An Engine of Prosperity

Freight Rail's Pivotal Role in Pacific Northwest's Export Economy

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Key Findings

- Freight rail contributes at least $28.5 billion to the Washington state economy (p. 27)
  - 7.5% of state GDP
- Over 342,000 Washington workers depend on freight rail (p. 27)
  - One out of ten jobs in the state
- Household income is $13.4 billion higher due to freight rail (p. 31)
  - More than $5,000 per family
- Rail's impact on Pacific Northwest region: about 3x those on Washington state alone (p. 29)
- All of the above estimates are highly conservative (p. 28-29)
  - Naïve use of traditional economic tools would produce even higher impacts
- Freight rail is a 19th century industry that is central to 21st century prosperity

Key Background

- Capitalism is premised on competition, specialization, and trade (p. 7)
  - Firms compete for customers
  - Firms specialize to gain an edge over competitors
  - Firms trade for goods and services in which they do not specialize
- International trade has been the greatest anti-poverty program in history (p. 10)
  - Has lifted three billion new capitalists in Asia toward the global middle class
- Freight transportation is the circulatory system of capitalism (p. 9-10)
  - Aircraft for high value items
  - Ships for waterborne bulk cargoes
  - Rail or trucks for cargoes shipped to or from inland sites
  - Rail is far more efficient than trucks, imposing less cost on society (by a factor of 4x to 9x)
- Freight rail was essential to the development of North America west of the Appalachians (p. 9)
  - It allowed farmers and manufacturers to sell beyond a local market
  - Firms could specialize, sourcing inputs from distant suppliers
  - It forced them to face competition from distant competitors
  - Wider competition improved productivity, and raised incomes
- The Pacific Northwest is an export powerhouse (p. 14-18)
  - Over twice as export-intensive as the U.S. average
  - Northwest ports are the throughways of trade for a dozen states and provinces
  - Four out of ten jobs in Washington state derive from trade
- Trade makes Washington prosperous (p. 14-18)
  - Per capita incomes 10% higher than U.S. average
  - Trade has smoothed economic fluctuations (recent recession and recovery)
- Without freight rail, benefits of trade would cease beyond a truck trip from the ports (p. 31)
  - Inland regions would be impoverished and depopulated

Executive Summary

The developed world's prosperity depends on trade, and the specialization that trade allows. This is especially true in the Pacific Northwest of the United States and nearby Canadian provinces. The population of this region is not large enough to sustain a modern economy self-sufficiently. Rather it must rely on imports of many goods that cannot be locally produced competitively, and it must pay for those imports by exporting items in which the region has a comparative advantage: particularly grains, fruit, timber and wood products, energy, software, and commercial aircraft. Railroads offer the most economically efficient means to transport over land (e.g., from inland sources to seaports) large volumes of relatively low value goods and materials. "Economic efficiency" here refers to total direct cost per ton-mile (the cost to move one ton for one mile paid by shippers). Railroads' superiority over alternative modes is generally even greater when broader definitions of "cost" are used, such as those that include fuel economy or social costs such as environmental impact.

The purpose of this report, which was commissioned by BNSF Railway and the Washington Council on International Trade, is to appraise the role of freight rail in the Northwest economy, focusing particularly on Washington state. This report will provide a rough estimate of the magnitude of the impact of freight rail on the region's economy. The estimate will be crude because traditional estimation methods are ill-suited to an industry whose impacts are so pervasive. Therefore, these estimates will be deliberately quite conservative.

The report's focus is on how rail connects our businesses, and their employees, with the global economy. Rail is a crucial channel in the circulatory system of capitalism.

Rail Transport, Globalization, and Prosperity

The growing integration of national and local markets into the globalized economy has been the greatest anti-poverty program in history. As an example, hundreds of millions of poor Chinese and Indians have risen above subsistence because they have been able to sell their wares to developed markets. For inland producers and customers—perhaps 75% of the world's population—this has only been possible due to freight rail. This industry has benefitted industrial economies for nearly 200 years, and today it is helping to bring billions of the poor into the global middle class.

Rail shipments emit 75% less greenhouse gases and other air pollutants per ton mile on average.

Railroad safety and productivity has far outstripped the average of U.S. industries, allowing fierce price competition.[2] American freight rail rates are the lowest in the developed world—about half the median rate internationally. Rail shipments cost shippers about one fourth as much as truck shipments.[3] Rail also is significantly more fuel-efficient than alternative modes of transport. The number of ton-miles transported per gallon of fuel has doubled since 1980, to nearly 500 ton-miles per gallon. This is four times as fuel efficient as trucks.[4] Rail shipments emit 75% less greenhouse gases and other air pollutants per ton-mile on average. Total social costs of rail are one ninth of those imposed by trucks.[5]

Exports and Freight Rail's Role in the Pacific Northwest

Washington State is more than twice as export-intensive as the U.S. average: in 2012 Washington exported $10,950 per capita vs. $4,938 for the U.S. as a whole. This is the second-highest of any state, after only tiny Vermont. According to the Washington Council on International Trade, 40% of the state's employment is dependent on trade, with about three out of four of those jobs related to exports.[6] This represents a one-fourth rise in trade intensity in just the past 15 years, due to the rapid economic growth in key trading partners such as China.[7] State merchandise and commodities exports in 2011 were $65 billion, about 21% of state gross domestic product (GDP).[8] Exports represent about twice as large of share of Washington's economy as they do for the U.S. as a whole.[9]

Exports allow Washington incomes to be higher than the national average: $47,140 state GDP per capita in Washington in 2012 vs. $42,784 for the U.S. average, superior by 10.2%. Washington was fourth among exporting states in absolute dollars (behind Texas, New York, and California, which each are much larger than Washington.)[10] Exports also made Washington's economy more dynamic and more resilient in the recent business cycle. Washington's incomes did not fall as much as the national average during that 2008-09 recession,[11] and they grew the 7th fastest in the nation in its aftermath.[12]

International trade has long been central to the region's economy, but its pivotal importance has grown in the past generation as three billion new capitalists, mostly in Asia, have joined the world's economy and are striving to catch up with the West. Because export jobs must compete globally, they tend to be especially productive and well-paying. While the dominant export industries have evolved over time, our region's strong export tradition has provided an enduring base for its competitiveness and prosperity. Current developments seem unlikely to disrupt the trend toward higher trade volumes in the Pacific Rim.

Economic Impact of Freight Rail

This report offers both naïve (too expansive) and narrow estimates of freight rail's regional economic impact. The latter estimate, in which we put the most credence, suggests that freight rail contributes 7.5%, 4%, and 10.6% to Washington's GDP, household incomes, and employment respectively. Without freight rail, inland producers would be restricted to local markets, and pressured to improve only by local competitors. One of capitalism's key driving forces—long-distance trade—would be largely absent. A slightly more thoughtful perspective is that all cargo would be hauled long distances inland via trucks, so only exports that are produced within a truck trip of Washington's seaports would be produced. Trade volumes would be significantly reduced because trucks' significantly higher costs.

Households earn $13.4 billion more than if rail did not exist: more than $5,000 per year for a typical family.

This crude estimate of the impact on the economy of freight rail is that it adds about $28.5 billion, or nearly 10%, to Washington's GDP: equivalent to most of a full decade of growth. Households earn $13.4 billion more than if rail did not exist: more than $5,000 per year for a typical family. Over 300,000 jobs—about 10% of total state employment—exist because of the economic dynamism enabled by freight rail. These estimates include both direct effects on the main freight-dependent industries, as well as ripple effects from those industries' purchases from the wider economy. They are, however, deliberately quite conservative, and much more likely to be understated than overstated. For example, they estimate only impacts on Washington state. The impact on the wider region would be roughly three times as large.

This 19th century industry remains a crucial enabler of the Northwest's 21st century prosperity.

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This Report is Organized as Follows:

Chapter 1 is an introduction and overview of the report.

