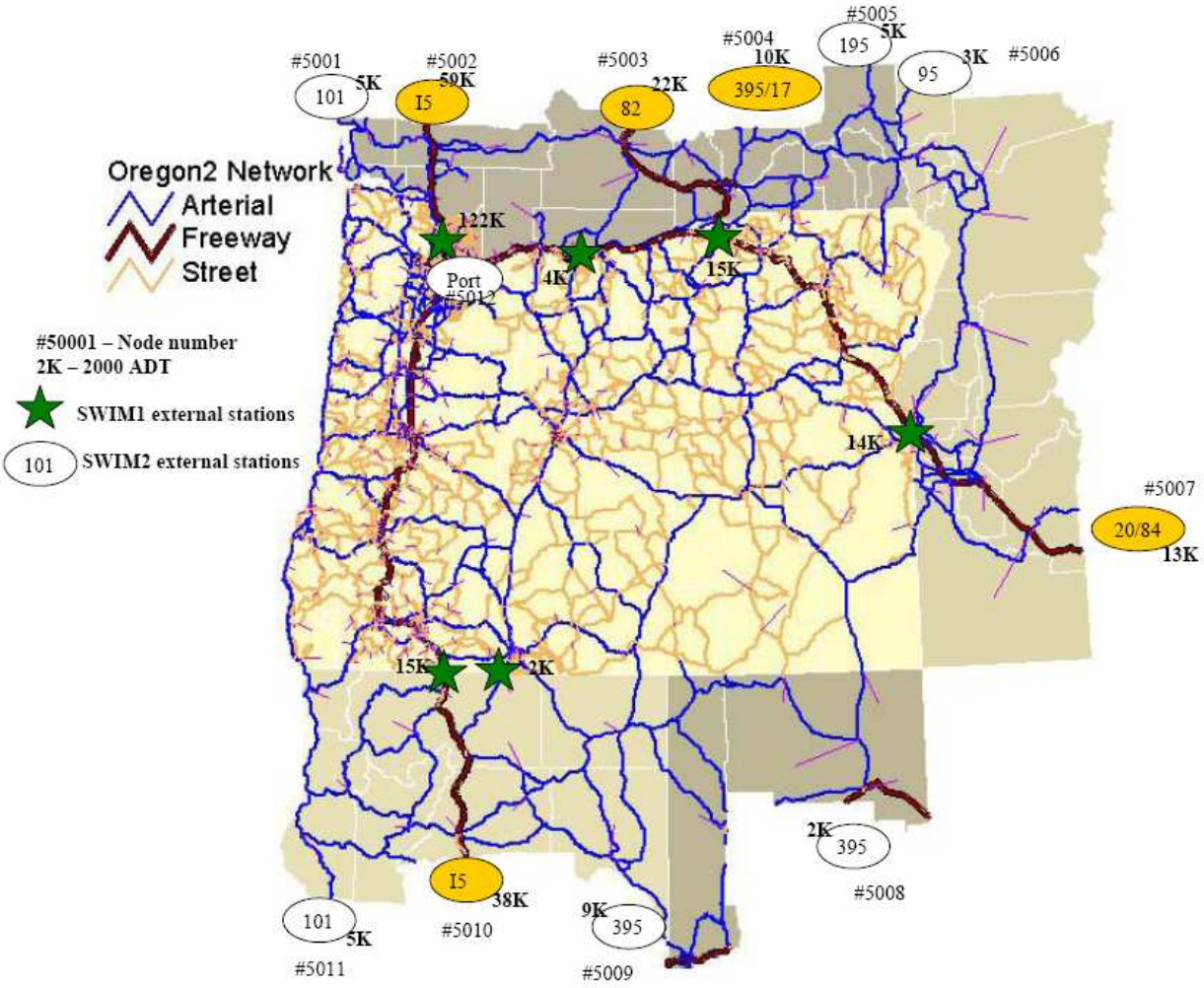


Table A.1. SWIM2 External Stations

SWIM2 Node#	External Station Description
5001	US101 (WA)
5002	I-5 (WA)
5003	I-82 (WA)
5004	US395/WA17 (WA)
5005	US195 (WA)
5006	US95 (ID near WA border)
5007	I-84/US20 (ID)
5008	US95 (NV, just north of I-80)
5009	US395 (CA, just north of I-80)
5010	I-5 (CA)
5011	US101 (CA)
5012	Port of Portland Terminal 6

Figure A.3. Map of SWIM2 External Stations



The Production Allocation and Interactions (PI) module operates on a more aggregated betazone system (dark lines in Figure A.2) and replace the 12 External Stations with six World Markets (Table 2.2). There are 518 betazones, collapsing zones only within Oregon, with a focus on the small urban zones. For example, the roughly 970 alphazones in Portland were collapsed to approximate a set of 66 employment regions used by the Metro MPO model. In other urban areas, zones were collapsed based on a sliding population scale (approximately 25,000 persons/zone), respecting similar employment clusters and transportation commute sheds. In rural areas, homogenous public lands (e.g., BLM, National Forests) were collapsed, while retaining most county and all ACT boundaries (Area Commissions on Transportation (ACTs), used in Oregon transportation planning, provide a convenient way to divide the State into 12 areas).

