PUBLIC RAIL NOW

Climate & Community Institute

FROM MARGINS TO GROWTH
THE ECONOMIC CASE FOR A PUBLIC RAIL SYSTEM

KIRA MCDONALD

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THE ECONOMIC CASE FOR A PUBLIC RAIL SYSTEM

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I. EXECUTIVE SUMMARY

The structure of the railroad industry in the United States constitutes a massive and ongoing missed opportunity. Freight service is in decline, and passenger service lags enormously behind international peers. Long-term trends of decreased freight service, decreased market share, and decreased employment have accelerated in recent years, particularly with the advent of precision-scheduled railroading (PSR) across most Class 1 railroads. **In many ways, these are predictable consequences of how the industry is structured: as a set of massive, largely underregulated, regional duopolies.**

Oligopolistic industries, particularly in the absence of effective and enforced regulations, will tend to collude to control prices; decrease service to accept only the most profitable customers; and scale back investment, employment, and capacity to accommodate the strategy of pursuing only the highest margin customers. Trends that are abundantly clear in the data and in accounts from industry stakeholders, including private shippers and passenger associations, outline in countless ways these predictable consequences of the industry's structure. **This focus on margins has also led the industry to an overreliance on specific commodities, especially coal, that set the industry up for further, more precipitous decline, as shipped coal volumes are set to steeply fall in the near future.**

In conjunction with massive subsidies for on-road and air transportation relative to rail, oligopolistic conditions lead to a marked underutilization of rail for both freight and passenger service. The American public and the American economy suffer as a result. Different modes of transportation have different financial costs to users and pose different levels of external costs to the public. Where financial and social costs can be quantified and compared across modes, rail tends to have far lower public and private costs than on-road transportation or air travel. For freight, rail tends to be three to five times cheaper per ton-mile compared to trucking. Trucking generates eight times as much greenhouse gas (GHG) pollution, kills six times as many people in crashes, injures 14 times as many people, and generates three times as much non-carbon air pollution for moving the same tonnage the same distance. Trucking also creates congestion on roads and highways and contributes to their deterioration. These large costs of time, money, and shortened lifespans are offloaded from the trucking industry onto others. For passenger travel, movement by cars, pickups, or SUVs causes 27 times more deaths and 160 times more injuries from crashes relative to diesel rail and creates five times as much GHG pollution for moving the same number of people the same distance. Air travel generates five to six times more carbon pollution than diesel rail per passenger-mile traveled while also contributing substantially to climate change through other, nonemission effects. While rail is already more climate friendly than these other modes of transportation when powered by diesel fuel, it is also far easier to decarbonize entirely.

Meanwhile, cost savings from shipping would help consumers, reduce prices, and improve US export competitiveness for key sectors. Shipping comprises a substantial portion of product costs, often accounting for 10% of product prices, but this share is estimated to reach as high as 40% for some agricultural commodities.[1] Given that rail can achieve much greater cost effectiveness compared to trucking—even while trucking is currently so highly subsidized in comparison**—improved coverage and quality of rail service is a potentially enormously powerful lever to reduce prices for US consumers and costs for US businesses**, especially those in agriculture, manufacturing, and other sectors that produce and move physical products. Conversely, when underregulated oligopolistic conditions and vastly unequal levels of public investment and subsidies push traffic from rail to trucks, the costs to society, the economy, businesses, and consumers all grow enormously.

The primary goals of this report are to quantitatively assess the extent and costs of this underprovision of rail in the US and evaluate the feasibility of public rail ownership to help reverse course. This report introduces new modeling on mode shift potentials for both freight and passenger travel, catalogs private and public costs across modes, and uses modeled mode shift scenarios to calculate the scope of potential benefits realizable from mode shift. A study of the industry structure in the US and a comparative analysis of historical and international rail institutions establish the role public ownership and other reforms could play in achieving modeled mode shifts.

1. Peterson and Choe, "The Effects of Rail Prices on U.S. Agricultural Exports."

Mode shift scenarios are constructed from historical trends and forecasted travel patterns for both freight and passenger movement. For freight, mode shift scenarios envision reversing prior shifts from rail to truck, bringing the majority of long-distance truck freight onto rail, and shifting back to rail substantial portions of agricultural and other commodities that are already well-suited for rail. For passenger travel, mode shift scenarios are constructed from national household travel data, with a portion of intercity trips shifted from on-road transportation to rail for the moderate scenario. The ambitious scenario also imagines a new build out of high-speed rail (HSR) that shifts some passenger travel from air to rail.

Combined with the differential costs by mode, the modeled scenarios allow estimates for the scope of potential benefits from mode shift. In short, the scope of benefits would be huge. The ambitious mode shift scenario modeled in this report shows that, by 2050, the US could save up to $400 billion annually on shipping costs; avert over $190 billion annually in averted public health, environmental, and fiscal costs; create 180 thousand new jobs in the railroad sector; and create up to four million other new jobs throughout the economy through indirect economic effects. These would be in addition to a range of other benefits that are not quantified in this report.

> "...the US stands to avert over **$190 billion in public health, environmental, and fiscal costs**; save up to $400 billion annually on shipping costs; create **180,000 new jobs in the railroad sector**; and create up to four million other new jobs throughout the economy through indirect effects."

The estimated $190 billion in annual averted public health, environmental, and fiscal costs breaks down across GHG emissions, other forms of air pollution (particulate matter [PM2.5] and nitrogen oxides [NOx]), crash deaths and injuries, road wear and tear, and traffic congestion. While new jobs in the railroad sector are likely to be offset or partially offset by fewer jobs in trucking, the vast majority of jobs created from this shift would be due to decreased shipping costs from rail, which would spur employment in a wide range of industries without declines elsewhere. The combined benefits from decreased shipping costs and averted social costs here amount to nearly $600 billion annually by 2050—a sum equal to 2% of US gross domestic product (GDP) in 2022. For additional context, many estimates put the total fiscal cost of the Inflation Reduction Act (IRA) at around $100 billion per year, meaning that **if rail service is improved and expanded in the US, the IRA could be paid for four times over by 2050 from shipping savings alone.**

Not only does public ownership have the potential to trigger a mode shift that would spur economic growth and deliver benefits to the public in the form of improved health and safety, time savings, and reduced shipping costs, this mode shift is also essential to reaching global climate emission targets. On its own, the average annual emissions reductions from mode shift to rail estimated here would **cut 1/10 from current transportation sector emissions**. By 2050, the total GHG emissions averted through mode shift to rail would reach nearly 5,000 million metric tons of carbon dioxide equivalent (MMT CO2e)—equivalent to 2% of the world's remaining carbon budget to maintain a 50% chance of staying within 1.5°C of warming. The transportation sector is currently the largest source of GHG emissions in the US and is seeing the slowest progress in decarbonization. Decreasing emissions in this sector by 10% would therefore constitute a major step toward decarbonization.

"By 2050, the total GHG emissions averted through the mode shift to rail would reach nearly 5,000 million metric tons of carbon dioxide equivalent (MMT CO2e) — equivalent to 2% of the world's remaining carbon budget to maintain a 50% chance of staying within 1.5°C of warming."

These economic, social, and climate benefits are realizable by reversing current trends of decline in rail freight while also meaningfully expanding passenger service. **But changing railroads' current trajectory will necessitate deep changes to the structures that currently shape the industry.** Public rail ownership provides a direct and decisive path from the current structure as a set of large, underregulated duopolies to a cohesive entity, well-positioned to reverse decades of decline and worsening service.

International and historical examples, as well as existing lines in the US, establish the potential for publicly owned and operated rail lines to vastly improve service and utilization. Within the US, publicly owned passenger lines account for a huge proportion of total rail passenger-miles traveled (PMT) and see far greater investments in improved service and decarbonization compared to routes that run on primarily privately owned rail tracks. Internationally, many countries around the world with mostly public rail operations have seen consistent, excellent results. Direct comparisons of rail mode shares across countries should be made with caution, because other factors also dramatically affect mode share and large variation exists in railroad governance even within systems that are predominately public or predominantly private. However, countries with publicly operated rail lines tend to have more intensely used rail systems, even when geography or dominant shipped commodities are less favorable to rail. Examples of countries with successful, primarily publicly owned rail systems include Switzerland, Austria, Ukraine, Germany, France, China, South Korea, and India.

While increasing the number of rail operators, to increase competition, may seem to be an intuitive solution to the oligopolistic conditions that currently characterize the sector, international precedents and empirical research caution against this approach. In both public and private systems, fragmentation of rail ownership and operation tends to increase complexity and reduce transparency: hindering efforts to modernize, obscuring responsibility when things go poorly, and inducing economic and financial costs.

Institutions for rail system governance can have tremendous variation. Ownership and operation of rail lines may be managed by a single entity or split across multiple entities, which may be public, private, or a mixture of both. While in-depth plans on how public ownership should be implemented is not the focus of this report, a comparative analysis of railroad institutions and international practices indicate the promise of public ownership, particularly when paired with integrated public operation. **As a whole, the findings in this report highlight the urgency of investing in rail—and dramatically altering the institutions that have undergirded rail's decline and underuse for decades.**

BY THE NUMBERS

The US railroad industry is currently structured as **an underregulated, fragmented network of large regional monopolies or duopolies**, in which private railroads have immense market power.

Over **10% of Freight Analysis Zones**,[2] including entire major metro areas, have **access to only one Class 1 Railroad provider**.

Over **60% of Freight Analysis Zones** have access to no more than **two railroad providers**.

$ Oligopolistic power allows private railroads to focus on only the most profitable business, rather than market share or growth potential.

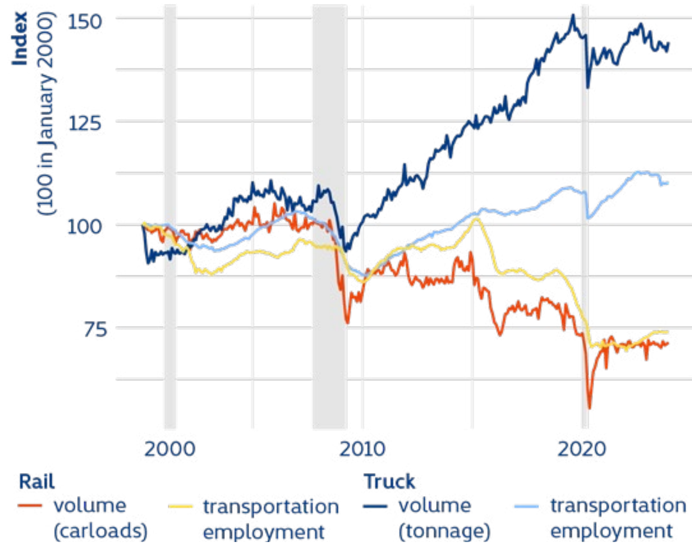
REVERSING RAILROAD DECLINE

Since 2000 ...

railroad **employment fell by 25%** and volume by **carloads fell over 30%.**

rail mode share has fallen 27% within agricultural freight, a key sector of the industry.

Trends in freight volume and employment in truck and rail



Over the last 30 years ...

rail has lost nearly 50% of its market share in agricultural freight. Trucks absorbed nearly 100% of all growth in this sector over this period, nearly quadrupling their tonnage, while the share by rail hardly budged.

The mileage of the Class 1 Railroad network declined by nearly 15%, or 30,000 miles.

Ongoing declines in rail freight are likely to accelerate further, as volumes of shipped coal, on which rail is currently extremely reliant, are set to fall precipitously.