Chapter 2 will outline transportation's role in economic history: how freight transport (of all types) has allowed specialization and trade.

Chapter 3 will focus specifically on rail's role in the development of modern economies, emphasizing rail's comparative advantages and disadvantages over other forms of transport.

Chapter 4 will briefly describe the central role trade plays in the Pacific Northwest economy.

Chapter 5 will outline freight rail's role in the Northwest's economic development.

Chapter 6 is the core of the report. It estimates the impact on the region's economy if freight rail were curtailed, under several alternative estimates. It discusses the limitations of traditional economic impact estimation methods, and describes how these estimates attempted to compensate.

Chapter 7 offers conclusions.

Back Matter includes an Appendix describing the methods used to make these economic impact estimates, as well as endnotes and a list of sources used. Front matter includes an executive summary.

On a personal note, the author is a specialist in regional economies and competitive strategies, not in railroads. (More about the author is listed near the end of this report.) His strategic perspective will be manifest throughout this document. He had no preconceptions about rail's role when this work began. Research for this report impressed him with the central role freight rail has played in economic history, its unique impact on our region's economy, and its central place in maintaining the region's competitiveness. His hope is that you will be educated, as he has been, about the pivotal role in a 21st century globalized economy that is played by an industry which dates from the 19th century.

Chapter 1
Introduction

Competition, specialization, and trade are key necessary conditions for capitalism. They are also essential for prosperity. Competition among the producers of any good or service obliges each competitor to continuously improve, or else lose customers to competitors who serve customers better or more cheaply. This motivates each producer to specialize in those activities where they have the greatest advantage. No one can be good at everything, and those who try usually become equally mediocre across their range of activities. Specialization is made possible if each specialist can trade with other specialists to get the things—raw materials, parts, or services—they do not produce themselves. If you were obliged to grow your own food and make your own clothes, you would be much poorer, because most of your time and energy would be devoted to such "maintenance" activities, and far less to producing income.

Railroads, therefore, offer the most economically efficient means to transport over land large volumes of relatively low value goods and materials.

The report focuses on the third of this great triumvirate: Trade. The developed world's prosperity is dependent on trade, and the specialization that trade permits. This is especially true in the Pacific Northwest of the United States and nearby Canadian provinces. The population of this region is not large enough to sustain a modern economy self-sufficiently. Rather it must rely on imports of many goods that cannot be locally produced competitively, and it must pay for those imports by exporting items in which the region has a comparative advantage: particularly grains, fruit, timber, energy, software, and commercial aircraft.

Trade requires transporting goods from their production site to their final customer. Although ships are the most efficient transport mode, waterborne transport is only possible between seaports, or on navigable rivers and canals. Otherwise, trade requires air transport (for those rare cargoes of high value per pound), or much more commonly (for lower-value bulk cargo), truck or rail transport.

Trucks are extremely flexible: they can transit between any two points on a road network. But they are not very efficient. Labor costs alone are relatively high: a single truck cab can transport at most three twenty-foot equivalent units (the standard size for a shipping container), and more commonly only one, per frontline employee (a single driver). In contrast, a train can haul between 220 and 280 containers per train that typically employs no more than 2 persons—or more than one-hundredfold higher labor productivity than trucks.

Any type of transport is constrained by the capacity of its network: aircraft by airports, ships by seaports, trains by rail lines and rail yards. Trucks share the road network with other vehicles and as such suffer especially from highway bottlenecks. According to the Washington Department of Transportation, bottlenecks cost shippers whose goods travel within Washington State by truck $3.3 billion per year in 2011, suppressing employment by 0.7% and output by 0.5%.[13] These magnitudes are equivalent to a large part of a full year of economic growth for the state.

Railroads, therefore, offer the most economically efficient means to transport over land large volumes of relatively low value goods and materials. “Economic efficiency” here refers to total cost per ton-mile (the cost to move one ton for one mile). Railroads’ superiority over alternative modes is generally even greater when broader definitions of “cost” are used, such as those that include fuel economy or social costs such as environmental impact.

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Chapter 2
The Role of Transportation in Economic History[14]

Throughout most of human history goods moved no faster than wind or horses could carry them. Even in one of the most mobile societies on Earth, the United States, in its early years the vast majority of citizens lived their entire lives within 20 miles of their birthplace. Economically, there was no "global market", but many local markets, with vast differences in the availability and prices of goods, because surpluses in one location could not be efficiently transported to another where there were shortages.

All this changed in the 19th century with the advent of steam engines. First used on ships, this technology cut travel times by over 75%, allowing perishable agricultural produce to be shipped across oceans. Steamships combined with refrigeration were the essential basis for the Argentinian, Australian and New Zealand economies, which had surpluses of grazing land for cattle and sheep, but needed to export meat to distant markets.

Of course, ships could transport goods only over water. In the early 19th century there was a boom in canal construction in England and the U.S., to expand the network of ship borne transport well inland of the seacoast. The Erie Canal, for instance, which connected the Great Lakes with the Hudson river, first opened in the 1820s, funneled the produce of the "Northwest" (what now would be called the Northern Midwest) east to the Hudson River, and thence to New York City, the entrepot where cargo was loaded on ships bound for Europe. The Erie Canal arguably was the greatest force behind New York's rise, eclipsing Philadelphia and Boston as the dominant cities in early America.

But inland shipping was limited to navigable rivers and canals. Opening up the vast landlocked region of the North American continent west of the Mississippi relied on another steam technology: railroads. First built in England in the early 19th century (and the catalyst of a giant investment bubble in the 1830s), steam locomotion grew rapidly: first to ship the dominant fuel (coal) to manufacturing hubs to fuel the Industrial Revolution; later to transport manufactures to markets, especially to ports for shipment overseas. In predominantly agricultural economies such as the early U.S., railroads enabled hundreds of millions of acres in the previously inaccessible interior of the continent to become the world's most productive farmland. Without railroads America west of the Alleghenies would be sparsely populated and unproductive—an isolated, impoverished, subsistence economy.

The same story applied throughout the world. Agricultural economies relied on railroads—often transshipping onto steamships—to deliver their produce to markets on distant continents. It is not an exaggeration to note that without steam-powered ships and railroads, the first great era of globalization in the late 19th Century could not have happened.

Railroads had higher costs per ton-mile than did river or canal barges—coal cost more than fodder for mules, or the "free" (unpriced) wind and current—so in their early years railroads' primary cargoes were passengers and high value items such as manufactured goods. By the 20th century railroads' dominance of high value freight was in turn supplanted first by trucks, and later by airplanes. But for bulk (low value per ton) cargo, railroads today remain far more efficient than these alternatives, as discussed in the next chapter.

Price Convergence and Diversification

Trade, and the transportation systems on which trade depends, also reduces what economists call transactions costs. These are the added costs to consummate a purchase, usually charged by intermediaries such as brokers, retailers, or transporters. High transactions costs tend to atomize markets: If a farmer must pay a large share of his revenue to middlemen, his incentive to sell into distant markets will be lost, and his market will only be local. Regions will rely only on local producers, because more efficient businesses elsewhere cannot compete in the region. Consumers will thus be robbed of the benefits of wide competition, paying higher prices and often getting inferior products.

Economical transportation changes this. Sellers in regions that have an abundance of a product—say, wheat—who face depressed local prices can transport that surplus to regions in shortage where prices are higher. Over time prices in the surplus region should rise (as the surplus ebbs), and fall in the shortage region. Eventually, prices will converge, after transaction costs. Thus economical transport will erode those transaction costs, and bring prices in different regions closer together. The steam transportation revolution of the 19th century cut disparities in prices across national markets for beef, wheat, and coal by 80 to 90%.

Economical transport also smooths out economic cycles. If a region falls into a recession for local reasons, its businesses will try to increase exports to other regions not directly affected by the economic downturn. Transport allows businesses, and the regions in which they operate, to diversify far more broadly.