The six World Markets, used only in the PI module, are defined in Table A.2 and Figure A.4 and A.5 including the assumptions on distance to reach these markets beyond the model halo boundary. It is assumed that goods transported by truck and rail is limited to the US (except Hawaii), Canada and Mexico. Imports and Exports to other regions in the world are shipped by barge, either from the Portland port or from other US East or Southeast ports. The Air mode is not estimated, since it represents less than 1 percent of all goods movement in Oregon, and at most 2 percent of any single commodity's flows. Reporting for that mode is handled outside the SWIM.

The distance represents the weighted average distance from the halo boundary to the centroid of the World Market. In the case of the Oceanic market (zone 6005), an equivalent distance was identified that would result in the correct overall shipping costs. The 'local' World Market 6006 is assumed to support commodities that are traded within 75 miles of the model area.

These six World Markets link to the model transport network at the 12 External Stations of Figure A.3, as shown in Table A.2. These External Stations roughly parallel the likely rail as well as truck freight routes. The local 6006 world market, trading within 75 miles of the model boundary, is linked to the minor External Stations, which is all but I-5 (5002, 5010), I-84 (5007) and the Port of Portland (5012).

Table A.2. PI World Market Zones and Distance Assumptions

Zone Number	Code	Distance beyond halo (miles)*	External Station/ Relevant Roads	World Market Definition
6001	N	240	5002 I-5	Washington State and Canada
6002	NE	800	5003 I-82 5004 US 395	Northern states of the Midwest
6003	E	1,200	5007 I-84	Central and Eastern part of the US and barge traffic through East and South Coast US ports
6004	S	460	5010 I-5	Southwestern states and Mexico
6005	Ocean	1500 for imports, 600 for exports	Port of Portland (5012)	Rest of the world
6006	Local	75	5001, 5003, 5004, 5005, 5006, 5008, 5009, 5011	Local markets in neighboring states

* Assumes 50 mph beyond halo to calculate equivalent travel time. The assignment of external origin/destination regions to external stations is based on a fastest travel time analysis to the centroids of each external region. Oceanic shipping costs for zone 6005 were calibrated to truck transport costs so that all World Markets would compete on the same measure. This assumes $600-900 import and $700-2200 export costs to ship a Truck Equivalent Unit (TEU) between Portland and Japan (per may 2007 discussions with Port of Portland Staff).