2. Regions created by the Census Bureau to analyze freight flows;

ECONOMIC BENEFITS & AVERTED SOCIAL COSTS

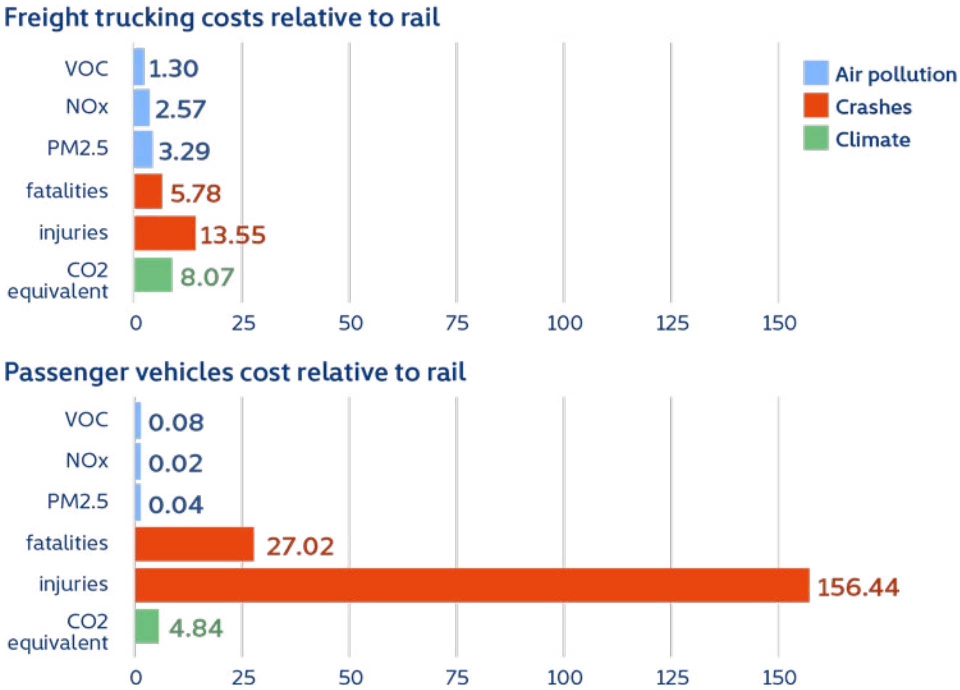
Shipping accounts for ~10-40% of the cost for many commodities, **shipping by rail can be 3-5 times cheaper per ton-mile.**

Increased rail service & frequency could save US shippers about **$400 billion annually by 2050 and $100 billion by 2030.**[3]

Shipping by rail would result in an estimated **4 million new US jobs by 2050 & 1 million new US jobs by 2030.**

Since shipping costs tend to be passed onto household consumers & other businesses, **lower shipping costs would decrease prices for US consumers and businesses and increase US export competitiveness.**

Social costs of transportation: trucks & cars cost more than rail



Factor relative to diesel rail

Different modes of transportationhave different financial costs to users and pose different levels of external costs to the public.

Compared to rail, **trucking generates eight times as much greenhouse gas pollution, kills six times as many people in crashes, injures 14 times as many people, and generates three times as much non-carbon air pollution** for moving the same tonnage the same distance.

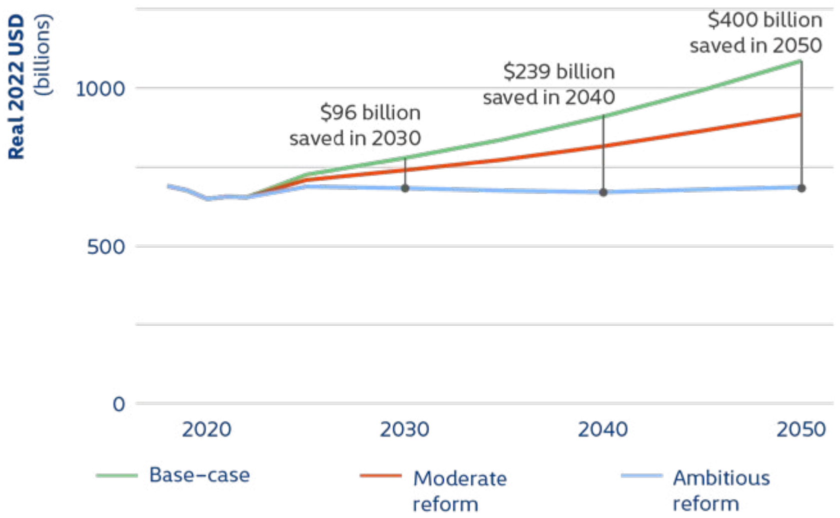
Compared to rail, trucking generates eight times as much greenhouse gas pollution, kills six times as many people in crashes, injures 14 times as many people, and generates three times as much non-carbon air pollution for moving the same tonnage the same distance. For passenger travel, cars, pickups, or SUVs cause 27 times more deaths and 160 times more injuries from crashes relative to diesel rail, and emit five times as much GHG pollution for moving the same number of people the same distance.

3. In real 2022 USD. $400 billion in savings would amount to about 1.5% of current US GDP.

FORECASTED COST SAVINGS AND JOB GAINS

By 2030, the US economy could be saving in real 2022 US dollars $100 billion in shipping costs per year, $240 billion by 2040, and $400 billion by 2050.

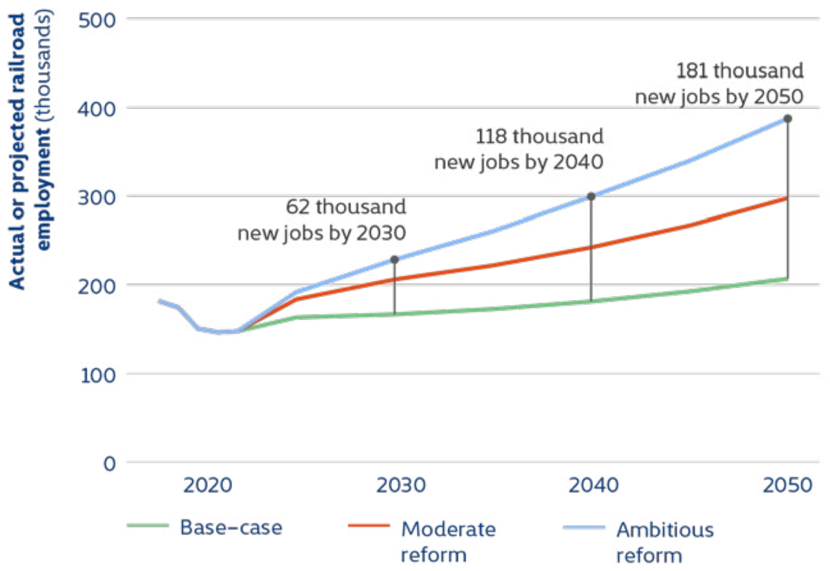
Shipping costs across forecast scenarios



Shipping freight by rail tends to have lower costs per ton-mile when service is available and reliable. Increasing rail's freight mode share relative to the baseline forecast therefore has the potential to reduce costs for goods throughout the economy. This figure shows how those savings are estimated to increase over time across freight forecast scenarios.

There are currently 153 thousand workers in railroad transportation in the US. **The ambitious reform scenario would see railroad workforce growth of over 150% by 2050,** while the baseline scenario sees growth of only 35%.

Railroad jobs across reform scenarios over time



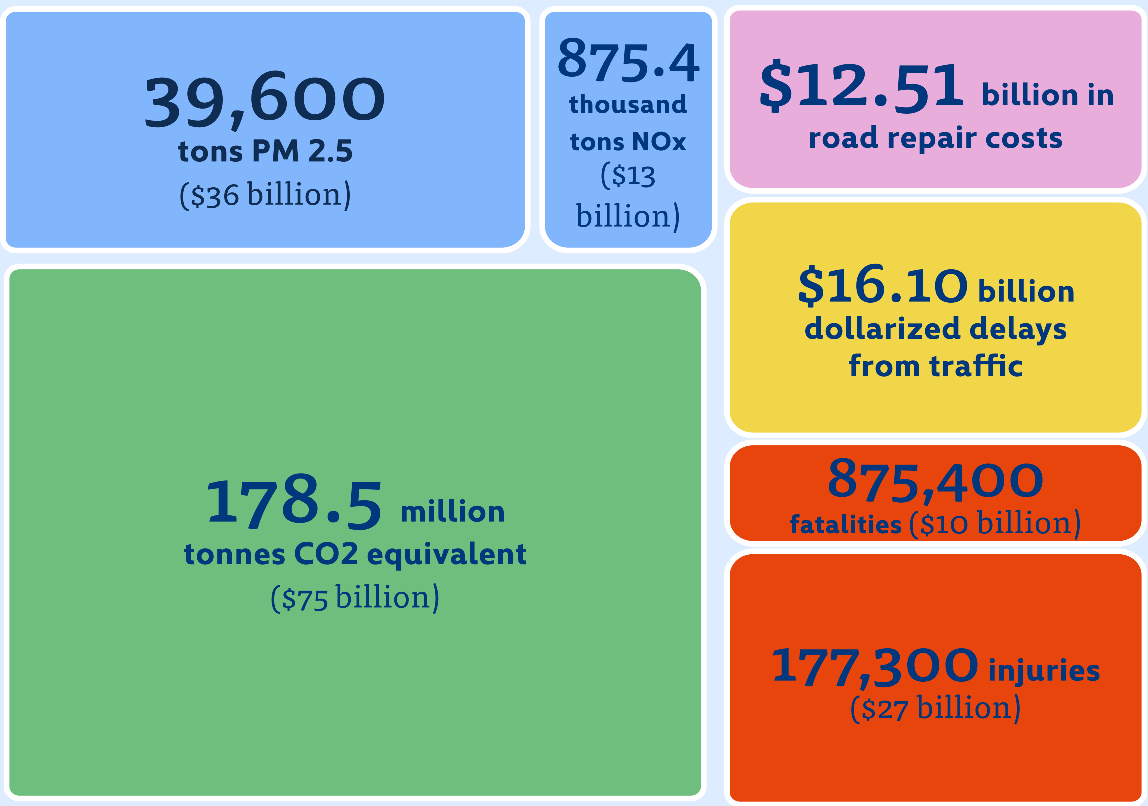
CLIMATE NECESSITY

On their own, the average annual emissions reductions from mode shift to rail estimated here would **cut 1/10 from current sectoral emissions.**[4]

By 2050, the total GHG emissions averted through mode shift to rail would reach nearly **5,000 MMT CO_2e — equivalent to 2% of the world's remaining carbon budget to maintain a 50% chance of staying within 1.5°C of warming.**[5]

Technologies to decarbonize air travel and truck freight are still largely undeveloped, unavailable, or controversial. In contrast, rail travel can be straightforwardly decarbonized using proven technologies that carry co-benefits beyond electrification. **If the US moves as quickly as other countries in doing so, its entire rail network could be electrified over the next thirteen years.**

Rail reform and modeshift also has the potential to **avert over $190 billion annually in externalized costs over the next 25 years.**[6]



Boxes are sized by estimated dollarized value of averted costs.

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4. US EPA, "Inventory of U.S. Greenhouse Gas Emissions and Sinks."
5. Lamboll et al., "Assessing the Size and Uncertainty of Remaining Carbon Budgets."
6. Using conservative assumptions to convert public health benefits to their dollar values.

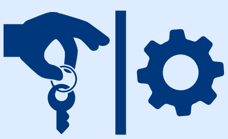
MODE SHIFT

By 2050, an ambitious, well-implemented rail industry reform could shift ...

- **2,100 billion ton-miles** from trucks to rail
- **110 billion passenger-miles** from flights to rail
- **300 billion passenger-miles** from cars, pickup trucks, and SUVs to rail

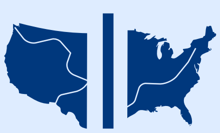
PUBLIC & PRIVATE RAIL INSTITUTIONS

While endless variation exists among the institutions that structure rail systems, public operation predominates among the most successful and intensely used rail systems internationally. While many external factors, including geography and mix of commodities being shipped, also affect mode shares and intensity of rail use, many vertically integrated public systems internationally are extremely successful and see higher modal shares for rail than countries with primarily privately operated rail systems

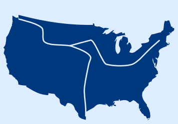


Vertical Separation: ownership & management are separated. One entity owns rail infrastructure; others operate trains.

Vertical Integration: ownership & management are integrated. A single entity can own rail lines and operate trains on them.



Horizontal Separation: the rail network is geographically segmented. Separate entities own or manage different portions of the rail network, which is divided by region.



Horizontal Integration: the rail network is geographically integrated. The same entities operate nationally.