Globalization

Arguably, the growing integration of national and local markets into the globalized economy has been the greatest anti-poverty program in history. As an example, hundreds of millions of poor Chinese and Indians have risen above subsistence because they have been able to sell their wares to developed markets. For inland producers and customers—perhaps 70% of the world's population—this has only been possible due to freight rail. This industry has benefitted industrial economies for nearly 200 years, and today it is helping to bring hundreds of millions of the poor into the global middle class.

Chapter 3
Special Advantages of Freight Rail

As the discussion of the Erie Canal in the last chapter suggests, modes of transportation compete for shipments. Rail quickly outstripped river and canal-borne traffic in the 19th century, but its market share was eroded by trucks in the early 20th century, and later by aircraft for high value items. Nevertheless, for a wide range of cargoes, rail remains highly competitive, in five primary dimensions.

Efficiency

Rail's direct cost per ton-mile (the cost to ship a ton of cargo one mile) is just over one fourth that of trucks, the next most common mode of transportation for bulk cargo.[15] (This efficiency advantage is magnified when indirect or "social" costs are included, as described below.) Given that transportation's largest cost drivers are labor and fuel (accounting for over 60% of railroads' expenditures, and likely a higher proportion of trucks')[16], for which rail is far more efficient, this is hardly surprising.

Since deregulation in 1980 and despite the consolidation of the freight rail industry (there are currently only seven Class I (large scale) railroads in the U.S.), rates charged by railroads have fallen over 40% after inflation adjustment. Railroad productivity has far outstripped the average of U.S. industries, allowing fierce price competition. American freight rail rates are the lowest in the developed world—about half the median rate internationally.[17] According to the American Association of State Highway and Transportation Officials, rail shipments cost about one fourth as much as truck shipments.[18] (These are direct costs only, and omit indirect or "social" costs, where the disparity between rail and trucks is even wider.)

As a result of this intense price competition, freight volume has grown faster than the overall economy for decades—with rail volume slightly outstripping truck volume growth—despite the longstanding economic shift from goods to service production.[19] Lower prices to transport goods have helped regions specialize while broadening their access to markets.

Speed

While rail and trucks achieve similar speeds in operation, rail is far less affected by system bottlenecks than are trucks. Automobiles and trucks share the road network, which in general is unpriced, and consequently has long faced faster growth in demand than supply. Nationwide, traffic congestion costs truck shippers, and their customers, $121 billion per year, almost 1% of GNP.[20] The State of Washington has estimated shippers' congestion costs on its highways at $3.3 billion per year.[21]

While all transportation modes can eventually face capacity constraints, railroads have increased their capacity at an accelerating rate, rising by over 50% in the last decade (from $16 billion in capital investment in 2004 to $25 billion in 2013).[22] Cumulative total investment in the past few decades exceeds $500 billion. This has been done exclusively with private funds.

Safety

Since railroads were deregulated in 1980, accident rates have fallen by 79%. Employee injury rates are about half that of trucking, and about 2/3rds the average rate of all private industries.[23]

In recent years the greatest growth in freight rail traffic has been of crude oil (known as "crude-by-rail", or CBR.) New horizontal drilling and fracturing ("fracking") methods have permitted exploitation of oil and gas fields long believed to be unproductive. Many of these fields are not yet served by pipelines, so oil must be transported to refineries by truck or rail. Some of this oil has a chemical composition that makes it more flammable than traditional light, sweet crude. Consequently, when the rare derailment does occur, if oil leaks from tank cars there is a significant risk of fire. A tragic instance occurred on July 6, 2013 in Lac-Megantic, Quebec (near the border with Maine), when a train carrying crude oil from the Bakken formation in North Dakota derailed within the city limits, causing a conflagration that killed 47 residents.

Pipelines are an efficient (but inflexible) means of transporting liquid fuels—although pipelines' safety isn't absolute, as tragically illustrated by the September 2010 explosion at a natural gas pipeline in San Bruno, California that killed eight people. But new pipelines are difficult to build, due largely to the challenge of securing local permission for rights of way. (New pipelines are necessary because many of the oil and gas fields being "fracked" had not been exploited for a century, if ever, so they aren't presently served by pipelines.) Transportation systems with legacy rights of way, such as those granted to railroads in the late 19th century, are not similarly handicapped. Rail shipments are significantly safer than trucks, as noted above.

Rail's safety performance has been the result of ongoing investment by railroads: about 17% of revenues, or several times the average for all industries.

To improve CBR safety, railroads are smoothing lines to reduce the incidence of derailments, and purchasing modern tank cars with safety systems to minimize spillage when derailments occur.

Since railroads were deregulated in 1980, accident rates have fallen by 79%. Employee injury rates are about half that of trucking, and about 2/3rds the average rate of all private industries.

Since 2011, railroads have been pressing regulators to update standards for the construction of oil tanker railcars. (Although an industry clamoring for more regulation is hardly common, it was motivated by a belief that universal technical standards could significantly reduce oil spills.) The federal government's proposed standards were announced on July 23, 2014, subject to a 60 day comment period.[24]

Economic Self-Sufficiency

Transport systems require investment to create and maintain their networks. Whereas the major facilities for trucking and air transport have been built with public funds (roads for trucks and airports for aircraft), railroads invest private (shareholder) funds to create, expand, and maintain capacity. That investment is the largest as a share of industry revenue of any large industry, nearly six times the national average for all industries.[25] The robust infrastructure this has created allowed the industry's significant productivity gains of the past few decades.

Social and Environmental Impact

Rail also is significantly more fuel-efficient than alternative modes of transport. The number of ton-miles transported per gallon of fuel has doubled since 1980, to nearly 500 ton-miles per gallon. This is four times as fuel efficient as trucks.[26] Since burning of fossil fuel emits greenhouse gases and other air pollutants, rail shipments emit 75% less per ton-mile on average.

Beyond environmental benefits, freight rail imposes lower social costs (costs imposed on society and generally not reflected in market prices) than trucks in a variety of ways. The most comprehensive estimates of comparative social costs have been produced by Gerald McCullough of the University of Minnesota in 2005 and David Fockenbrock of the University of Iowa in 2001.[27] Estimating the costs imposed on society by rail and trucks respectively in eight categories of indirect cost (congestion, accidents, pollution, energy security, noise, and public infrastructure), rail imposed lower social costs in all but one category (noise). Total social costs of rail were found to be one ninth of those imposed by trucks.[28]

The number of ton-miles transported per gallon of fuel has doubled since 1980, to nearly 500 ton-miles per gallon. This is four times as fuel efficient as trucks.

Not surprisingly, railroads held a 40% market share of national freight revenues (for domestic shipments), according to the Bureau of Transportation Statistics, U.S. Department of Transportation, for the most recent year available. Trucks had the second highest share at 33%. These data use a very wide definition of the market, including domestic ship borne transportation, domestic air, and pipelines for transporting oil. Rail's share would be higher if the market was more narrowly-defined.[29]

In sum, freight transportation has enabled economic growth, and the need for it has expanded even faster than the economy. Rail is the superior mode of travel for most long inland trips: it is less fuel-, pollutant-, and labor-intensive. Rail's cost advantage has stimulated volume growth, and allowed regions to specialize and prosper. Such opportunities are especially important in a lightly populated but strategically located region like the Pacific Northwest.

Chapter 4
The Northwest's Role in the Global Economy

"Washington, like the rest of the Northwestern states, has tied its economic fate to trade with Pacific nations."

—Timothy Egan, 'Economic Pulse: The Pacific Northwest - A special report', New York Times, March 14, 1991

Western Canada and the Northwestern United States have always been more sparsely populated than their nations' economic centers. So they have been especially dependent on exports, to other regions within their countries, and across the U.S.-Canada border. From colonial times some of those exports have been shipped overseas: Otter pelts were shipped to China in the late 18th century.