Figure A.4. World Markets in North America

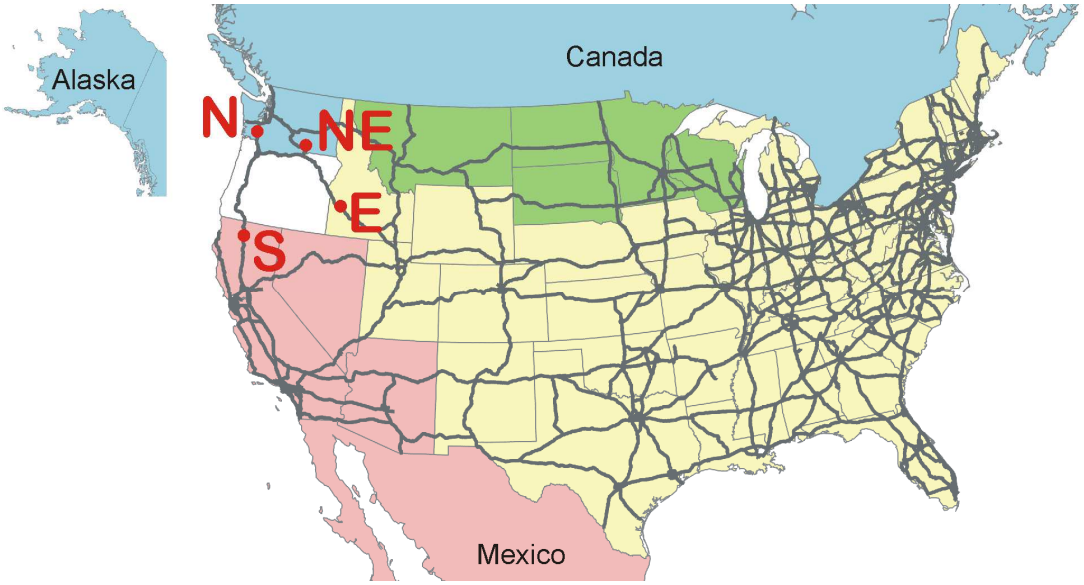
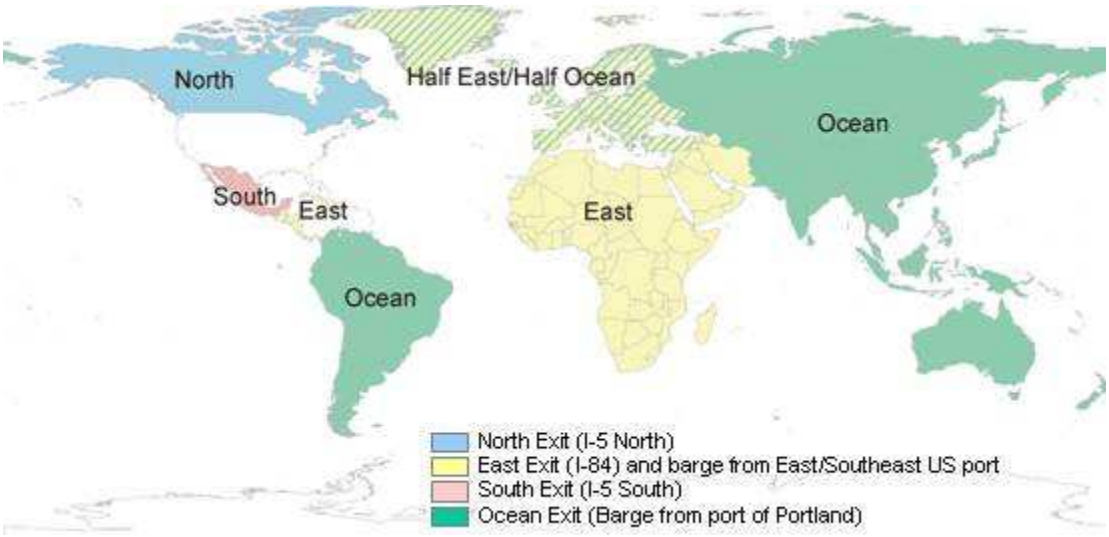
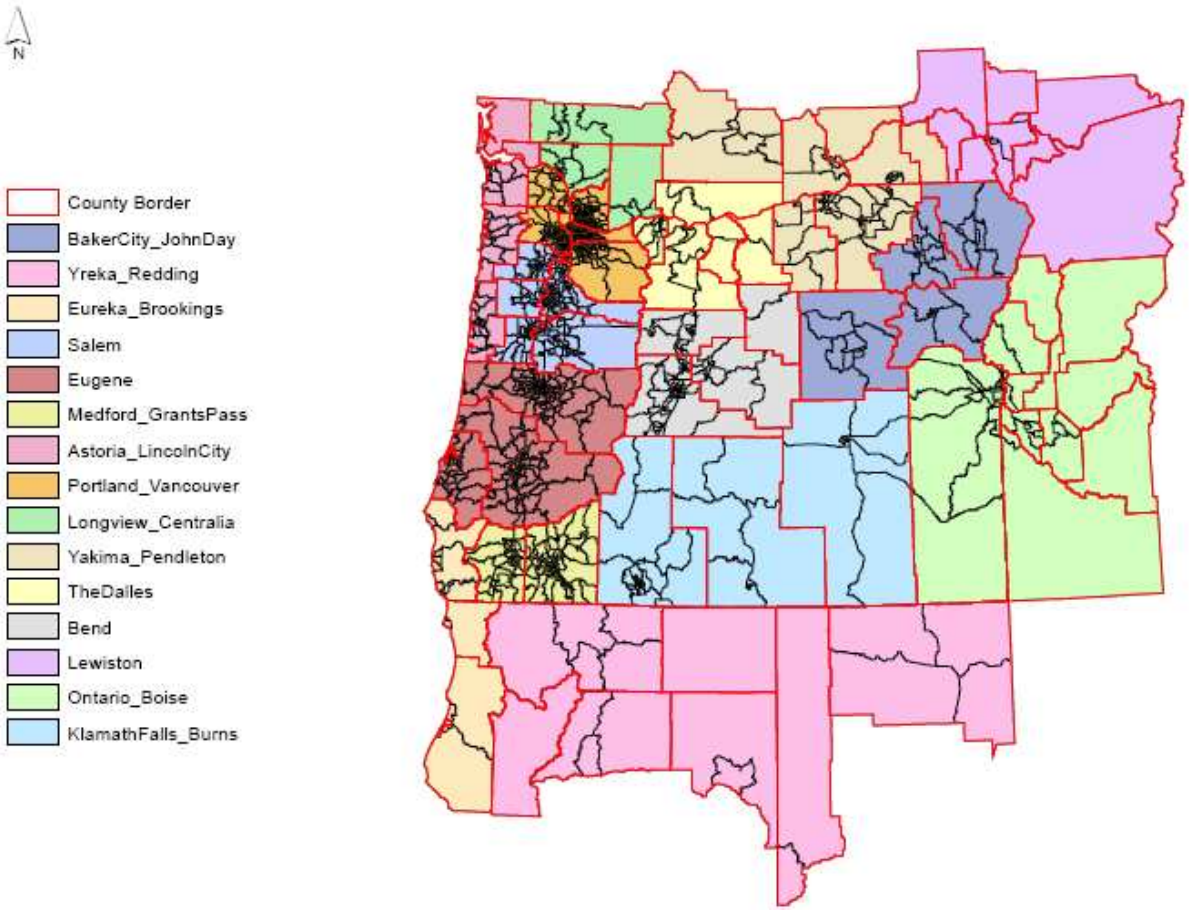