COUNTRY	VERTICAL SEPARATION OR INTEGRATION	HORIZONTAL SEPARATION OR INTEGRATION	TRACK OWNERSHIP	OPERATION	APPROX. FREIGHT MODE SHARE[7]	APPROX. PASSENGER MODE SHARE
United States of America	Vertically integrated for freight, primarily vertically separated for passenger	Horizontally separated	Primarily private	Primarily private for freight; primarily public for passenger	37%	0%
Canada	Vertically integrated for freight, primarily vertically separated for passenger	Horizontally separated	Primarily private	Primarily private for freight; primarily public for passenger	62%	(not reported)
Japan	Vertically integrated for passenger, primarily vertically separated for freight	Horizontally separated	Primarily private	Primarily private	7%	32%
United Kingdom	Vertically separated	Horizontally integrated	Primarily public	Primarily private	9%	10%
Korea	Vertically separated	Primarily horizontally integrated	Primarily public	Primarily public	5%	21%
Switzerland	Primarily vertically integrated	Primarily horizontally integrated	Primarily public	Primarily public	40%	17%
France	Primarily vertically integrated	Primarily horizontally integrated	Primarily public	Primarily public	15%	11%
Austria	Primarily vertically integrated	Primarily horizontally integrated	Primarily public	Primarily public	30%	6%
Ukraine	Primarily vertically integrated	Primarily horizontally integrated	Primarily public	Primarily public	70%	(not reported)

Railroad structure and mode shares for selected counties

To provide a sense of international variation across rail systems, the table to the left shows railroad structures and mode shares for a selection of countries.

7. Mode shares calculated from OECD ITF data using 2019 data. Mode shares refer to percent passenger miles or ton-miles for freight. Note that because OECD data is used for this table, the US mode share will not match values cited elsewhere in this paper, which are calculated from other data sources. "OECD Statistics." The denominators to calculate freight mode shares do not include coastal or ocean freight but do include inland waterways.

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II. INTRODUCTION

The primary goals of this report are to quantitatively assess the extent and costs of the underprovision of rail in the United States and to evaluate the feasibility of public rail ownership to help reverse course. This report introduces new modeling on mode shift potentials for both freight and passenger travel, catalogs private and public costs across modes, and uses modeled mode shift scenarios to calculate the scope of potential benefits realizable from mode shift. A study of the industry structure in the US and a comparative analysis of historical and international rail institutions establish the role public ownership and other reforms could play in achieving modeled mode shifts.

Railroad trackage, employment, and freight volumes have been in decline for decades. Class 1 railroad trackage fell by 60% since 1960 and has continued to decline more recently, with a 14%, or 30,000 mile, decline since 1990. Since 2000, volume by carloads fell over 30%, while mode share for rail has fallen 27% within agricultural freight, a key sector for the industry. In the context of decreasing trackage and service, rail freight employment is also in decline, **with railroad employment 25% lower than it was twenty years ago.**

> “Class 1 railroad trackage fell by 60% since 1960 and has continued to decline more recently, with a 14%, or 30,000 mile, decline since 1990. Since 2000, volume by carloads fell over 30%, while mode share for rail has fallen 27% within agricultural freight.”

The structure of the US railroad industry provides the conditions for these declines. Massive government subsidies for road and air transportation during the twentieth century created a crisis in the prior regulatory regime: As more freight traffic shifted from rail to trucks and more passenger traffic similarly shifted to on-road or air transportation, many rail lines became unprofitable. Competition from other modes of transportation justified a large degree of deregulation of railroads, but rail and other modes are not perfect substitutes.

Deregulation of railroads and massive subsidies for other modes has resulted in an oligopolistic industry structure in which only six private railroads—the Class 1s—own the majority of the national rail network. The ongoing trends of decline for the industry follow clearly from its oligopolistic conditions. A very basic tenet in economic theory is that monopoly power tends to result in reduced output at higher prices. Market power allows producers to focus on only their most profitable customers, reducing output but realizing higher-than-normal profits. Supernormal profits and reduced outputs are clearly visible in railroad industry data.

These conditions constrain passenger service even more than they do freight. By law, the Class 1 railroads are required to share their rail tracks with Amtrak and grant passenger trains priority over their own freight traffic, but this law has been extremely sparsely enforced. Meanwhile, the few stretches of track that are mostly owned directly by Amtrak—particularly the Northeast Corridor—demonstrate the potential for passenger rail on publicly owned tracks to attract passengers, decarbonize transportation, and provide bases for entire regional transit systems, beyond only Amtrak's intercity trips. In contrast, passenger service on private tracks tends to be heavily constrained by reluctance or recalcitrance by private Class 1s.

International precedents also show the potential of publicly owned rail to provide improved and expanded freight and passenger service. Rail systems may be structured with ownership of tracks separate from operation or have both ownership and operation managed by a single entity. Track ownership may be separated geographically, with separate owners or managers in different regions, or it may be integrated over a country. These variations are referred to as vertical integration or separation and horizontal integration or separation, respectively.

While rail institutions vary enormously, the basic framework of horizontal and vertical separation or integration allows international comparisons. Although geography, the mix of commodities being shipped, and other external factors also dramatically affect mode share, countries with vertically integrated, publicly owned and operated systems tend to have more intensely used rail relative to those with primarily private operators. While some countries with primarily privately owned railroads—including Canada, Australia, and Japan—have high rail mode share for either passenger or freight, countries with greater public involvement often have rail systems that successfully serve both passenger and freight traffic.

While the first major chapter of this report focuses on existing conditions in the US and international comparisons, the second major chapter focuses on quantifying the financial and social costs of movement by transportation mode and using mode shift scenarios to estimate total realizable benefits from potential shifts to rail.

Historical trends, forecasts for freight growth by commodity and distance band, and other data are used to construct mode shift potentials. For example, rail tends to be more cost effective than trucking for freight, particularly at distances greater than 300–450 miles. This distance is not a hard-and-fast rule but will vary based on the type of commodity and other factors. In the US, 40% of ton-miles that trucks move are due to trips over 500 miles, and forecasts predict that the average truck distance is set to increase further over time. Shifting the vast majority of truck freight trips above 300–450 miles to rail would move mode shares to be in line with the ambitious forecast scenario.

Different modes of transportation have different costs to users and pose different levels of external costs on the public and the environment. These can be put into dollar terms to compare marginal social and economic costs by modes. There will necessarily be ambiguity converting costs across different categories to common, monetized terms. Dollarized costs based on traffic deaths and crashes rely on assumptions on how a human life can be valued monetarily. Dollarizing greenhouse gas (GHG) emissions and global warming potentials can be even more complex and rely on even more controversial assumptions. Due to this complexity, when social costs are reported in dollarized terms, they will also be reported in their own terms (crash deaths or injuries; tonnes CO2e; volume of other air pollution) throughout this report.

While differences in social or externalized costs, such as GHG emissions, are often emphasized in discussions of rail's advantages over other modes of transportation, the modeling in this report finds that **reduced shipping costs and direct financial savings for US businesses and consumers could be even more significant in dollarized terms**. Higher shipping costs tend to be passed onto consumers and producers reliant on input goods. Domestic shipping prices impact US export competitiveness in key sectors like agriculture and comprise a major portion (up to 40%, according to a recent federal study) for major agricultural commodities like wheat. In other sectors, transport costs frequently account for 10% of total product costs. Based on the most recent data, shipping by truck tends to be over five times more expensive per ton-mile compared to rail, and truck transportation costs have also been more volatile and subject to inflationary pressures. In prior years, trucks have been closer to three to four times more expensive per ton-mile relative to rail. These are averages, and costs by mode are also heavily impacted by distance, commodity type, and other factors.

As emphasized throughout this report, oligopolistic conditions allow private railroads to curtail service for all but their most profitable customers. Freight that may be profitable but may have lower margins will often be neglected. Other countries with public rail operation and more deliberate regulation of the negative consequences of truck freight (for examples, air and noise pollution, road congestion, traffic deaths, and road wear and tear) have seen innovative techniques to increase rail's feasibility for more different types of freight. **In contrast, private railroads in the US are increasingly focused on shipping fewer commodities more slowly, less reliably, over further distances, on longer trains**. This type of service requires minimal new capital investments and permits a skeletal workforce, which in turn reduces costs and expands profit margins, even while volume declines and room for growth is undermined.

However, when private freight railroads neglect potential customers to focus on only their highest margin business, it means shippers—especially those more concerned with speed, flexibility, and reliability—will tend to shift to the more expensive option: trucks. Because shipping costs are reflected in overall prices, the consequences of this mode shift ripple throughout the economy. Differences in shipping costs by mode mean that improved rail service is an enormously powerful lever that could reduce prices for US consumers and costs for US businesses—especially those in agriculture, manufacturing, and other sectors that produce and move physical products.

While it can be argued that private railroads' focus on margins rather than growth is a form of efficiency, it is also a form of attrition. Private railroads have oriented their strategy around serving their most profitable customers while neglecting growth opportunities. Underregulation of the oligopolistic industry, along with massively imbalanced public subsidies for different modes of transportation, have meant decades of decline in freight service, while rail passenger mode share hovers within a rounding error of 0%. This report describes the current state of the rail industry in the US and evaluates the feasibility and potential benefits of shifting course.

GLOSSARY OF ACRONYMS

BEV
Battery-electric vehicle.

Class 1 railroad
Private rail operators in the US realizing above a specific annual revenue threshold ($900 million in 2023). The six Class 1 railroads own and operate the majority of the US rail network.

FAF zones
Freight analysis framework zones. Regions created by the US Census Bureau to analyze freight flows; they typically comprise large metro areas or sometimes entire states.

GHG
greenhouse gas. Any of the various gases that contribute to global warming. These include carbon dioxide, methane, nitrogen oxides, and other gases.

LDV
Light-duty vehicle. Cars, pickup trucks, and SUVs.

MMT CO2e
Million metric tonnes carbon dioxide equivalent. A measure of greenhouse gas emissions. While CO2 is the major greenhouse gas, there are others with different Global Warming Potentials. The warming effect of a mixture of greenhouse gases can be reported as CO2e.

PMT
Passenger-miles traveled.

PSR
Precision-Scheduled Railroading.

SCC
Social Cost of Carbon. The estimated dollar equivalent cost to society of emitting one unit of CO2e.

Ton-miles
A measure of freight movement, equal to tonnage multiplied by distance travelled.

III. THE STATE OF US RAILROADS

A. RAILROAD INDUSTRY TRENDS

- Rail freight volume has fallen enormously over the past decades, with decreases accelerating more recently.

- Railroad employment has tended to track rail volume by many metrics, but railroad employment has fallen more than volume since the implementation of precision-scheduled railroading (PSR).

- Ongoing declines in rail freight are extremely likely to accelerate further, as shipped volumes of coal and fossil fuel products—commodities on which rail is currently extremely reliant—are set to fall precipitously.

    - Practices and trends in the railroad industry can be interpreted as following straightforwardly from these conditions. The sector has been characterized by disinvestment, declining workforce, diminished service, and accusations of collusion. All of these are straightforward consequences of under-regulated, oligopolistic industries in economic theory.

BY THE NUMBERS

Since 2000 ...

- **Railroad employment fell 25%, and volume by carloads fell over 30%.**

- **Rail mode share has fallen 27% within agricultural freight, a key sector for the industry.**

Over the past 30 years ...

- **Rail has lost nearly 50% of its market share in agricultural freight. Trucks have absorbed nearly 100% of all growth in this sector over this period, nearly quadrupling their tonnage, while that moved by rail has hardly budged.**

- Class 1 railroad trackage fell by 60% since 1960. The vast majority of that decline occurred in the lead-up and immediately following the Staggers Act of 1980, but it has continued to decline steadily in more recent decades. Since 1990, total track mileage has fallen 14%, or by nearly 30,000 miles.

FREIGHT VOLUME

The market share for freight rail has been in decline for as long as data is available. Rail volume can be measured through many metrics: by carloads, tonnage, ton-miles, value of shipped products, and others. Most frequently, it is measured in ton-miles, which account for both weight and distance. Although the extent can vary based on metric, the direction of change is consistent across measures and shows an unmistakable story of declining market share for rail. The decline has been long term, falling over decades, with rates of decline by many measures accelerating more recently.