International trade has always been a primary driver of regional economic growth. Washington State is more than twice as export-intensive as the U.S. average: in 2012 Washington exported $10,950 per capita vs. $4,938 for the U.S. as a whole. This is the second-highest of any state, after only tiny Vermont. According to the Washington Council on International Trade, 40% of the state's employment is dependent on trade, with about three out of four of those jobs related to exports.[30]

This represents a one-fourth rise in trade intensity in just the past 15 years, due to the rapid economic growth in key trading partners such as China.[31] State merchandise and commodities exports in 2011 were $65 billion, about 21% of state gross domestic product (GDP).[32] Exports represent about twice as large of share of Washington's economy as they do for the U.S. as a whole.[33]

Some of the highest value-added-per-worker industries such as aircraft and software are dominated by exports: 80% of Boeing's customers are located outside the United States[34], as are nearly 50% of Microsoft's customers.[35]

More than 60% of employment in several entire industries is export-dependent, spanning the spectrum from forest products to computers and aircraft. As this chapter's epigraph suggests, exports have been a core economic strategy in the Northwest for a very long time. Industries with significant dependence on freight transportation are shown in Table 1.

Industry Employment	No. of Freight-Dependent Jobs	% of State
Agriculture, Forestry, Fishing/Hunting	74,018	3%
Mining	2,800	.1%
Construction	186,495	6%
Manufacturing	298,970	10%
Wholesale trade	126,563	4%
Retail trade	322,256	11%
Transportation and warehousing	114,006	4%
Total	1,125,108	39%
-Of which primarily export-dependent	*802,852*	*28%*

Table 1. Washington Industries Dependent on Freight Transportation, 2008 (Source: WSDOT) Total state employment in 2008: 2,881,000 jobs[36]

Washington's largest trading partner by shipment value is Canada, with 29.1% of all exports. China is second with 17.8%, and Japan accounts for 12.9% of state exports. Not surprisingly, Pacific Rim nations (including Canada) receive more than two thirds of all goods exported from Washington.[37]

40% of the state's employment is dependent on trade, with about three out of four of those jobs related to exports.

By far the largest export industry in the state is transportation equipment, shipping $28 billion in 2011. While most of these shipments are assembled aircraft, which can be flown to their destinations, even aircraft manufacturing relies heavily on rail in its supply chain. (This was underscored dramatically in early July 2014, when a train carrying six Boeing 737 fuselages produced in Kansas derailed in Montana.) For example, the elaborate supply chain of Boeing's 787 Dreamliner involves sourcing from many countries (including Japan, South Korea, Italy, France, Sweden, Australia, and the United Kingdom) and several U.S. facilities in Wichita, Tulsa, Dallas, and South Carolina for final assembly in Everett.[38]

Other products that are exported in large volumes include agricultural and forest products (including fruits, lumber, grains, and grass seed); petroleum and coal; computers and electronics; machinery; and metals and chemicals. Many of these originate in Washington, but some are transshipped through Washington from origins in the North Central states and provinces. The last categories (metals and chemicals) were once a much larger export force, driven by low electricity prices from hydropower, but declined in importance in the late 20th century. They may expand again as abundant natural gas reduces costs in energy-intensive production processes.

The Importance of Exports to Long-Term Prosperity

Economic geography posits that all jobs are not equally important, economically. Economists segment industries into two broad categories: "basic" and "population-serving". Jobs in the base sell to customers outside the region—in other words, they export. Population-serving jobs, as the name implies, offer goods or services to the region's residents. Examples are government, retail stores, and restaurants.

Economic development specialists argue that emphasis in attracting businesses should be on "basic"—that is exporting—industries. The assumption is that the resulting economic growth will raise demand for local services, which local entrepreneurs can exploit naturally.

Note that anything sold to foreigners is an export. So educational, legal or consulting services are exports if their clients are not local. Likewise, tourism is an export to the extent that tourists come from elsewhere.

"Basic" or export industries and jobs are significant for another reason. By definition, they compete on a wider playing field, which disciplines them to be especially productive. It is no accident that many of the Northwest's largest exporting industries are also among the most productive. By "productive" we refer to labor productivity: the value added per hour of work. Since no worker will be paid more than the value of what they produce, industries with high labor productivity can offer the best wages. In many cases the most export-intensive industries are also among the highest-paying.

Given Washington's high export-intensity, it isn't surprising that incomes are also high compared to the national average: $47,140 state GDP per capita in Washington in 2012 vs. $42,784 for the U.S. average—superior by 10.2%. Washington was fourth among exporting states in absolute dollars (behind Texas, New York, and California).[39] Exports also made Washington's economy more dynamic and more resilient in the recent business cycle. Washington's incomes did not fall as much as the national average

during that 2008-09 recession,[40] and they also grew the 7th fastest in the nation in its aftermath.[41]

Finally, one of the dominant economic trends of the early 21st century has been and will be the deceleration of developed economies under the weight of demographics and debt, coincident with the catchup of formerly underdeveloped economies, including post-communist societies.[42] Asian economic growth has far exceeded Western growth for several decades. While the long-term pace of growth in both regions is likely to abate in absolute terms to midcentury due to aging demographics, in relative terms Asia's growth margin will remain far superior to the West's, and may magnify.

Current Developments That Can Affect Pacific Northwest Exports

Developments that may impact regional exports include the following:

Positive: New trade agreements such as the Trans-Pacific Partnership.

Negative: China's growing assertiveness on sovereignty matters in surrounding seas, which impact several of America's allies including Japan, South Korea, and the Philippines, could cast a pall over bilateral U.S.-China trade. China's attempts to diversify its sources of raw materials will affect commodity producers like Australia and Chile far more than North America.

Mixed: Completion of the Panama Canal widening project, scheduled for 2016. In principle this will allow higher volumes of trade between Asian and U.S. East Coast ports, bypassing U.S. West Coast ports. In anticipation, a number of East Coast ports are planning expansions, especially those on the Gulf of Mexico. Negative market share impacts are likely to be much more pronounced for California ports, which currently receive the majority of Asian imports.[43]

In sum, international trade has long been central to the region's economy, but its pivotal importance has grown in the past generation as three billion new capitalists, mostly in Asia, have joined the world's economy and are striving to catch up with the West. Because export jobs must compete globally, they tend to be especially productive and well-paying. While the dominant export industries have evolved over time, our region's strong export tradition has provided an enduring base for its competitiveness and prosperity. Current developments seem unlikely to disrupt the trend toward higher trade volumes in the Pacific Rim. As will be seen in the next chapter, freight rail has been essential to this.

Chapter 5
Freight Rail's Contribution to Economic Growth

As mentioned earlier, freight rail is an indispensable link in the web of international trade. It is the most efficient way to get bulk goods to or from inland sites. Driven by trade with Asia, rail volumes have grown faster than the overall economy: for Washington state, roughly twice as fast, doubling in the two decades after 1990.[44] Figure 2 shows some major rail lines in the western U.S.