Figure A.5. World Markets outside US



The Aggregate Land Development (ALD) land use module uses a 15 region aggregation of the alphazones for making land development decisions. These regions, shown in Figure A.6, represent land development markets within the study area.

Figure A.6. ALD Land Market Regions



Tables A.3 lists the industry used in SWIM2. In general, a given industrial sector is split into blue-collar and white-collar (or 'management') components using associated 'production' and 'office' space, respectively. The industries are split this way so that the allocation processes in the module can consider the very different location behavior and space requirements of these two components separately. The few industries without separate management and production sites include FIRE (Finance, Insurance, Real-Estate), hotel, personal services, construction, and home-based services. Home-based services are self-employed workers who sell their services to households (e.g., housekeepers, nannies, handymen). The brokerage portion of real estate, which uses labor and floorspace, was folded into FIRE. The remaining rents of the 'real estate' category, and other non-spatial activities were folded into imports (if negative) or exports (if positive). These non-spatial activities don't consume floorspace or labor and include private and institutional money flows (rents, enterprises, capital, federal/state/local government funding and investment, accounting/financial transactions, change in inventories, salvage).

Internal management activities for the remaining industries require separate offices and employees that have different characteristics (income, location, trip generation) then the specific purpose of the industry.

Table A.3. Activities - Industries

Index*	Industry	Floorspace	Internal Service
2, 3	Agriculture And Mining	in Agriculture space	and Office space
7,8	Electronics And Instruments	in Light industry space	and Office space
10, 12	Food Products	in Heavy industry space	and Office space
11, 12	Food Products	in Light industry space	
23 , 24	Lumber And Wood Products	in Heavy industry space	and Office space
25, 27	Other Durables	in Heavy industry space	and Office space
26, 27	Other Durables	in Light industry space	
28, 30	Other Non-Durables	in Heavy industry space	and Office space
29, 30	Other Non-Durables	in Light industry space	
32, 33	Pulp And Paper	in Heavy industry space	and Office space
4, 5	Communications And Utilities	in Light industry space	and Office space
36, 37	Transport	in Depot space	and Office space
38, 39	Wholesale Trade	in Warehouse space	and Office space
34, 35	Retail Trade	in Retail space	and Office space
16, 18	Health Services	in Hospital space	and Office space
17, 18	Health Services	in institutional space	
19, 22	Higher Education	in institutional space	and Office space
21, 22	Lower Education	in Grade-school space	
14, 15	Government Administration	in Support space	and Office space
13	Forestry And Logging	in Logging space	
1	Accommodations	in Accommodation space	
9	FIRE, Business, and Professional Services	in Office space	
31	Personal & Other Services And Amusements	in Retail space	
20	Home-based Services		
6	Construction		

* Second index is for 'office' portion of split industry

Household categories (Table A.4) are base on the 1990 Census PUMS categories of household income (1990$) and persons per household. Household activities include the production of labor and consumption of various goods (primarily through retail) and services. Note that internal money flows commodity, 'Money and Unclassified Goods' does not produce commercial truck trips within CT and ET.