By ton-miles, recent Government Accountability Office (GAO) analysis shows a 12% decrease in ton-miles from 2011–2021. This decline, while substantial, is dwarfed by the decline over the same period when measured in carloads, which decreased 21% over the period.[8] The different rates in decline across these metrics helps tell the story of private railroaders focusing on only the most profitable types of shipments. Shorter-haul traffic, or more diverse mixes of goods, can be more labor and capital intensive relative to long-haul trains or "unit trains," which carry only a single commodity or intermodal freight. Shorter-haul freight, or "manifest trains," which carry a variety of freight that may be designated for more varying destinations, can be more labor intensive. For oligopolistic railroads focused on margins, rather than growth and market share, these shorter-haul and manifest trains will therefore tend to be neglected. This phenomenon is showing up in the data as a greater decline in carloads relative to ton-miles in the last decade.

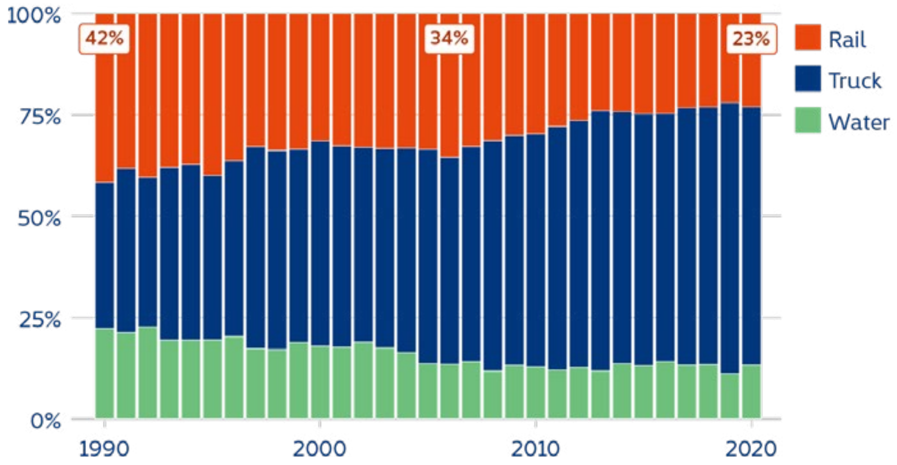
As tonnage of agricultural freight, the story of rail freight over the last decades is again one of unambiguous decline. The US Department of Agriculture provides agricultural freight tonnage by mode over a longer historical period than is available for most commodity groups,

8. GAO, "Freight Rail."

and agricultural goods account for a large share of the total market for moving freight as well as an important potential growth sector for rail.

However, rail has been losing market share in agricultural freight for decades, with the loss accelerating in the last decade. Since 1990, rail share of agricultural freight has fallen from just over 40% of all shipments by tonnage to just over 20%—a decline in market share of nearly 50% (Figure III-1). Over the last thirty years, total agricultural freight has increased substantially, but nearly 100% of that growth was captured by trucks (Figure III-2). This means that while agricultural freight by truck nearly quadrupled since 1990, the volume by rail has hardly budged. Rail's stagnancy in the growing market for agricultural freight represents an enormous, missed opportunity for the sector from a growth perspective.

Figure III-1. Long-term trends in mode share for agricultural freight, 1990–2020.



Source: USDA Modal Share Analysis; Author's analysis

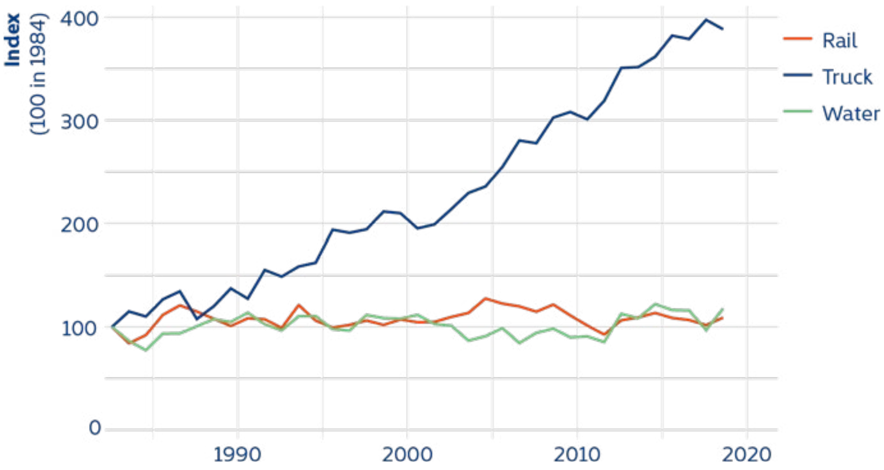
The share of grains moved by rail has nearly halved over the last thirty years. Agricultural freight is the second-leading commodity group in terms of total domestic ton-miles. Due to the large share currently shipped by trucks; the suitability of most agricultural freight for rail; and imminent, continuing declines in coal freight, agricultural goods are a major potential growth sector for rail. Historical data that span a longer time period is also available for agricultural freight but not for many other commodity groups.

The Bureau of Transportation Statistics forecasts the shift toward trucks continuing, with the total ton-miles shipped by truck growing by 70% by 2050 and ton-miles by rail growing only 45%, indicating a continued mode shift toward trucks.[9] Continued growth in truck mode share, paired with growth in total freight, means that total ton-miles moved by truck is expected to grow enormously in this baseline forecast: from about 2.2 trillion total ton-miles by to 4 trillion

9. BTS, "Freight Analysis Framework."

in 2050. Alternate scenarios that reverse, rather than continue, this trend in freight shift from rail to truck, are described later in this report, in Section IV.A, "Mode Shift Potentials."

Figure III-2. Long-term trends in total volume for agricultural freight, 1984–2020.



Source: USDA Modal Share Analysis; Author's analysis

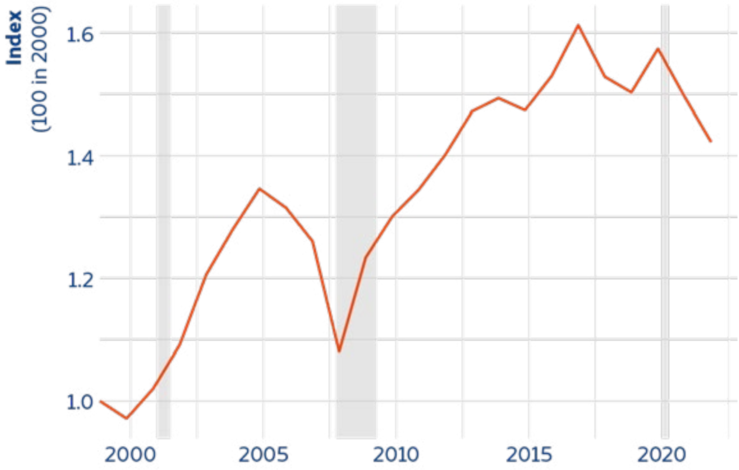
Trucks have absorbed nearly all growth in agricultural freight for decades, while the amount moved by rail has remain static. This plot uses the same data as the previous figure but emphasizes how total volume by mode has changed over time rather than mode share. While share by rail and water have stayed constant for decades, trucks have absorbed nearly all growth in this important sector, nearly quadrupling their shipped tonnage.

A rare upward trend in rail traffic exists in the intermodal freight market, which grew substantially (by about 50%) from 2000–2021, although volume in this sector too has declined in the few years since then (Figure III-3). Intermodal freight is discussed by industry analysts as an important potential growth sector for rail,[10] and increased market shares of both intermodal and agricultural freight will be essential to achieving mode shift in line with forecast scenarios discussed later in this report. However, given the current focus of private freight railroads on longer trains traveling farther distance, intermodal traffic shipped partially by rail still tends to be moved by truck between rail terminals and the shipment origin or final destination, meaning an important subcategory of intermodal traffic will tend to be ceded to trucks. However, success in short-haul intermodal rail freight both abroad and in the US in prior decades has shown the potential for rail to move more short-haul intermodal freight as well, given investment and reform.[11]

10. Marsh, "Can Intermodal Rail Increase Its Market Share by 25% by 2030?"; Schabas and Bailey, "The Path To Long-Term Shareholder Value For Rail Is Growth."

11. Schultz, "Better Freight Policy"; Green, "Swiss Operators Optimise Short-Haul Railfreight."

Figure III-3. Rail intermodal traffic, 2000–2023



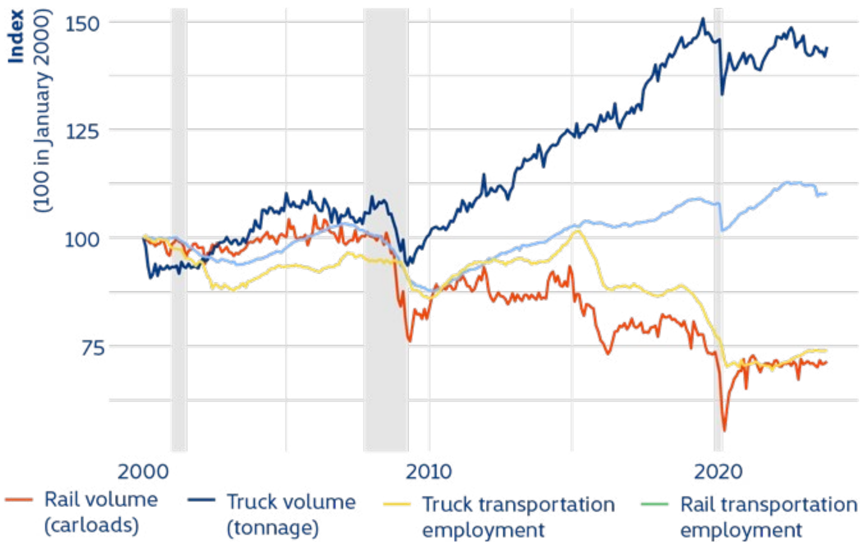
Grey bars indicate recessions.
Source: FRED; Author's analysis.

Intermodal freight has been a rare growth area for rail in the past few decades, although volume has declined here too from 2021–2023. Nonetheless, intermodal freight represents an important opportunity for rail to begin expanding service.

Among commodity groups, rail currently has its largest market share in coal, gasoline, and petroleum products. Managerial focus on providing only the most profitable service has led to a strong focus on these commodities. Coal, gasoline, and petroleum products account for 35% of all ton-miles shipped by rail—by far the largest of all commodity groups (Figure III-4 and Figure III-5). However, coal and fossil fuel shipments are in decline and are extremely likely to decline steeply in the near future as the US continues to curtail its dependence on fossil fuels, particularly coal.[12] As Class 1s have decreased their total freight volume, they have increased their dependence on this sector. In doing so, they have set themselves up for further, more precipitous decline, as the market that comprises their current major focus is slated to rapidly shrink.

12. BCG, "Taking the Railroad Playbook Beyond PSR"; Schabas and Bailey, "The Path To Long-Term Shareholder Value For Rail Is Growth."

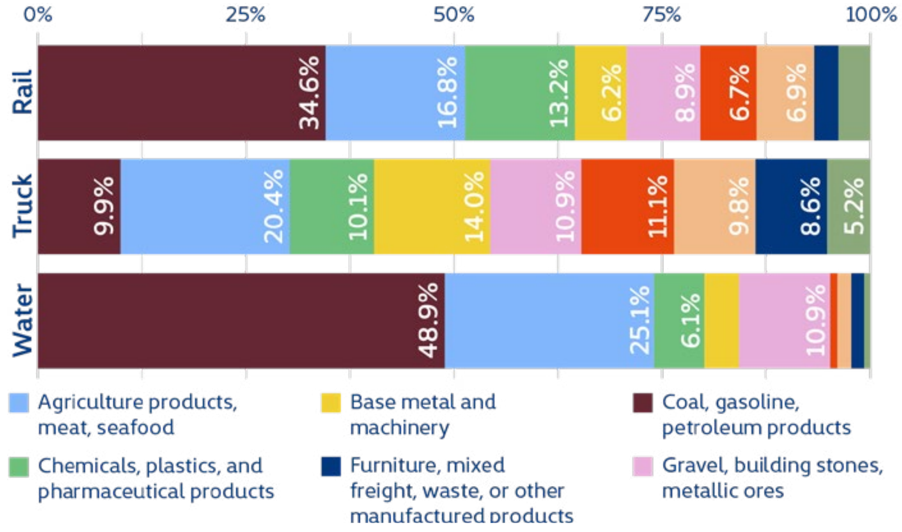
Figure III-4. Long-term trends in freight volume and employment in truck and rail, 2020 to end of 2023.