Figure 2. Major Freight Rail Corridors in the Western U.S. (Source: BNSF Railway)

Rail has been essential to American economic development west of the Appalachians, but nowhere more so than our region:

> *"The arrival of transcontinental railroads in the Pacific Northwest during the 1880s marked one of the key turning points in the region's history. The Northwest had been integrated into global trading networks since the 1780s, when British vessels began carrying away sea otter pelts to China; and the Northwest had been integrated into far western trading networks since the time of the Gold Rush, when California's demand for produce and lumber had sent ships to regional shores. Yet as late as 1880 the Pacific Northwest remained largely isolated from both the main currents of the global economy and the bulk of the population in the United States. From the writings of people like James Swan, Americans knew that the Northwest possessed resources to be exploited. Yet other parts of the country generally provided plenty of the kinds of resources that the Northwest had to offer, and the place remained too inaccessible for most people. Consider, for example, the extent to which people homesteaded in the region. Between 1862 and 1880, only 9,800 people in Oregon and 9,500 in Washington filed homestead claims; by contrast, 62,000 and 59,000 filed claims, respectively, in Minnesota and Nebraska—states located closer to, and served better by railroads from, eastern centers of population."*[45]
>
> —Center for the Study of the Pacific Northwest, "Industrialization, Technology, and Environment in Washington"

The eight U.S. states and three Canadian provinces in the "Great Northern Corridor" (the principal U.S. rail corridor in the Northwest, connecting the northern Midwest with Pacific Northwest ports) have a combined GDP of nearly $2 trillion, over 10% of that of the two

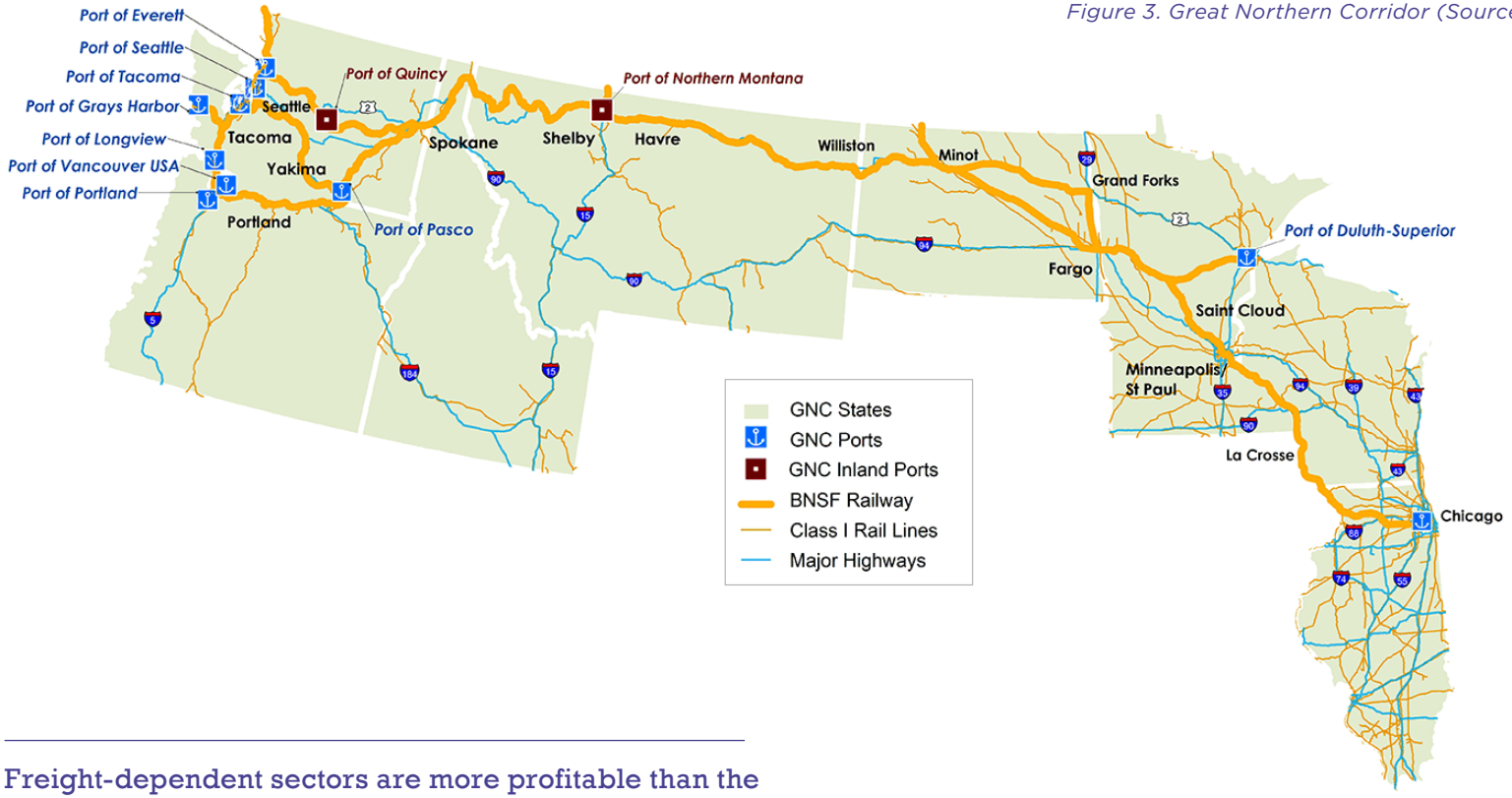

Figure 3. Great Northern Corridor (Source: BNSF Railway)

Freight-dependent sectors are more profitable than the state economic average: they account for 33% of state employment, but 71% of business income, according to the Washington State Department of Revenue.

parent nations. 13% of total combined U.S. and Canadian exports (by value) is shipped by rail through this corridor and onward by sea to Pacific trading partners.[46] The largest volume originates in U.S. North Central states, with a smaller portion originating in the Canadian West. The U.S. states along this corridor supply 41% by volume of all U.S. exports shipped by water, and 61% of those shipped to Asia—roughly twice as much as those shipped through the great ports in California.[47] Figure 3 maps the Great Northern Corridor.

By connecting inland agriculture and mineral producers with Pacific ports, rail has been central to the Northwest's growth as an exporter to Asia:

> *Rail provides critical transportation for manufacturers, agricultural producers, lumber and wood product producers, the food products industry, and the ports and international trade sector—all important sectors of the state economy. Freight rail, in terms of tonnage, accounted for 19 percent of total freight in the state in 2007.*[48]
>
> —Washington State Freight Mobility Plan, Public Review Copy, June 4, 2014

Freight-dependent sectors are more profitable than the state economic average: they account for 33% of state employment, but 71% of business income, according to the Washington State Department of Revenue.[49] Figure 4 shows the freight rail network in Washington state.

Freight Rail Corridors in Washington State

Figure 4. Freight Rail Corridors in Washington State (Source: WSDOT)

Chapter 6
Economic Impact of Freight Rail on Washington State

The Limits of Regional Economic Impact Estimation Methods

In this chapter we report the results of our analysis of the economic impact of freight rail in Washington State. In candor, we readily acknowledge that the question asked overwhelms traditional analytic methods.

The common analysis framework for such questions is input/output modelling (I/O). In general, I/O models attempt to measure how much each industry in the economy is dependent on other industries. For example, how much steel, fuel, legal services, and computers (outputs of four other industries) does the mining industry purchase as inputs to its production process? When a given industry enjoys more or less demand for its output, it will increase or decrease its own demand for those inputs. I/O models can produce multipliers that estimate the total "ripple" effects on the broader economy that stem from changes in demand to a given industry. Effects are measured in terms of total output (gross domestic product, or GDP), household earnings, and employment. More about I/O modelling is discussed in the Appendix.

I/O models are often used to estimate the total effect of, say, a new factory; or of a factory closure. For a factory expansion, that facility will purchase inputs from other industries, which will use their revenues to buy from other industries. Some portion of those revenues will find their way to households whose members are employed by, or owners of, firms in the supplying industries. A factory closure will have the reverse effect: its purchases will cease, so all of its suppliers will have less income (and so spend less), affecting their workers and vendors. The ripples of a factory start or closure expand into the entire economy. I/O multipliers translate the direct effects (the added or lost revenue due to the factory's change in status) to total effects, taking into account changes in spending by the factory's suppliers, and their suppliers, including households who furnish their workers.

This approach is premised on a key assumption: the change being estimated directly affects only a small portion of the overall economy. All other parts of the economy are assumed to remain unchanged. Multipliers capture the minor adjustments other sectors will make to changes in demand in the directly affected sector—but they are assumed to be quite minor; and they are assumed to scale linearly with their own changes in demand.