Table A.4. Activities - Household Income-Size Categories (1989$)

Code	Description	
HH0to5K1to2	Household Income $0 to 4,999	Household size 1 to 2 persons
HH5to10K1to2	Household Income $5,000 to 9,999	Household size 1 to 2 persons
HH10to15K1to2	Household Income $10,000 to 14,999	Household size 1 to 2 persons
HH15to20K1to2	Household Income $15,000 to 19,999	Household size 1 to 2 persons
HH20to30K1to2	Household Income $20,000 to 29,999	Household size 1 to 2 persons
HH330to40K1to2	Household Income $30,000 to 39,999	Household size 1 to 2 persons
HH40to50K1to2	Household Income $40,000 to 49,999	Household size 1 to 2 persons
HH50to70K1to2	Household Income $50,000 to 69,999	Household size 1 to 2 persons
HH70plusK1to2	Household Income over $70,000	Household size 1 to 2 persons
HH0to5K3plus	Household Income $0 to 4,999	Household size 3 or more persons
HH5to10K3plus	Household Income $5,000 to 9,999	Household size 3 or more persons
HH10to15K3plus	Household Income $10,000 to 14,999	Household size 3 or more persons
HH15to20K3plus	Household Income $15,000 to 19,999	Household size 3 or more persons
HH20to30K3plus	Household Income $20,000 to 29,999	Household size 3 or more persons
HH30to40K3plus	Household Income $30,000 to 39,999	Household size 3 or more persons
HH40to50K3plus	Household Income $40,000 to 49,999	Household size 3 or more persons
HH50to70K3plus	Household Income $50,000 to 69,999	Household size 3 or more persons
HH70plusK3plus	Household Income $70,000 and over	Household size 3 or more persons

Tables A.5 through A.8 identify various commodities produced and consumed in the model, including study area imports and exports. Table A.5 identifies the commodities tracked in the CT module, including 42 types of goods, based on standard commodity (SCTG) classifications.

Table A.5. Commodities – Goods Categories

Goods	
SCTG01: Live animals and live fish	SCTG25: Logs and other wood in the rough
SCTG02: Cereal grains	SCTG26: Wood products
SCTG03: Other agricultural products	
SCTG04: Animal feed and products of animal origin n.e.c.	
SCTG05: Meat fish seafood and their preparations	SCTG27: Pulp newsprint paper and paperboard
SCTG06: Milled grain and bakery products	SCTG28: Paper or paperboard articles
SCTG07: Other prepared foodstuffs and fats and oils	SCTG29: Printed products
SCTG08: Alcoholic beverages	
SCTG09: Tobacco products	
	SCTG31: Nonmetallic mineral products
	SCTG32: Base metal in primary or semi-finished forms and finished basic shapes
SCTG10: Monumental or building stone	
SCTG11: Natural sands	SCTG33: Articles of base metal
SCTG12: Gravel and crushed stone	SCTG34: Machinery
SCTG13: Nonmetallic minerals n.e.c.	SCTG35: Electronic/electrical equipment and components
SCTG14: Metallic ores and concentrates	SCTG36: Motorized and other vehicles (including parts)
	SCTG37: Transportation equipment n.e.c.
SCTG15: Coal	
SCTG16: Natural Gas & Crude Petroleum	
SCTG17: Gasoline and aviation turbine fuel	
SCTG18: Fuel oils	SCTG38: Precision instruments and apparatus
SCTG19: Coal and petroleum products n.e.c.	SCTG30: Textiles leather and articles of textiles or leather
	SCTG39: Furniture mattresses and mattress supports lamps lighting fittings and illuminated signs
SCTG20: Basic chemicals	
SCTG21: Pharmaceutical products	SCTG40: Miscellaneous manufactured products
SCTG22: Fertilizers	SCTG41: Waste and scrap
SCTG23: Chemical products and preparations n.e.c.	
SCTG24: Plastics and rubber	Money and unclassified goods (not used in CT/ET)

Table A.6 identifies the 16 services, including internal management services tracked in the Personal Travel (PT) Model. Internal Management Services, defined as 'value added office labor', spatially connect the production and office components of split industries. This commodity is the service provided by management and other office support workers to the production floor of the same industry. In many cases, this flow represents a relationship between two establishments of the same firm.

Table A.6. Commodities – Services Categories

Services	
Internal Management Services (B)	Transport (B)
Fire, Business, And Professional Services (B)	Communications And Utilities (B)
Personal And Other Services And Amusements (P)	Construction (B)
Health Services (P)	Government Administration (P)
Accommodations (B)	Higher Education (P)
Real Estate (P)	Lower Education (P)
Homebased Services (P)	
Retail Trade (P)	
Wholesale Trade (B)	

Note: Assumed to be primarily business (B) or personal (P) services

Labor, tracked in the PT module, is included as a commodity that is produced by households and consumed by economic production activities. Labor of different occupation categories is treated as different commodity categories, as shown in Table A.7.

Table A.7. Commodities - Labor Occupation Categories

Index	Labor Occupations	1990 US Census Occupation Codes
0	0_NoOccupation: Not employed	NA
1	1_ManPro: Managers/Professionals	0-82
2	1A_Health: Health Workers	83-112
3	2_PstSec: Post-Secondary Teachers	113-154
4	3_OthTchr: Other Teachers	155-162
5	4_OthP&T: Other Professional/Technical Office	163-262
6	5_RetSls: Retail Sales Workers	263-282
7	6_OthR&C: Other Retail/Clerical Office	283-402
8	7_NonOfc: Non-Office workers	all other

Floorspace categories are shown in Table A.8, while Table A.3 identifies which floorspace types are used by each industry category. The ALD Module adjusts the amount of space available in alphazones in any model period.