Grey bars indicate recessions
Source: FRED; Author's analysis

Employment in truck transportation has risen with truck freight volume. Rail employment has fallen with rail volume. Trends over the last decades show how employment can tend to track volume for both truck and rail freight transportation. However, while truck volume has increased nearly 50% since the end of the 2008 recession, rail volume has fallen substantially, and so has employment in railroad transportation.

Figure III-5. Breakdown of commodity groups shipped by inland mode, average over 2018–2022.



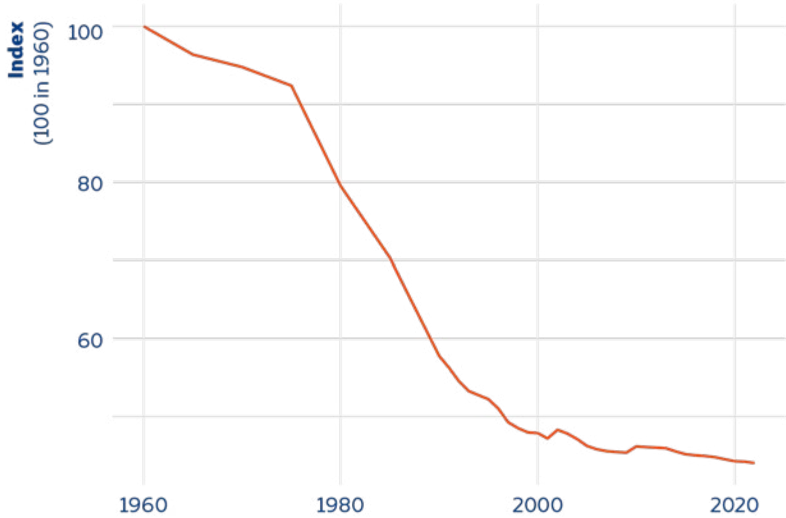
Total ton-miles modeshare averaged over 2018 to 2022
Source: FAF 5.5.1; Author's analysis

Coal, gasoline & petroleum products account or 35% of all ton-miles shipped by rail, by far the largest share of all commodity groups. This figure shows how total ton-miles shipped by rail, truck, and domestic waterways break down across commodity groups. Coal, gasoline, and petroleum products by far comprise the largest share of ton-miles shipped by rail, followed by agricultural products. Agricultural products are a large share of ton-miles across all modes.

Trackage

As volumes have declined, so has total trackage. The total mileage of the Class 1 rail network fell nearly 60% since 1960. The vast majority of that decline occurred in the lead-up and immediately following the Staggers Act of 1980 (Figure III-6), but it has continued to decline steadily in more recent decades. Since 1990, total track mileage has fallen 14%, or by nearly 30,000 miles (Figure III-6).

Figure III-6. Class 1 rail mileage, 1960–2022.



Source: BTS, NTS table 1-1

The total mileage of the Class 1 rail network declined precipitously in the lead-up and immediately following the Staggers Act of 1980, which radically altered the previous structure of railroad regulation in the US. Total Class 1 railroad mileage is now nearly 60% lower than it was in 1960, having declined 120 thousand miles.

This decline contrasts with the lengthening highway system. Since 1980, the earliest year of consistent data on highway mileage, the Class 1 rail network shrank by 45% in terms of mileage, while the highway system grew over 40%.[13]

While the major, precipitous decline in rail mileage occurred in the lead-up and immediately following the Staggers Act of 1980, the decline in track mileage has continued in more recent decades. In the context of the remaining mileage, these declines are still substantial. Since 1990, mileage has declined by 14%, or nearly 30,000 miles.

EMPLOYMENT

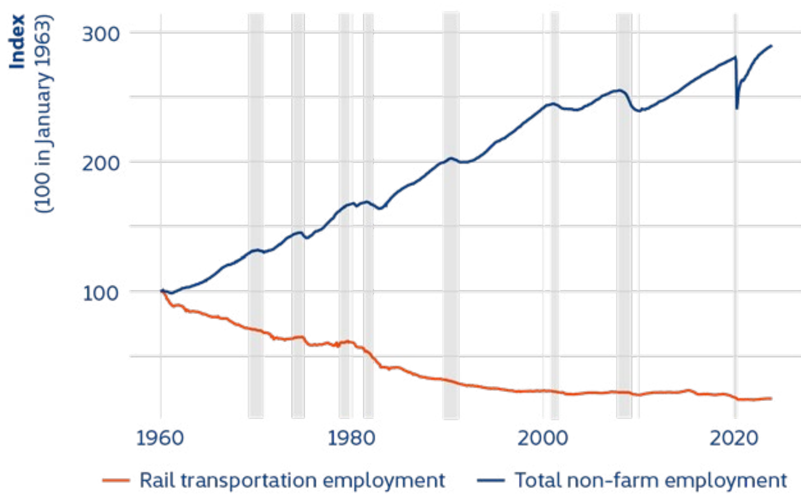
As a whole, the picture of rail freight volumes is one of decline. With service and market shares declining by nearly all measures, employment has also fallen precipitously. While employment in this sector has tended to follow various measures of service or volume, it has declined even more than volume since the implementation of PSR in more Class 1 railroads since 2017. [14]

13. Bureau of Transportation Statistics National Transportation Statistics (NTS) table 1-1 for Class 1 rail network and Federal Highway Administration Highway Statistics Table HM-220 for highway length. Highways here include all interstates and "other freeways and expressways" by functional class. The NTS table is not used for highways as well because they characterize all public roads as highways.

14. Most US Class 1 railroads implemented PSR between 2017 and 2019. GAO, "Freight Rail."

Railroad industry employment has been in a long, secular decline for decades, which has accelerated in recent years. Railroad industry employment is now less than one-fifth of what it was in 1960, while overall employment increased threefold (Figure III-7). From 2000 to 2023, railroad transportation employment fell by over 25% while freight volume by rail, as measured in carloads, fell by over 30% (Figure III-4). With rail service declining while total shipping needs continued to increase, freight growth was shifted to truck, with truck volume increasing by 44% over this same period (Figure III-4).

Figure III-7. Diverging employment trends in rail transportation and the rest of the economy, 1960–2024.



Grey bars indicate recessions
Source: FRED; Author's analysis.

Employment in rail transportation has been declining steadily for decades. Rail employment is now less than one-fifth of its level sixty years ago, while total employment has nearly tripled. Rail employment over this long period due to productivity gains in the sector but also due to declining market share, reduced maintenance workforce, and other reductions in headcount more recently.

A recent report from the GAO highlights large decreases in railroad employment in the decade in which PSR was implemented in most Class 1 railroads. Across employment categories, employment fell by 20%–40% from 2011–2021, with the deepest declines in equipment maintenance workers (including inspectors and machinists), which fell by 40% (Figure III-8).[15]

The GAO report notes that declining freight volume during COVID-19 lockdowns could also have caused that decline in employment, which then could have continued due to worker shortages in post-lockdown years. However, while truck freight and employment bounced back

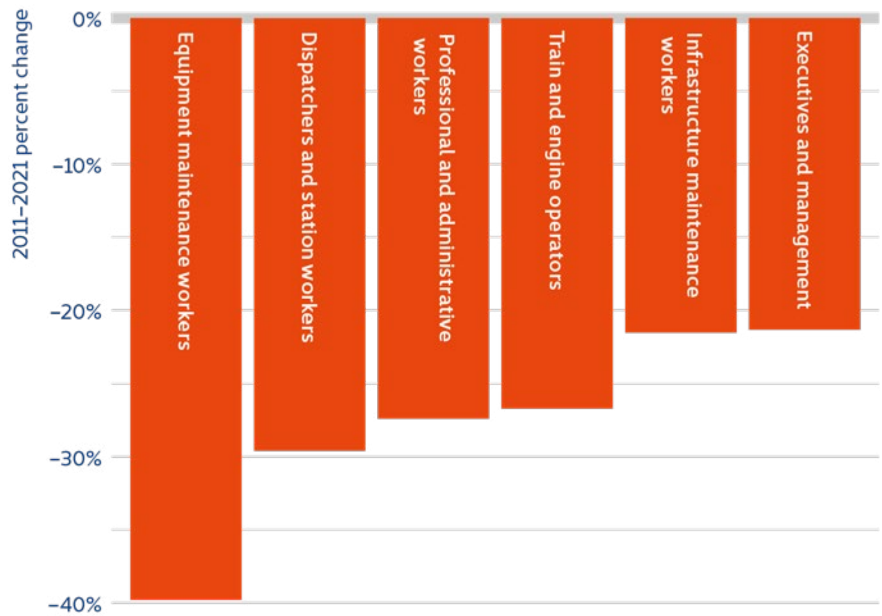
15. GAO.

since 2020, rail employment has not. From January 2019 to December 2023, railroad employment declined 16% over just those few years (Figure III-4).[16] This suggests persistent negative impacts on railroad employment associated with PSR practices that have not seen a parallel in truck transportation.

While rail sector employment has often tracked various measures of rail freight volume, since PSR implementation, employment has fallen faster than ton-miles freight (Figure III-9). The combination of increasing employment in truck transportation since COVID-19 and the decoupling of rail ton-miles and employment since PSR's implementation across more major railroads suggests that managerial trends associated with PSR are at least partially to blame for continued depressed employment.

16. Federal Reserve Bank of St. Louis; series CES4348400001 and CES4348200001.

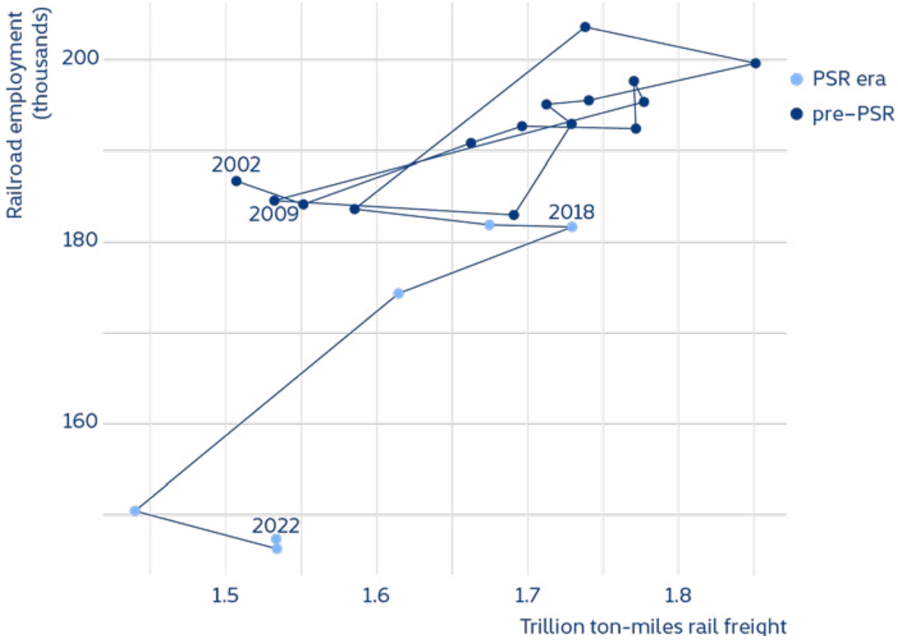
Figure III-8. Class 1 rail employment declines with PSR implementation.



Source: GAO 2022.

Employment by Class 1 Railroads across categories has declined 20-40% from 2011-2021. With PSR, downward trends in rail employment accelerated. The GAO highlighted how declines in railroad employment fell across categories from 2011 to 2021, the period they associate with PSR implementation for the majority of Class 1 Railroads. Maintenance workers saw the steepest decline, of 40%, over this short period.

Figure III-9. Association between railroad employment, ton-miles shipped, and PSR implementation, 2002–2022.