The I/O approach is widely accepted and has been repeatedly validated when applied to examine relatively small changes in economic activity—say, a $1 billion factory in a $300 billion state economy. But its results can be nonsensical, if taken literally, when considering a large change. In the case of freight rail's economic impact, a literal interpretation of the question addressed in this report is: What if freight rail didn't exist? Or said another way, what if some natural disaster, government policy, or change in shipper preference, eliminated all demand for freight rail services?

Below we show a "naïve" estimate to answer this naïve question. Before discussing the numbers, we can reason through to a qualitative approximation.

Before railroads, as described in Chapter 2, economic life was mostly local and trade was limited. Because competition among firms was limited to those nearby, there was far less pressure to specialize and continuously improve. Consequently, productivity grew at virtually nonexistent rates. Economic historians have estimated that prior to the modern era per capita incomes grew at rates statistically indistinguishable from zero.[50] By contrast, after the commercialization of steam power for ships and rail, per capita incomes have been doubling about every generation. Real incomes (i.e., adjusted for inflation) in the early 19th century—just before the beginning of the railroad era—were about 1/25th of those today—little more than $1,000 per year, far below the poverty line.

Less dramatically, a simple estimate (termed the "naïve estimate" later in this chapter) would simply remove from the economy all direct economic activity in the portion of freight-dependent industries that rely on rail. As a first order approximation, consider that about 40% of Washington state's GDP stems from spending by the following freight-dependent industries: agriculture, forestry, and wood products; mining; construction; manufacturing; and wholesale and retail trade. 19% of freight volume is transported by rail, so an estimate is that about 8%—19% x 40%—of Washington state GDP would not exits if freight rail didn't exist. This would idle all workers in those industries directly affected, and a portion of workers in industries which supply them. Multipliers capture these indirect effects. Adding in these ripples, perhaps 11% of the economy would be idled, roughly tripling the state unemployment rate.[51]

An Alternative, but Still Flawed, Approach

But even an almost purely qualitative estimate must recognize that other transportation modes can replace rail—albeit at a higher cost. It can be assumed that if rail ceased to exist, many of its loads would be hauled instead by trucks. But transporting by truck costs nearly four times as much (3.79x to be precise) as rail per ton-mile, and 9x if social costs are included. Those higher costs would be enough to drive off the least profitable shippers—the ones whose profit margins would be eliminated by higher shipping rates. The price elasticity of demand measures the responsiveness of customer demand (measured in terms of changes in the volume purchased) when prices change. It is defined as the percent change in volume for each one percent change in price.

Shippers' demand is fairly inelastic—that is, shipping volumes do not change proportionate with price changes. Our literature review of shippers' demand elasticity uncovered a range of estimates from a low of 0.29 to a high of 1.1. That means that a 1% increase in shipping rates would reduce the volume shipped by between 0.29% and 1.1%.

But like I/O modelling, price elasticities are estimated under modest changes, to which customers are assumed to respond linearly. Elasticities may produce reasonable results for a 1% or 10% change in prices, but be highly suspect for a much larger price change. Since trucks' direct costs are 3.79 times that of trains, the elimination of trains would impose a 279% price increase on shippers. Even a low price elasticity taken literally would suggest that essentially all bulk freight transport would cease. Inland producers of bulk products would be isolated from the global economy. Their geographic market would shrink enormously: from the entire globe down to a radius of a few hundred miles.

Our Two Estimates: Naïve and Narrow

Table 2 summarizes the results of our I/O-multiplier-based analysis. Three types of impacts are shown:

- Output: Change in total economic activity—GDP—including the indirect effects on other industries.
- Earnings: Change in earnings by all households: those with workers in the directly affected industries, those whose members work in indirectly affected industries, and those which received dividends from the affected companies.
- Employment: The total number of jobs added or subtracted per million dollars in revenue added or subtracted in the directly affected industry.

	Naïve			Narrow		
Industry	**Output ($M)**	**Earnings ($M)**	**Employment (Jobs)**	**Output ($M)**	**Earnings ($M)**	**Employment (Jobs)**
AgTimWP	$926	$267	8,078	$390	$112	3,401
Mining	$117	$27	625	$49	$11	263
Constrctn	$13,593	$4,960	98,434	$5,723	$2,089	41,446
Manufrng	$35,001	$8,433	192,073	$14,737	$3,551	80,873
Whlsl Tr	$34,882	$10,868	186,694	$3,675	$3,675	83,707
Retl Tr	$28,583	$9,404	314,556	$3,960	$3,960	132,445
Total	$113,102	$33,959	800,460	$28,535	$13,398	342,135
WA state total 2013	**$381,017**	**$332,823**	**3,222,488**	**$381,017**	**$332,823**	**3,222,488**
Estimates' percent of state total	**29.7%**	**10.2%**	**24.8%**	**7.5%**	**4.0%**	**10.6%**

	Multipliers used (from RIMS II)		
Industry	**Output ($M)**	**Earnings ($M)**	**Employment (Jobs)**
AgTimWP	1.5197	0.437733	13.26053
Mining	1.266	0.2931	6.7702
Constrctn	1.4828	0.5411	10.7375
Manufrng	1.383	0.3332	7.5893
Whlsl Tr	1.3316	0.4149	7.127
Retl Tr	1.3167	0.4332	14.4903

Parameters used for narrow estimates			
Percent increase in direct costs per ton-mile (substituting trucks for trains):			279%
Price elasticity of demand for transportation (low):			0.3
Price elasticity of demand for transportation (high):			1
Therefore, direct reduction in trade volumes ($M) if rail didn't exist:			
GDP	% change	$M	% of WA GDP
Low E	84%	$373,866	120%
High E	279%	$1,246,220	410%

Table 2. Naïve and Narrow Estimates of Freight Rail's Impact in Washington State (author's calculations)

In our case there are six directly affected sectors: the freight-dependent sectors mentioned in Chapter 4. Those industries' Output, Earnings, and Employment multipliers from the Bureau of Economic Analysis' RIMS II model are listed on the lower half of the table. The upper portion shows the total effects on the economy for each of the six sectors that most heavily depend on freight rail (and which would be most harmed if freight rail ceased).

The output, earnings and employment that would be lost if freight rail didn't exist are shown for two estimates:

- The naïve estimate simply reduces activity in each of these sectors based on freight rail's share of their shipments (an average 19% share). These estimates show the total effect on the Washington economy if 19% of the shipments in each sector simply did not happen.
- The narrower estimates make an attempt to reflect the substitution to trucks from rail that would occur if rail did not exist, acknowledging that trucks' higher cost would reduce shipping demand, and therefore demand in these industries.

"Multipliers" capture the total economic impact (in terms of the metric listed in the column header) of one dollar of change in demand to the row industry—except for employment, which is denominated as change in jobs per one million dollars change in demand to the row industry. It reflects all of the row industry's purchases from other industries, and similar downstream "ripple" effects. Thus for example a $1 million change in direct demand to the Mining industry generates a total impact in Washington state of:

- $1,266,000 in GDP (output)
- $293,100 in household income (earnings)
- 6.77 jobs

Multipliers capture impact within the designated area (in this case, Washington state.) Multipliers tend to be higher in larger economic regions (since less activity "leaks" beyond its borders) and in highly productive industries, such as most exports.

Interpretation of These Estimates

As its name implies, the naïve estimate is really a "strawman"—an artificial construct not to be taken seriously (although many analysts would do so), since it implies that all goods formerly shipped by rail are simply not produced if rail didn't exist. Its numbers are dramatic: the state of Washington would see its GDP shrink by 30%, household income by 10%, and employment by 25%. These magnitudes are comparable to the Great Depression. But they are really meaningless: they ignore human beings' inherent ability to adapt—to at a minimum shift loads from (nonexistent) trains to trucks. Nevertheless in some literal sense it can be claimed that freight rail contributes almost one third of state GDP and one fourth of state employment, when its ripple impacts are included.