Table A.8. Commodities - Floorspace Categories

Residential Floorspace	NonResidential Floorspace	Other Floorspace
FLR SFD (Single Family Home)	FLR Accommodation	FLR Agriculture (includes Mining)
FLR MH (Manufactured Home)	FLR Office	FLR Logging
FLR AT (Attached Home)	FLR Government Support	
FLR MF (Multi-family, Institutional)	FLR Retail	
FLR RRSFD (Rural Residential SFD)	FLR Warehouse	
FLR RRMH (Rural Residential MH)	FLR Depot	
	FLR Light Industry	
	FLR Heavy Industry	
	FLR Hospital	
	FLR Institutional	
	FLR Grade-school	

Table A.9 identifies the various modes and vehicles used in the model to transport person and goods flows. Non-motorized passenger modes and non-truck freight modes are not assigned to the network.

Table A.9. Modes and Vehicle Types

Trip Code	SDT	LDT	CT	ET	Trip Mode	Trip Mode Definition
Passenger (PT SDT and PT LDT)						
DA	X	X			Drive-Alone	Single-occupant auto
SR2	X	X			Shared-Ride 2	2 person occupant auto
SR3P	X	X			Shared-Ride 3+	3+ person occupant auto
WALK*	X				Walk	Walk
BIKE*	X				Bicycle	Bicycle
TRANSIT_WALK		X			Walk-Transit	Walk-Access Transit
TRANSIT_DRIVE		X			Drive-Transit	Auto-Access Transit
SCHOOL_BUS*	X				School bus	School bus (not assigned to the network)
AIR		X			Drive-Air	Drive-Access Air travel within the modelarea
HSR_DRIVE		X			Walk-HSR	Drive-Access intercity Rail
HSR_WALK		X			Drive-HSR	Walk-Access intercity Rail
Freight						
STK			X		Truck	
TRK1			X		TRK1	<34,000 lbs. (likely single-unit)
TRK2			X	X	TRK2	34,000 -64,000 lbs.
TRK3			X		TRK3	64,000 -80,000 lbs. (articulated)
TRK4			X	X	TRK4	80,000 - 105,500 lbs. (articulated)
TRK5			X		TRK5	>105,500 lbs. (articulated)
SAA*			X		Air	
SRR*			X		Freight Rail	
SWA*			X		Waterborne Freight	
SPA*			X		Pipeline	

* Not assigned to the network.

Table A.10 provides a listing of all of the attributes of persons and households created in the Synthetic Population Generator (SPG) module and used in the PT module. The table also shows the Census-based coding categories for each attribute. The fields of the synthetic population used in the SWIM2 model are described below (asterisked values are synthesized by the model, others are drawn from PUMS records):

- Household-Person File Link (HH_ID, PER_ID). The household attributes were linked to each person in the household, by storing a household (HH_ID) and person (PER_ID) id in the person file. HH_ID are numbered sequentially across the whole sample (starting with 1). PER_ID are numbered sequentially across all persons in a household.
- Household Attributes (PERSONS, AUTOS*). The number of persons and the total number of autos in the household. The Census auto value is updated by the PT module.
- Home Location (ALPHAZONE). The alphazone location of the household, assigned by SPG2 (consistent with PI labor flows).
- Household Income (RHHINC). Total household income in units of 1989 dollars.
- Residential Floorspace Type (UNITS1, SINGLE_FAMILY*). The household's residential floorspace type is indicated by the number of units in the dwelling unit (UNITS1). In PT, a binary variable is created to indicate whether the dwelling unit is a single family unit.
- Demographics (AGE, SEX). Age and gender for each household member.
- Employment Information (RLABOR, OCCUP, INDUSTRY, ESR*, SW_OCC*, SW_SPLIT_IND*, WORKTAZ*). Employment status for each household member indicates whether each person is employed or not in labor force (RLABOR). If employed, PUMS occupation and industry from PUMS (OCCUP, INDUSTRY) are reassigned consistent with SWIM2 categories (SW_OCC and SW_SPLIT_IND). The PT module assigns a work location alphazone (WORKTAZ) and employment status code (ESR)
- School Status (SCHOOL). School status of each household member representing whether the person was currently enrolled in school.