Source: FRED, BTS, GAO; Author's analysis.

Railroad industry employment has tended to track shipped volumes by various measures, but since PSR implementation, employment has fallen more than volume. Employment has not recovered from declines associated with the heights of the pandemic, even as volume has ticked back up.

In the plot below, the line connects dots by year, while the location of the dot shows railroad employment and freight volume. Selected years are labeled

SAFETY

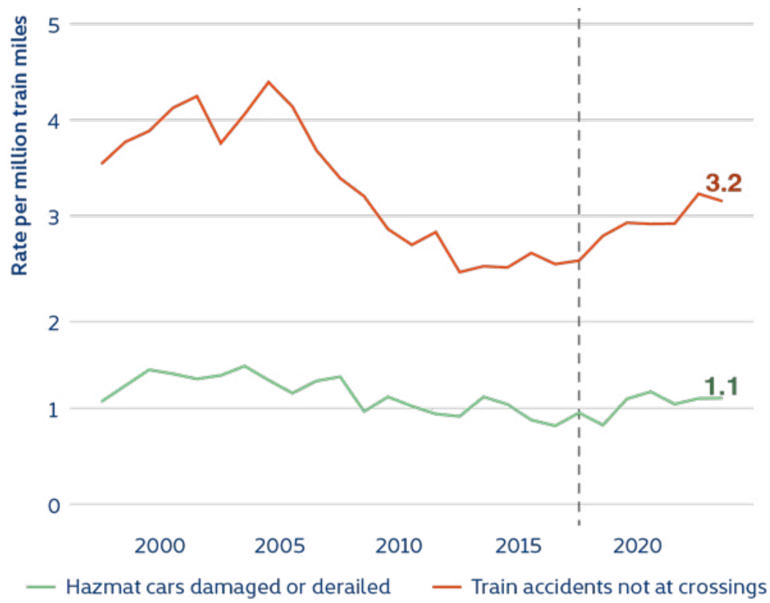
Safety concerns are often raised in the context of PSR, particularly following the disaster in East Palestine, Ohio, in which a train containing hazardous materials derailed, several train cars caught on fire, and toxic chemicals were released into the air and leaked into the water and soil. The derailment triggered an evacuation of the surrounding area, mass deaths of wild and domestic animals, and reports of persistent health issues for the town's residents.[17]

The past decades have seen new railroad safety technologies and new safety practices mandated by Congress and new railroad management approaches associated with PSR. These two concurrent developments are likely to have conflicting impacts, and it is not straightforward to attribute trends in safety and derailments to one phenomenon or the other. The 2022 GAO study on the impacts of PSR did not find

17. Keppler, "East Palestine 6 Months Later."

conclusive evidence that PSR was associated with increased train accidents and worse safety outcomes,[18] but analysis of updated data does show an increase in train accidents and a slight increase in derailed or damaged train cars carrying hazardous materials, following a period of decreasing or steady accidents.[19] New safety technologies like Positive Train Control (PTC) were implemented over the past decades, which likely contributed to falling accidents over the earlier part of this period: Implementation of PTC by Class 1 railroads was mandated by Congress in 2008 and was completed at the end of 2020.[20] However, after a period of decline, crashes have been ticking up since the implementation of PSR in more Class 1s (Figure III-10).

Figure III-10. Train accident rates and PSR implementation, 1997–2023.



Dashed line indicates PSR implementation beginning at most Class 1 Railroads
Source: FRA Office of Safety analysis, accident/incident overviews.

Meanwhile, practices directly associated with PSR have also been connected to recent, high-profile rail derailments, including the disaster in East Palestine, Ohio, in which train length, mechanical failures, and understaffed maintenance crews were all identified as contributing factors.[21] As the GAO report on PSR and many other accounts emphasize, increasing train length is a major feature of PSR, and Class 1 railroads shed 40% of their equipment maintenance workers over the PSR implementation period. A faulty hot-box detector, which would be meant to detect overheating rail equipment and automatically alert train crews, seems to have been a major factor

18. GAO, "Freight Rail."

19. Department of Transportation, "Rail Equipment Accident/ Incident Data (Form 54) Subset – Unique Train Accidents (Not at Grade Crossings)."

20. FRA, "Positive Train Control (PTC)."

21. Kaplan, "Ohio Train Derailment."

in the derailment, and workers specialized to maintain equipment were eliminated in the derailment region just a few years prior to the East Palestine derailment.[22] This strongly suggests that the reduction in maintenance workforce was a major contributing factor in the East Palestine, Ohio, derailment.

In this context, it is important to note that rail in general is far safer and less prone to crashes than trucks, even if this safety advantage has eroded somewhat in the context of PSR. Most hazardous materials are shipped by rail rather than truck for precisely this reason, and, on average for each ton-mile shipped, trucks kill six times as many people in crashes and injure fourteen times as many people than rail.

22. Premack, "Norfolk Southern Eliminated Role in Derailment Area."

B. RAILROAD INDUSTRY STRUCTURE

- Six private companies—the Class 1 railroads—own the majority of the freight rail network and account for nearly all revenues from freight shipment by rail in the US. This form of private rail ownership is not standard internationally.
    - Class 1 railroads have huge amounts of market power, typically operating in duopolistic conditions in competition with one other railroad.
    - Entire states and metro areas tend to have access to only one or two private railroads and are captive to those operators for rail access.
    - Practices and trends in the railroad industry can be interpreted as following straightforwardly from these conditions. The sector has been characterized by disinvestment, declining workforce, diminished service, and accusations of collusion. All of these are straightforward consequences of underregulated, oligopolistic industries in economic theory.
    - Over 10% of freight analysis zones (regions created by the US Census Bureau to analyze freight flows), including entire major metro areas, have access to only one Class 1 railroad provider.

- Over 60% of freight analysis zones have access to no more than two railroad providers.

- The structure of the rail networks as large, regional monopolies or duopolies can also create bottlenecks or add transaction costs at points where these large regional networks meet.
- Railroad deregulation and underregulation has often been justified based on competition from other freight modes, especially trucks, but railroads still have many captive markets, and different modes are not substitutable in many contexts.
- In conjunction with oligopolistic conditions and underregulation, massive subsidies for on-road and air transportation relative to rail also contribute to the underutilization of rail.

MARKET POWER AND DECREASED CAPACITY

A very basic tenet in economic theory is that monopoly power tends to result in reduced output at higher prices. Market power allows producers to focus on only their most profitable customers, reducing output but realizing higher-than-normal profits. This pattern is clearly visible in railroads in the US: reduced service, reduced investment, reduced workforce but higher prices and profits.[23] Diminished output is visible in the data and consistent across metrics, while the industry has been seeing far higher-than-normal profits.[24]

Precision-Scheduled Railroading

While service has declined, so has investment. This has become particularly visible in the context of PSR, the managerial regime implemented in nearly all Class 1 railroads. PSR is often characterized by downsizing workforce and asset ownership (including railcars, facilities, and trackage) and running fewer, longer trains.[25] PSR is also easily interpretable in part as a managerial style oriented toward capitalizing on railroads' market power: decreasing service and output to serve only the most profitable customers.[26] This is the general prediction in economic theory for markets characterized by monopoly or other forms of market power—producers will be less concerned with growth or total output but will produce less and focus on only their highest-margin markets. This means that firms will often turn away

23. Longman, "Amtrak Joe vs. the Modern Robber Barons."

24. American Journal of Transportation, "Railroads Are USA's Most Profitable Industry with a 50% Profit Margin."

25. GAO, "Freight Rail."

26. DeFazio, "Commentary."

profitable business, because market power permits a focus on only the most profitable business. In the context of railroads, this means that private rail operators will tend not to expand their business but will instead allow more freight to shift to trucking and more passengers to shift to driving and air flight, as long as their most profitable business is retained.

Notably, as detailed in the previous section, many trends of decline in railroad service and capacity began much earlier than PSR but accelerated with PSR's implementation across more Class 1 railroads. While Class 1 railroads that have implemented PSR often tout increased reliability as a benefit, freight rail customers often note that PSR has resulted in worse, more unreliable service.[27] Multiple industry groups have submitted testimony to Congress and the Surface Transportation Board (STB) on poor, inadequate, or declining rail service, with one group summarizing flatly: "[Rail service] is the worst that it has ever been."[28] This sentiment is echoed in interviews the GAO conducted with freight rail customers as part of its assessment on the impacts of PSR as well as other independent accounts of the impacts of PSR.[29]

PSR is often described by railroads that have implemented it as a set of measures to increase efficiency—but the form of efficiency being celebrated is often largely a corollary of reduced service and investment. For example, PSR can mean reduced trackage as less profitable lines are shut down or multitracked lines are downsized to single-track lines; it can also bring closures of freight handling facilities and railyards.[30] This reduces freight capacity and can also hamstring passenger service. Because only the most profitable shipments are run on the remaining trackage, it can, however, increase certain efficiency measures, such as asset utilization rates and operating ratios, even as it means reduced service and impediments to future growth.

Decreased investment, capacity, and employment not only reduce service directly but also tend to reduce system resiliency. The GAO's assessment of PSR's impacts emphasizes how smaller train crews, which have become common particularly following PSR implementation, impact railroads' ability to deal with even routine, expectable circumstances, such as adverse weather. This lack of resiliency introduces unpredictability and unreliability to railroad schedules.[31] Given the value of reliability to shippers, this in turn

27. Union Pacific, "What Is Precision Scheduled Railroading?"; GAO, "Freight Rail."

28. National Grain and Feed Association, "Passenger and Freight Rail: The Current Status of the Rail Network and the Track Ahead"; Cleaver, "NGFA Testifies on Grain Industry Rail Service Issues"; National Stone Sand and Gravel Association, "National Stone, Sand and Gravel Association Comments on Urgent Issues in Freight Service"; DeFazio, "Commentary."

29. GAO, "Freight Rail"; Longman, "Amtrak Joe vs. the Modern Robber Barons."

30. Green and Miller, "Examining the Effects of Precision Scheduled Railroading on Intercity Passenger and High-Speed Rail Service"; Longman, "Amtrak Joe vs. the Modern Robber Barons."

31. GAO, "Freight Rail."

decreases the attractiveness of rail relative to other modes and likely contributes to falling market shares for rail. Because customers for whom reliability is less of a factor allows lower costs, oligopolistic railroads opt to focus on this business in order to increase profit margins rather than increasing reliability and, with it, market share.

Along with declining service, collusion is another straightforward expectation in oligopolistic and duopolistic markets. Again, freight railroad customers across industries have accused Class 1 railroads of price-fixing collusion in current market conditions.[32] A major class action lawsuit that comprises over 200 of the country's largest rail freight shippers, which accuses four of the six Class 1 railroads of price collusion, has been ongoing for years, and additional lawsuits are still being filed.[33]

Notably, this is also a focus on short-term profit, with longer-term prospects for the industry's financial health neglected. While cost-cutting that reduces capacity, service, growth potential, and resiliency increase margins in the short run, particularly as captured by railroads' operating ratios, which is a financial metric that has gained particular prominence in the PSR era. As discussed in the preceding section, "Railroad Industry Trends," **this short-term focus has aligned with a dependency on a few major commodities, particularly coal. With shipped coal volumes now in decline and poised to precipitously decline in the near future, this threatens not only the growth prospects for the industry but also its ongoing viability.** In this context, even private consultants are urging railroads to shift from "margin focus" to "growth."[34]

DEREGULATION AND UNEVEN SUBSIDIZATION

In the context of increased competition from other modes, particularly trucking, railroads were heavily deregulated through the Staggers Act in 1980. However, railroads and other freight modes are not perfect substitutes. Shipment by truck is not always a feasible alternative to rail. A single train moving agricultural freight can replace hundreds of trucks. Shipping by rail rather than truck can be three to five times cheaper per ton-mile.[35] Due to the vastly smaller crash risk of trains relative to trucks, shipments of hazardous materials are far better

32. Lester, "More Shipper Accusations of Railroad Price Fixing"; Funk, "Court."

33. Lester, "More Shipper Accusations of Railroad Price Fixing"; Lester, "Court Issues Key Ruling on Shipper Accusations of Class 1 Price Collusion."