A more realistic, but still inherently crude, quantification of freight rail's impact is the narrow estimate. It attempts to reflect the substitution (by shippers of trucks for trains) omitted from the naïve estimate. But even here, taking shipping demand's responsiveness to price increases too literally also inflates the impact. Shifting from trains to trucks would increase shipping rates by almost 300%. Even using the low range of demand elasticities (0.3) eliminates nearly all shipments from these heaviest rail-using industries.

The final narrow estimates adjust for demand elasticity as well as rail's share of total shipments. These estimates' magnitude are roughly 40% of the naïve estimates. They suggest that freight rail contributes 7.5%, 4%, and 10.6% to Washington's respective GDP, household incomes, and employment. These magnitudes are broadly consistent with the best qualitative reasoning discussed in the previous section.

Why These Estimates Are Conservative

Any analysis requires simplifying assumptions. Whenever a decision about assumptions was needed, the author leaned towards greater conservatism. In other words, the estimates above are far more likely to be understated than overstated.

> **...if freight rail did not exist, Washington state's economy would be at a very minimum between 4 and 10% poorer...**

The principal sources of downward bias in these estimates include:

- Concentrating on shipper industries and omitting the railroad industry itself. The most direct impact of the nonexistence of railroads would be on that industry, by definition. But we have omitted the industry within Washington for two reasons: (1) Its employment is reported in establishments in other states, making it difficult to ascribe specific jobs to the state. State figures show no Washington railroad employment. (2) As a very rough proxy, employment in water transportation (mainly ferries) was less than 3,500 in 2013, suggesting that the omission of Washington railroad workers would not have a major impact on our estimate:[52] it excludes only about 1% of our estimated employment effect.
- Recognizing that shippers can substitute trucks for trains—an approach often omitted from economic impact analyses. All loads shipped by rail would not remain at their places of origin (or not be produced) if rail didn't exist. Rather, shippers would choose an alternative mode of transportation, which for most bulk cargos would mean trucks.

- Reflecting the shipping demand suppression caused by trucks' higher transportation costs. Price elasticities measure how demand responds to price changes—the percentage by which volume demanded is reduced if prices increase by 1% (or by which it is increased if prices fall by 1%). This is a countervailing force to the shift of volumes from trains to trucks if trains did not exist. Some shipments would certainly still occur, but higher transportation costs would reduce their volume.
- Ignoring rail's superior social costs. Rail is superior to trucks in terms of every type of impact it imposes on society except noise. The total costs (what economist term those "social costs") per ton-mile imposed by trucks is nine times that of rail. Any efforts to increase fuel taxes or impose carbon taxes or "cap and trade" would cause shippers to internalize those social costs. This would magnify the price increase from substituting trucks for trains.
- Omitting regional impacts beyond Washington State. Washington is a proxy for the entire Pacific Northwest region, to include several U.S. states and Canadian provinces. Total regional impacts could be roughly triple those shown above. (Regional GDP is roughly 3x Washington's, as shown in Table 3.) We limited our estimate to Washington alone to be deliberately conservative.

As noted in the previous section, while all of these adjustments improve upon the naïve estimate, judgment was still necessary to make our final narrow estimate realistic. It is the author's belief that our estimate is far more likely to be too low than too high.

To summarize, if freight rail did not exist, Washington state's economy would be at a very minimum between 4 and 10% poorer, depending on the metric. These numbers are almost certainly low, but conventional estimation methods founder when confronted by an industry whose imprint is as pervasive as rail. A large portion of the economy—certainly more than 10%, perhaps as much as 40%—would have far smaller markets for their product, and consequently far less sales and income, if they were denied the significant efficiencies that freight rail offers.

Our methodology is discussed further in the appendix.

Washington	$381,017	
Oregon	$211,241	
Idaho	$57,024	
Montana	$39,840	
British Columbia	$203,698	
Alberta	$288,794	Washington percentage of total
TOTAL-wide	$1,181,615	32.2%
TOTAL-narrow	$1,084,751	35.1%
"Narrow" omits ID and MT from definition of region.		

Table 3. State and Provincial GDPs in Pacific NW Region, US $M, 2013 (2012 for Canadian provinces)

Chapter 7
Conclusions

The ability to transport goods over long distances is a precondition of modern capitalism because it allows companies and regions to specialize in the productions of items for which they have a productivity advantage. For inland consumers and producers, by far the most efficient mode of transport—to shippers, and even more so to society in general—is freight rail.

Rail was essential to the development of the North American west. It has allowed the Pacific Northwest, and Washington state in particular, to become an export powerhouse—fourth in the nation, behind only states with four to six times its population. The state is more than twice as export-intensive as the national average.

Exports are central to prosperity, because they enormously broaden markets; and even more fundamentally, because they expose local firms to global competition, forcing continuous improvements in productivity to remain world-class. Washington's strategic position athwart a major route of trans-Pacific trade has been a major source of competitive advantage and has paid economic dividends: per capita incomes about 10% above the national average, and a more resilient economy than the U.S. as a whole: experiencing both a milder downturn and stronger recovery from the recent recession.

Without freight rail, Washington's footprint on the global economy would be limited to products produced within a few hundred miles of its seaports—that is, to within the state. Rail enables it to be a crucial export channel for producers from much of the continent. Freight rail allows Washington to be the path through which trade occurs. For example, trade that passes to and from eight states and four Canadian provinces to Washington allows for a combined regional GDP of nearly $2 trillion, larger than that of many medium-sized developed economies such as Italy or Australia.

To answer the question, "What is the impact of freight rail in Washington state?" implicitly involves a related question: "Compared to what?" This report has conjectured that freight rail was assumed not to exist, to see how much poorer Washington would be without it.

A reading of history provides one answer: Without freight rail, inland producers would be restricted to local markets, and pressured to improve only by local competitors. One of capitalism's key driving forces—long-distance trade—would be absent. A slightly more thoughtful answer is that all cargo would be hauled long distances inland via trucks, so only exports originating within a truck trip of Washington's seaports would be produced. Trade volumes would be significantly reduced because trucks' significantly higher costs—a factor of four if only direct costs to shippers are counted, but a factor of nine if all costs to society are—would depress demand for transportation.

A crude, and deliberately quite conservative, estimate of the impact on the economy of freight rail is that it adds about $28.5 billion, or nearly 10%, to Washington's GDP: equivalent to much of a full decade of growth. Households earn $13.4 billion more than if rail did not exist: more than $5,000 per year for a typical family. Over 300,000 jobs—about 10% of total state employment—exist because of the economic dynamism enabled by freight rail. These estimates include both direct effects on the main freight-dependent industries, as well as ripple effects from those industries' purchases from the wider economy. They are, however, deliberately quite conservative, and much more likely to be understated than overstated. For example, they restrict impacts to Washington state. The impact on the wider region is roughly three times as large.

At the beginning of this project, this author viewed freight rail as a ho-hum mature 19th Century industry, of little interest in the technological 21st Century. But as this report reveals, that view is short-sighted: the 21st globalized economy could not exist without efficient transportation that allows producers far inland to sell to, and compete with, the entire planet. Freight rail truly is an engine of prosperity.

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Appendix
Analysis Methodology

The analytic framework used in this report is a very common one for regional and national economic impact analysis: input-output (I/O) modelling. This schema was developed by Wasily Leontief, one of the first recipients of the Nobel Prize in Economic Sciences. I/O modelling is based on an accounting framework that organizes the economy by industry. It attempts to capture production in the economy in terms of all of a given industry's inputs and outputs. For example, consumer electronics manufacturers will use glass, integrated circuits, and plastics to produce gaming consoles and televisions. These are laid out in a matrix format like an Excel spreadsheet, where for example cell E37 shows the outputs from Industry 37 used as inputs to Industry E. The I/O framework establishes how much total production will occur across industries if one industry produces one more unit, or one more dollar worth of output—buying inputs from other industries. It is intuitive that one industry's purchases are another industry's income; I/O modelling merely measures these relationships. The two best known I/O frameworks in use are the IMPLAN model (originated by the U.S. Census Bureau, now maintained by a private Minnesota firm) and the U.S. Department of Commerce/Bureau of Economic Analysis' Regional Input-Output Modelling System (RIMS II). This report utilizes RIMS II.