Table A.10. Synthetic Population Household and Person Attributes

Household Attributes	
Code	Description
HH_ID	Household ID
AZONE	Home Location alphazone 0001-4141
PERSONS	Number of Person (person records) in household
RHHINC	Household income (1989$) 0000000 .N/A(GQ/vacant/no income) -999999..9999999 .Total household income
AUTOS (PUMS version, replaced by PT-version)	Vehicles (1 ton or less) available 0. N/A (GQ/vacant) 1 . No vehicles 2 . 1 vehicle 3 . 2 vehicles 4 . 3 vehicles 5 . 4 vehicles 6 . 5 vehicles 7 . 6 vehicles 8 . 7 or more vehicles
UNITS1	Units in structure 00 .N/A or Group Quarters (MF) 01 .Mobile home or trailer (MH or RRMH) 02 .One-family house detached (SFDor RRSFD) 03 .One-family house attached (AT) 04 .2 Apartments (AT) 05 .3-4 Apartments (MF) 06 .5-9 Apartments (MF) 07 .10-19 Apartments (MF) 08 .20-49 Apartments (MF) 09 .50 or more apartments (MF) 10 .Other (MF)
Household Attributes	

Person Attributes	
HH_ID	Household ID
PER_ID	Person ID
AGE	00 .Less than 1 year 01..89 .Age in years 90 .90 or more years old
SEX	0 .Male 1 .Female
SCHOOL	0 .N/A (less than 3 years old) 1 .Not attending school 2 .Yes, public school, public college 3 .Yes, private school, private college
RLABOR	Employment status 0 .N/A (less than 16 years old) 1 .Civilian employed, at work 2 .Civilian employed, with a job but not at work 3 .Unemployed 4 .Armed forces, at work 5 .Armed forces, with a job but not at work 6 .Not in labor force
OCCUP	Census Occupation ### (1990 Census Occupation codes)
INDUSTRY	Census Industry ### (1990 Census Industry codes)
SW_OCCUP	SWIM2 Occupation (based on PUMS OCCUP fields) See Table 2.7 Index
SW_SPLIT_IND	SWIM2 Split Industry ('office' split from 'production') (based on SW_OCCUP and INDUSTRY fields) See Table 2.3 Index
Person Attributes	

From SPG output files: SynPopP.csv and SynPopH.csv

Household Attributes	
Code	Description
SINGLE_FAMILY	Single Family 0. Multi-family household 1. Single-family household
AUTOS	Vehicles (1 ton or less) available 0. No vehicles 1 . 1 vehicle 2 . 2 vehicles 3 . 3 or more vehicles

Person Attributes	
WORKTAZ	Work Location alphazone 0001-4141 (assigned by PT work location choice model)
ESR	Simplified Employment Status 0. Not employed 1. Employed

From PT output files: personData.csv and householdData.csv

Appendix B. SCTG Commodity Groups Represented in SWIM2

Commodity Code	Category Description*	Commodity Group-7
SCTG01	Live animals and live fish	Food or Kindred Products
SCTG02	Cereal grains	Food or Kindred Products
SCTG03	Other agricultural products	Food or Kindred Products
SCTG04	Animal feed and products of animal origin, n.e.c.	Food or Kindred Products
SCTG05	Meat, fish, seafood, and their preparations	Food or Kindred Products
SCTG06	Milled grain products and preparations, and bakery products	Food or Kindred Products
SCTG07	Other prepared foodstuffs and fats and oils	Food or Kindred Products
SCTG08	Alcoholic beverages	Food or Kindred Products
SCTG09	Tobacco products	Food or Kindred Products
SCTG10	Monumental or building stone	Clay, minerals, stone
SCTG11	Natural sands	Clay, minerals, stone
SCTG12	Gravel and crushed stone	Clay, minerals, stone
SCTG13	Nonmetallic minerals, n.e.c.	Clay, minerals, stone
SCTG14	Metallic ores and concentrates	Clay, minerals, stone
SCTG15	Coal	Petroleum, Coal, Chemicals
SCTG16	Crude Petroleum	Petroleum, Coal, Chemicals
SCTG17	Gasoline and aviation turbine fuel	Petroleum, Coal, Chemicals
SCTG18	Fuel oils	Petroleum, Coal, Chemicals
SCTG19	Coal and petroleum products, n.e.c.	Petroleum, Coal, Chemicals
SCTG20	Basic chemicals	Petroleum, Coal, Chemicals
SCTG21	Pharmaceutical products	Petroleum, Coal, Chemicals
SCTG22	Fertilizers	Petroleum, Coal, Chemicals
SCTG23	Chemical products and preparations, n.e.c.	Petroleum, Coal, Chemicals
SCTG24	Plastics and rubber	Petroleum, Coal, Chemicals
SCTG25	Logs and other wood in the rough	Forest or Wood Products
SCTG26	Wood products	Forest or Wood Products
SCTG27	Pulp, newsprint, paper, and paperboard	Pulp or Paper products
SCTG28	Paper or paperboard articles	Pulp or Paper products
SCTG29	Printed products	Pulp or Paper products
SCTG30	Textiles, leather, and articles of textiles or leather	Other/Misc
SCTG31	Nonmetallic mineral products	Clay, minerals, stone
SCTG32	Base metal in primary or semi-finished forms and in finished basic shapes	Machinery, Instrum, Transp Equip, Metals
SCTG33	Articles of base metal	Machinery, Instrum, Transp Equip, Metals
SCTG34	Machinery	Machinery, Instrum, Transp Equip, Metals
SCTG35	Electronic and other electrical equipment and components, and office equipment	Machinery, Instrum, Transp Equip, Metals
SCTG36	Motorized and other vehicles (including parts)	Machinery, Instrum, Transp Equip, Metals
SCTG37	Transportation equipment, n.e.c.	Machinery, Instrum, Transp Equip, Metals
SCTG38	Precision instruments and apparatus	Machinery, Instrum, Transp Equip, Metals
SCTG39	Furniture, mattresses and mattress supports, lamps, lighting fittings, and illuminated signs	Other/Misc
SCTG40	Miscellaneous manufactured products	Other/Misc