34. Schabas and Bailey, "The Path To Long-Term Shareholder Value For Rail Is Growth."

35. Austin, "Pricing Freight Transport to Account for External Costs"; Department of Transportation and Bureau of Transportation Statistics, "National Transportation Statistics (NTS)."

suited for rail rather than truck, even as cost-cutting associated with PSR has diminished rail's safety advantage.[36] Rail freight also tends to generate far lower social costs and negative externalities per ton-mile than truck freight (see section "Averted Social or Externalized Costs"). Depending on the distance and type of commodity, freight may be more or less suited for one mode or the other from the perspective of shippers, from a broader social perspective, or both.

Despite deregulation, railroads are still subject to oversight and regulations designed to halt excessive market concentration or check monopolistic practices. However, mergers have been permitted to the extent that the majority of metro areas in the country have access to only one or two railroads, and regulations frequently go unenforced or underenforced.[37]

Beyond private ownership and the underregulation of railroads are vastly differing levels of investment in infrastructures for the different freight modes. Highways in particular constitute a massive public outlay to create infrastructure for truck freight: The National Interstate and Defense Highways Act of 1956, which created much of the interstate highway system, comprised the largest public works project in American history,[38] and roads and highways since have still tended to enjoy massive, ongoing public subsidies relative to rail.[39] The massive differentials in unpriced negative externalities (meaning, for example, how public costs such as traffic deaths, air pollution, and traffic congestion are not typically captured by the price of shipping with trucks but are passed on to others) between rail and on-road freight should also be seen as a massive public subsidy for on-road freight relative to rail. The unequal levels of subsidies by mode helps push more freight to trucks and contributes to lower mode shares for rail.

Massive public subsidies have helped build trucking as a feasible means of moving a large proportion of inland freight. Competition from trucking then drove the prior regulatory regime to a crisis and spurred railroad freight deregulation, but rail and trucks aren't perfect substitutes. This creates conditions in which Class 1 railroads benefit from both market power and underregulation, while the majority of inland freight is shifted to trucks.[40] Due to the higher private and

36. RSI Logistics, "The Advantages of Rail vs Truck Shipping." Trends in railroad safety and derailments are discussed in the following section.

37. Longman, "Statement."

38. Nall, The Road to Inequality.

39. CBO, "Public Spending on Transportation and Water Infrastructure, 1956 to 2017."

40. With pipeline excluded. Across rail, trucks, and domestic waterways, trucks move 55% of total freight by ton-miles; rail or "multiple modes" move 35%; and inland waterways move the remainder. BTS, "Freight Analysis Framework."

public social costs of moving freight by road rather than rail, this poses massive harms and missed opportunities for both shippers and the country at large, as will be detailed later in this report.

An analogous process proceeded for passenger rail. Massive government investments in airports, highways, and other roadways subsidized other modes of transport, while rail infrastructure was being funded through investment from private operators. In the context of these massively uneven public investments, per capita passenger-miles by intercity rail fell 75% from 1951 to 1970.[41] As with freight, this sent the prior regulatory regime into a crisis. Private railroad operators had been prohibited by law to end service on unprofitable passenger lines without permission from specific public bodies, but the large-scale shift in passenger traffic from rail to other modes made many passenger routes unprofitable for private operators.[42] The Rail Passenger Service Act of 1970 allowed private railroads to end unprofitable passenger lines and established Amtrak as a "quasi-public" corporation, and shifted responsibility for intercity passenger rail from regulated private railroads to Amtrak.[43]

41. Davis, "Amtrak at 50."

42. Davis.

43. Davis; Amtrak, "Amtrak and Freight Railroads: The Public Bargain."

44. Green and Miller, "Examining the Effects of Precision Scheduled Railroading on Intercity Passenger and High-Speed Rail Service"; Amtrak, "Amtrak Host Railroad Report Card"; Ryan, "Dude, Where's My Train?"

45. Green and Miller, "Examining the Effects of Precision Scheduled Railroading on Intercity Passenger and High-Speed Rail Service."

CONSTRAINTS ON PASSENGER SERVICE

Amtrak now runs passenger service on tracks that are typically owned by the private Class 1 railroads. Amtrak pays its host railroads for use of their tracks—but in the context of market power in which private railroads focus on margins rather than growth, this is often not adequate or efficient to incentivize better passenger service.

By law, private railroads are directed to give preference to Amtrak passenger trains over their own freight trains, but this has rarely been enforced. Many Amtrak routes currently see atrocious on-time performance, with the majority of trips on many routes not arriving on time. On some routes, 80% of trips or more may be late; on many long-distance routes, 50% or more are late, with delays reaching up to five hours.[44] The primary cause for these delays is "freight train congestion," suggesting that Amtrak trains are not receiving priority.[45] A recent action by the Department of Justice to finally uphold this law puts into relief decades of non-enforcement: In summer 2024—for the first time since 1979 and the second in the law's 51-year history—the

Department of Justice finally filed a civil complaint against a private railroad for failing to grant priority to Amtrak trains.[46]

Passenger service is constrained by freight traffic, and this problem is exacerbated by the minimal infrastructure maintained by Class 1 railroads. Shortly after the agreement that Amtrak trains must have preference was put into place, major freight railroads "began selling off their less profitable lines, consolidating their trains onto more congested main lines, selling equipment, and terminating employees in order to increase their profits."[47] These trends have all also continued with the implementation of PSR. Train traffic congestion has now become the major reason for Amtrak delays, but infrastructure that could have helped manage this congestion was abandoned or undermaintained by private railroads.[48]

The needs of passenger and freight trains running on the same lines can conflict, particularly when rail infrastructure has been reduced to its barest. Freight trains, especially longer and heavier freight trains more common under PSR, tend to be much slower than passenger trains. Private railroads have reduced double- or multitracked lines to single track to reduce maintenance costs and tax burdens. Rail sidings—which are sections of track where trains can pull over to allow faster trains, or trains approaching from the opposite direction, to pass—may be removed, or they may not be expanded to fit longer trains run under PSR. Without multitracked lines or even adequate sidings, passenger trains can become stuck behind slower freight trains, which severely limits their speed.[49] Again, private operators with market power will tend to reduce costs and output while keeping only their most profitable business—so this downsizing does not mean those assets were unused, or even unprofitable, but only that they were not consistent with the supernormal profits the rail industry is currently seeing.[50] The structure of taxation of railroad assets may also contribute to this issue by perversely incentivizing abandonment of tracks that would increase railroad tax burdens.

Notably, this is an example in which improved asset utilization, often touted as a benefit of PSR, also means reduced service and capacity. While remaining trackage may be more intensely used, service has declined, and constraints are placed on future growth. The American Public Transportation Association has specifically noted that "increased

46. Rail Passengers Association, "Rail Passengers Statement on Complaint Against Norfolk Southern."

47. Green and Miller, "Examining the Effects of Precision Scheduled Railroading on Intercity Passenger and High-Speed Rail Service."

48. Amtrak, "Amtrak and Freight Railroads: The Public Bargain"; Green and Miller, "Examining the Effects of Precision Scheduled Railroading on Intercity Passenger and High-Speed Rail Service." See also the previous section, on the length of the Class 1 rail network over time.

49. GAO, "Freight Rail." "Specifically, Amtrak officials stated that longer trains cannot fit in track sidings to allow the Amtrak train to pass. According to the officials, when a freight train is dispatched ahead of a faster Amtrak train, the Amtrak train must follow the freight train at reduced speed until the freight train reaches a siding long enough to accommodate it."

50. American Journal of Transportation, "Railroads Are USA's Most Profitable Industry with a 50% Profit Margin."

asset utilization" has decreased the resiliency of the rail network and reduced reliability for passenger rail.[51] Lack of infrastructural investment and maintenance not only contributes to congestion and slow speeds, but it also limits the extent of the passenger network, with abandoned or undermaintained rail lines sometimes interfering with Amtrak operations or preempting new lines.[52]

Where intercity passenger service has seen dramatic improvements, it has often been enabled by direct, public ownership of rail tracks, as when the state of Virginia bought hundreds of miles of track and right-of-way from a Class 1 railroad to expand Amtrak and commuter rail service.[53] However, even in this case, negotiation with private freight railroads has prevented the electrification of passenger trains with overhead wires.[54] Electrified passenger trains are much faster than diesel trains—and electrification also eliminates GHGs and other air pollution from train operations—but private railroads resist the overhead catenary wires that would allow electrification.[55] This is nominally due to the difficulty of running double-stacked freight trains under catenary lines, but this issue has been solved in other countries, and the US is an international outlier for its low usage of overhead catenaries.[56]

The Amtrak Northeast Corridor (NEC) provides another clear example of passenger service benefiting from direct public ownership of rail tracks. In contrast with most of its network, Amtrak directly owns most of its trackage along the NEC. And in contrast with the portion of the network owned by private railroads, the NEC serves a large number of passenger trains, with Amtrak sharing the trackage with eight separate commuter or regional rail operators. The line serves an estimated 820,000 passengers on 2,163 trains on an average weekday, with the majority of those trips—nearly 95%—on commuter or regional rail operators with whom Amtrak shares NEC trackage.[57]

While Amtrak shares its NEC trackage with eight commuter or regional rail operators, Class 1 railroads have often sued or otherwise resisted sharing their tracks with passenger providers, despite the law requiring that they give Amtrak trains preference. A law passed in 2008, the Passenger Rail Investment and Improvement Act, contained provisions to improve enforcement of this law, mandating the creation of standards for minimum service, and allowing the STB to award

51. Interviews with American Public Transportation Association cited in GAO, "Freight Rail." "Officials from the American Public Transportation Association stated that precise scheduling for freight railroads can reduce disruptions for passenger railroads but noted that changes such as longer trains and increased asset utilization had reduced the resilience of the network."

52. TransitMatters Rail Group, "Public Has Interest in Pan Am Railways Sale."

53. Gordon, "Virginia's Big Buy-in on Rail Could Transform Regional Mobility."

54. Gordon, "Electrified Rail Is the Future. Is Virginia All Aboard?"

55. Gordon.

56. Singh et al., "Double-Stack under the Wires"; Gordon, "Electrified Rail Is the Future. Is Virginia All Aboard?"

57. Northeast Corridor Commission, "Northeast Corridor Annual Report: Operations and Infrastructure Fiscal Year 2019."

damages to Amtrak when host railroads allowed service to fall below the determined standards. The Association of American Railroads, an industry group that represents the Class 1 railroads, sued to prevent the implementation of these provisions of that law, and the lawsuit delayed implementation by a decade.[58]

The public interest in expanded service is in conflict with private railroaders' interest in cutting costs to maintain supernormal profits. This antagonism of interests means that lengthy or expensive lawsuits and negotiations become commonplace in efforts to expand passenger rail service. Years of litigation preceded eventual passenger service between Boston, Massachusetts, and Portland, Maine.[59] It took over a decade of advocacy and $144 million in public money to allow two passenger trains per day, rather than only one, to run on the private tracks between Harrisburg and Pittsburgh, Pennsylvania.[60] Reports on attempts to expand passenger service often note extreme differences in cost estimates from private railroad owners and government or third-party entities.[61] When passenger service is expanded, it often will be after large sums of public money are invested in railroad tracks that will remain under private ownership. Phillip Longman of the Open Markets Institute contends that private railroads can massively overestimate the cost of capital improvements necessary to improve passenger service in order to either sabotage plans for expanded passenger service or draw massive public subsidies, of which the private railroad itself will be the primary beneficiary.[62]

In meaningful ways, the current arrangement entails a privatization of profits but a socialization of costs. Passenger lines were taken over by the public once they became unprofitable, while profitable freight lines remained with the private sector. Major infusions of capital for improvements still come from the public, but assets are still mostly owned by private railroads. Amtrak pays private railroads for running passenger trains based on the costs incurred on host railroads, but private freight railroads will still neglect passenger trains to focus on the supernormal profits they can realize in the oligarchical structure of their industry.

58. Rail Passengers Association. "Decision Allows Amtrak and FRA to Set Quality Standards for Intercity Rail Operations," July 2018. https://www.railpassengers.org/happening-now/news/releases/federal-court-acts-to-protect-rail-passengers/.