The row or column totals of the I/O matrix are industry multipliers: the total effect on the economy if Industry X receives one more dollar in sales. Industry multipliers are very common in regional economic impact analysis, and often are computed for three variables: output, income, and employment. Each captures the total effect in the economy of a dollar of additional sales by Industry X: how much regional GDP (output), how much household income, and how many more jobs would occur. (Likewise, these multipliers are assumed to capture the decline in overall economic activity if Industry X lost sales.) Multipliers include immediate effects of a change in industry income, as well as the effects on suppliers to the industry ("indirect effects"), and further effects on industries which sell to the suppliers ("induced effects".)

I/O modelling, and its resulting multipliers, are premised on several significant simplifying assumptions. Quoting from the BEA:

Assumptions of the model to keep in mind:

> ***Firms have no supply constraints—Input-output based multipliers assume that industries can increase their demand for inputs and labor as needed to meet additional demand.*** If local firms are already operating at full capacity, then additional inputs may need to come from outside the region, thereby reducing the local impact.
>
> ***Firms have fixed patterns of purchases—Input-output based multipliers assume that an industry must double its inputs to double its output.*** If a firm can increase its output without hiring additional employees and without purchasing additional inputs, then the impact of the change on the local economy will be smaller than the impact that is estimated using a full multiplier.
>
> ***Firms use local inputs when they are available—The method used by RIMS II to develop regional multipliers assumes that firms will purchase inputs from firms in the region before using imports.*** If a clothing manufacturer located in an area that produces textiles, purchases its textiles from outside the region, then the impact of a change in clothing production on the local economy will be smaller than implied by the full multiplier.

In other words, I/O modelling can best produce impact estimates when the change being appraised is very much "at the margin"—a small perturbation to a large economy. It can only crudely capture the impact of changes in large economic components, such as entire industries. (Implications of this key limitation are discussed in the first section of Chapter 6.) As the BEA notes, I/O-derived multipliers tend to have an upward bias—they can overestimate the impact of a change. This analysis consciously uses low multipliers, and makes a variety of other conservative assumptions mentioned in Chapter 6, so its impact estimates are more likely to be underestimated than overestimated—by design.

The BEA omits one important caveat: If a good or service becomes too expensive (or never existed), users of that service will substitute for it something more cost-effective. The following example will illustrate.

Say that you are estimating the economic impact of the pencil industry. Arguably, almost every other industry uses pencils. If pencils didn't exist, would those industries also cease to operate? Of course not. There are a wide range of substitutes available. The economic impact of the pencil industry is much more limited: without it, other industries would be obliged to use other, more expensive substitutes, which would force them to cut back on some other purchase to compensate. So if some natural catastrophe killed off the pencil industry—say, a blight killed every tree whose wood is used to create pencils—the economy would not cease to function. Rather, every pencil-using industry would spend a larger amount on pencil substitutes, leaving fewer funds available for other purchases. Industries which produce substitutes would win a lot, but every other industry would lose a little. Total economic activity would be modestly reduced.

In the context of the question underlying this report—what is the economic impact of freight rail?—the most likely substitute for rail on many routes would be trucks. As noted in Chapter 2, truck shipments cost more, directly to shippers and indirectly to society. These higher costs will lead to less volume being shipped and less non-transportation spending by shippers to compensate for the higher transportation costs. The estimates in Chapter 6 use the price elasticity of demand for freight transportation to crudely estimate shippers' response to the higher costs of trucking vs. rail. The underlying assumption is that shippers would choose not ship some loads by truck because of trucking's higher transportation costs. Reduced shipments means reduced exports, reduced employment in exporting industries, and lower spending by workers in those industries. I/O modelling captures these ripple effects from the directly affected industries to the broader regional economy.

This report computes both a "naive" estimate of the impact of freight rail—as if shippers would not use substitutes if rail didn't exist—as well as a "narrow" estimate, reflecting the more modest impact if all shippers substituted, but reduced their shipment volumes due to higher transportation costs. The latter, narrow estimate reflects the author's guess at the true magnitude.

About the Author

Dr. Philip J. Romero is Professor of Business Administration at the University of Oregon's Lundquist College of Business, where he served as dean from 1999 to 2004. He emphasizes strategies to enhance the competitiveness of firms, states and regions. This focus stems from his earlier career as chief economist to two California governors, RAND Corporation consultant to senior intelligence and national security officials, and corporate strategist for one of the world's leading industrial conglomerates.

He is the author of two books: What Hedge Funds Really Do (Business Expert Press, 2014), and Your Macroeconomic Edge: Investing Strategies for the Post-Recession World (Business Expert Press, 2012), as well as coauthor of several other books on regional public policy. He has been interviewed by virtually every major news outlet, including the Investor's Business Daily, MarketWatch, the New York Times, the Economist, Business Week, Wall Street Journal, Associated Press and United Press International, as well as major television and radio networks including the BBC, PBS, CNBC, NPR, and Bloomberg. His opinion articles have appeared in the Wall Street Journal, Oregonian, Los Angeles Times, San Francisco Chronicle, Kansas City Star, Miami Herald, Sacramento Bee, and many other dailies. He also served as a columnist and member of BrainstormNW magazine's editorial board (the Pacific Northwest's premier public affairs/business magazine) from 2002 until its demise in 2009. An experienced public speaker, he has made 100 speeches per year since the early 1990s, mostly on public policy for the economy and businesses.

Romero's research focuses on the dynamics of competition, on how to introduce competition to monopolistic arenas such as government, on how businesses erect barriers to entry around their market space, and on how demographic and geopolitical trends shape the investing environment. His consulting work estimates the economic impact of projects or industries (as in this report), or of proposed public policies.

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Endnotes

1 Organizational affiliations provided for identification purposes only. No endorsement of the content of this report is implied.

2 Michael Grunwald, "Back on Track," Time magazine, July 9, 2012. See also "Back on Track: The Quiet Success of America's Railways", Economist, April 13, 2013.

3 Author's calculation based on AASTHO data cited in Association of American Railroads, Overview of American Railroads, April 2014.

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6 Washington Council on International Trade and Trade Alliance of Greater Seattle, An International Competitiveness Strategy for Washington State, October 2012 (Hereafter, "WCIT Competitiveness Strategy")

7 According to ibid, two studies in the late 1990s found that 32% of Washington employment derives from international trade, which had risen to 40% by 2012. So the state's trade intensity increased by one fourth in 15 years. It rose further to 2014, as mentioned in note xxiii below.

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31 According to ibid, two studies in the late 1990s found that 32% of Washington employment derives from international trade, which had risen to 40% by 2012. So the state's trade intensity increased by one fourth in 15 years. It rose further to 2014, as mentioned in note xxiii below.

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50 To be more precise, the late Angus Maddison created the most authoritative estimates of income growth from 0 AD to the end of the 20th century. He found that per capita world GDP did not grow at all for the first 1000 years, and remained at the level of about 0.2% until the early 1800s (with a possible modest acceleration after the discovery of the Americas and the significant trade opportunities thus created.) The rate of growth in incomes increased by a factor of more than ten after the advent of steam, beginning around 1820. Whereas incomes barely changed prior to 1820, thereafter they doubled about every 30 years.

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The Washington Council on International Trade (WCIT) is the only organization in Washington dedicated exclusively to advocating for public policies that increase our state's international competitiveness. On behalf of its members — manufacturers, retailers, service providers, farmers & ranchers, non-profit organizations and individuals — WCIT advocates for strong, pro-trade policies and investments that benefit Washington's small, medium and large employers and that create jobs for Washington residents.