* For detailed descriptions of commodities included in each group, see “SCTG Commodity Codes” booklet CFS-1200, October 2006, U.S. Department of Transportation and U.S. Department of Commerce.

Appendix C. Standard Industrial Codes (SIC)

	Industry	IndustryGroup-7
1	ACCOMMODATIONS	Gov't, Education, Biz Services, Accommodations
2	AGRICULTURE AND MINING-Agriculture	Ag, Mining, Food
3	AGRICULTURE AND MINING-Office	Ag, Mining, Food
4	COMMUNICATIONS AND UTILITIES-Light Industry	Retail, Personal Service, Communication
5	COMMUNICATIONS AND UTILITIES-Office	Retail, Personal Service, Communication
6	CONSTRUCTION	Electronics, Durables, Construction
7	ELECTRONICS AND INSTRUMENTS-Light Industry	Electronics, Durables, Construction
8	ELECTRONICS AND INSTRUMENTS-Office	Electronics, Durables, Construction
9	FIRE BUSINESS AND PROFESSIONAL SERVICES	Gov't, Education, Biz Services, Accommodations
10	FOOD PRODUCTS-Heavy Industry	Ag, Mining, Food
11	FOOD PRODUCTS-Light Industry	Ag, Mining, Food
12	FOOD PRODUCTS-Office	Ag, Mining, Food
13	FORESTRY AND LOGGING	Forestry, Wood
14	GOVERNMENT ADMINISTRATION-Government Support	Gov't, Education, Biz Services, Accommodations
15	GOVERNMENT ADMINISTRATION-Office	Gov't, Education, Biz Services, Accommodations
16	HEALTH SERVICES-Hospital	Health
17	HEALTH SERVICES-Institutional	Health
18	HEALTH SERVICES-Office	Health
19	HIGHER EDUCATION	Gov't, Education, Biz Services, Accommodations
20	HOMEBASED SERVICES	Retail, Personal Service, Communication
21	LOWER EDUCATION-Grade School	Gov't, Education, Biz Services, Accommodations
22	LOWER EDUCATION-Office	Gov't, Education, Biz Services, Accommodations
23	LUMBER AND WOOD PRODUCTS-Heavy Industry	Forestry, Wood
24	LUMBER AND WOOD PRODUCTS-Office	Forestry, Wood
25	OTHER DURABLES-Heavy Industry	Electronics, Durables, Construction
26	OTHER DURABLES-Light Industry	Electronics, Durables, Construction
27	OTHER DURABLES-Office	Electronics, Durables, Construction
28	OTHER NON-DURABLES-Heavy Industry	Paper, NonDurables
29	OTHER NON-DURABLES-Light Industry	Paper, NonDurables
30	OTHER NON-DURABLES-Office	Paper, NonDurables
31	PERSONAL AND OTHER SERVICES AND AMUSEMENTS	Retail, Personal Service, Communication
32	PULP AND PAPER-Heavy Industry	Paper, NonDurables
33	PULP AND PAPER-Office	Paper, NonDurables
34	RETAIL TRADE-Office	Retail, Personal Service, Communication
35	RETAIL TRADE-Retail	Retail, Personal Service, Communication
36	TRANSPORT-Depot	Retail, Personal Service, Communication
37	TRANSPORT-Office	Retail, Personal Service, Communication
38	WHOLESALE TRADE-Office	Retail, Personal Service, Communication
39	WHOLESALE TRADE-Warehouse	Retail, Personal Service, Communication