59. Longman, "Amtrak Joe vs. the Modern Robber Barons."

60. Delano, "More Train Service Coming to Pittsburgh to Points East"; Longman, "Amtrak Joe vs. the Modern Robber Barons."

61. Ngo, "An Obstacle to Amtrak Expansion That Money Won't Solve"; Longman, "Amtrak Joe vs. the Modern Robber Barons."

62. Longman, "Amtrak Joe vs. the Modern Robber Barons."

FRAGMENTED NETWORKS

Notably, the current railroad industry structure of large, super-regional duopolies or monopolies creates the worst of all worlds in some regards. Not only do rail carriers have immense market power, but interchanges between portions of the rail network under different owners increase costs by decreasing length-of-haul economies (referring to how costs of shipping per mile can decrease the farther something is shipped on the same line or network) and introducing the need to coordinate with multiple railroads.[63]

Moving freight between different private networks has tended to add costs for shippers, increased congestion around freight hubs, and limited railroads' growth in important market segments like intermodal freight.[64] Chicago, Illinois, provides an archetypal example of the congestion that can be created from the work of moving freight between separate rail networks. Many Class 1 railroad networks meet in Chicago, and the city and its entire metro area has persistently struggled with congestion.[65] Particularly when compounded with the PSR trend of ever-longer trains, freight trains block intersections, forcing residents in surrounding cities to wait for hours or risk death crawling beneath trains that may start again without warning. Death and disruption from this traffic has become a major, recurrent problem. [66]Truck traffic is also intensified, because trucks are used to move freight the short distances between separate private rail networks in the city.[67] Substantial investments, primarily from the state and federal government, have ameliorated the problem, but the fundamental issue of fragmented networks remains.[68] This issue of moving rail traffic throughout the fragmented networks in Chicago was even recognized by Hunter Harrison, the former railroad executive famous for originally pioneering PSR, when he was brought to testify before the STB. His testimony notes the difficulty that competing railroads had in cooperating to solve this issue.[69]

The issue of fragmentation of operators and networks in rail systems has been studied in numerous other contexts. A recent, major report on the UK rail system notes how fragmentation of operating entities vastly complicates the country's rail system, impedes service quality,

63. A major study commissioned by the STB estimated that, at its peak, interchanging between railroad tracks can increase marginal costs by up to 40% by decreasing length-of-haul economies. Christensen Associates, "A Study Of Competition In The U.S. Freight Railroad Industry and Analysis of Proposals That Might Enhance Competition: Revised Final Report."

64. The fragmentation issue can increase truck congestion because trucks are often used to ferry intermodal containers between trains on different Class 1 networks. The use of trucks for this purpose, as well as added coordination and complexity from moving between networks, adds to costs. Schultz, "Chicago's Railroad Problem."

65. Schultz.

66. Davis, "As Rail Profits Soar, Blocked Crossings Force Kids to Crawl Under Trains to Get to School."

67. Schultz, "Chicago's Railroad Problem."

68. CMAP, "CREATE Program Status Check"; Schultz, "Chicago's Railroad Problem."

69. Begeman and Miller, "Public Listening Session On CSX Transportation, Inc.'s Rail Service Issue."

and hinders modernization efforts and investment.[70] Fragmentation by country is a major challenge for European rail operators broadly.[71] Academic research on rail systems in the US similarly emphasizes increased transaction costs from coordinating between different rail operators when moving between networks.[72] Different forms of fragmentation and how they can increase costs are discussed more in the following section.

Figure III-11 and Figure III-12 show how Class 1 rail networks divide the country into these large duopolistic or monopolistic networks. The vast majority (over 70%) of states and metro areas that are classified as freight analysis framework (FAF) zones have access to only one or two Class 1 networks. This means any given metro area will have access to no more than two railroads—indicating the rail industry's current status as a duopoly throughout most of the country.

Figure III-11. Class 1 Rail Network in the United States Map

BNSF - Burlington Northern Santa Fe
CN - Canadian National Railway
CPKC - Canadian Pacific Kansas City
CSXT - CSX Transportation
NS - Norfolk Southern
UP - Union Pacific

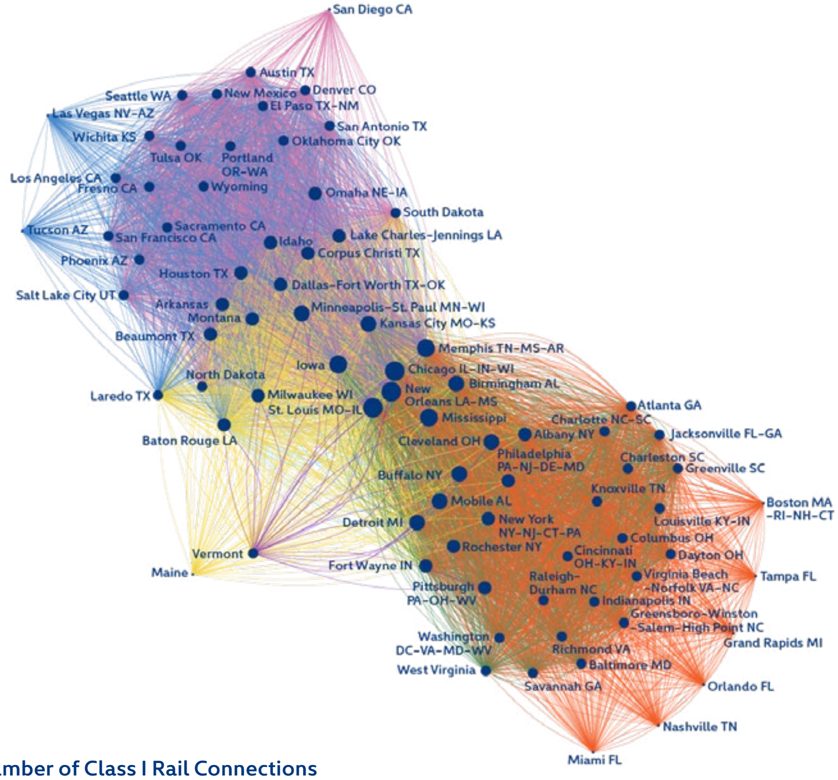
Source: Author's analysis

70. UK Department for Transport, "Great British Railways."

71. International Union Of Railways, "The Modal Share of Rail in Inland Transport and Infrastructure Investment."

72. Gómez-Ibáñez, "Open Access to Infrastructure Networks."

Figure III-12. Class I Rail Network in the United States Network Diagram



Number of Class I Rail Connections

6 1

Class I Railroads

- BNSF - Burlington Northern Santa Fe
- CN - Canadian National Railway
- CPKC - Canadian Pacific Kansas City
- CSXT - CSX Transportation
- NS - Norfolk Southern
- UP - Union Pacific

Source: Author's analysis

The figure illustrates the current structure of the rail industry as large, regional, fragmented duopolies. Large, regional duopolies mean that private providers are often operating alongside only one other competitor. Monopolies also exist for many areas, including much of Florida and Arizona and Maine. Meanwhile, cities like Chicago bridge the fragmented networks, which creates other drawbacks associated with interchanging freight between them. The figure is meant to illustrate this industry structure but does not reflect the US geographically.

Each freight analysis zone is represented as a node on the network, with lines colored by Class 1 railroad showing connections between them. Each freight analysis zone is represented as a gray circle that is sized based on how many railroad providers connect the region; for example, states and metro areas that have access to only a single railroad provider, such as Orlando, Florida, and Tucson, Arizona, are represented as very small dots. In contrast, Chicago, Illinois; New Orleans, Louisiana; and St. Louis, Missouri, have access to all six Class 1 networks and are represented by larger circles. The visual is based on the most recent version of the National Transportation Atlas Database from the Bureau of Transportation Statistics (BTS), updated to reflect the recent merger between CP and KCS to form CPKC.[73]

73. BTS and Department of Transportation, "National Transportation Atlas Database."

C. REFORM & PUBLIC OWNERSHIP FEASIBILITY

- Public rail ownership can take a huge range of possible forms, as can privately owned rail systems.
- Many countries with predominantly public operation of their rail networks have seen consistent, excellent results. Examples include Switzerland, Austria, Ukraine, Germany, France, China, South Korea, and India.
- The most successful and intensely used passenger lines in the US operate largely on publicly owned tracks. In contrast, passenger service on private tracks in the US tend to perform much worse.
- Some countries, notably Japan, have maintained excellent passenger service in primarily privatized rail networks. The private rail operation in Japan is paired with thoughtful and well-enforced regulation, including of fares.
- The rail system in Switzerland provides an example of a publicly operated rail system that achieves impressive success for both passenger and freight service, while more successful private systems (such as Japan's) have only seen success in one area or the other.
- Rail systems characterized as "vertically separated" or "open access" have been pursued internationally to create more competition in the rail industry. In these systems, rail infrastructure is owned by one entity and lines are operated by other entities.
    - Many studies of these systems find that transaction and coordination costs, antagonistic relationships between owners and operators, and reduced economies of scope result in sometimes drastically increased costs in these systems.
    - Empirical studies on open access systems have found mixed results: some stress substantial increased costs or lost economies of scale associated with open access; others

stress that open access can nonetheless decrease costs in specific conditions.[74]

  - Qualitative and historical studies and stakeholder interviews consistently give cause for caution in pursuing open access systems. Many countries have seen disastrous results with pursuing vertically separated systems, most notably the UK, which is now subjecting its system to drastic reforms.

  - While increased competition may seem to be an intuitive solution to the oligarchical structure that currently exists in the railroad sector, available research and case studies on attempts to foster competition in the railroad industry, as through vertical separation, indicate extreme drawbacks relative to other potential reforms.

- Rail operators that also invest in related sectors, such as tourism and residential real estate, which tend to see benefits from passenger rail investments, have often seen substantial success. Notably, both public and private rail operators have successfully pursued strategies along these lines.

The previous sections of this chapter establish long-term trends in declining service, output, and capacity among railroads, particularly for freight. These trends have been long term, but many have accelerated in recent years with the implementation of PSR across most Class 1 railroads. These trends are unambiguous and pervasive in the data; they are also predictable, given the industry's structure as an underregulated oligopoly. To reverse the trends outlined in this chapter, it will therefore be necessary to reform the structures that gave rise to them. One direct path to doing so would be public rail ownership, which is advocated for by anti-monopoly think tanks, advocates, and railroad workers, who have provided consultation and support in the writing of this report. **While endless variation exists among the institutions that structure rail industries, forms of public ownership and operation predominate among the most successful and intensely used rail systems internationally.**

Other reforms noted in this report include equalization of subsidies

74. Abbott and Cohen, "Vertical Integration, Separation in the Rail Industry"; Gómez-Ibáñez, "Open Access to Infrastructure Networks."

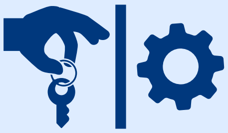
and public investment between rail and other modes of transportation, particularly on-road transportation (including trucking for freight and light-duty vehicles [LDVs] for passengers) and passenger air. These subsidies include both direct subsidies for infrastructure and operation but also unpriced externalities. Different modes of transportation, for both passengers and freight, tend to generate vastly different levels of externalities, such as air and climate pollution or crash deaths, as discussed further in section IV-B, "Averted Social or Externalized Costs."

The primary goal of this report is to model potential mode shifts and social and economic benefits realizable from deep reforms of the rail system, including public rail ownership. Details on how these major reforms should be implemented and more in-depth discussions of various public and private rail ownership structures are left for other works. However, this section introduces examples of public rail ownership—as it exists internationally, in isolated lines in the US, and in prior periods of US history. It also provides some discussion of different public rail ownership structures and compares public rail feasibility to a continuation of the industry's status quo.

STRUCTURE AND VARIATION IN RAILROAD INSTITUTIONS

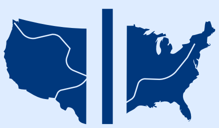
Rail systems vary enormously internationally and historically. Even across systems that can be characterized as predominantly publicly owned or privately owned, there is still tremendous scope for variation. Tracks may be owned by one entity or one set of entities; operations may be conducted by the same or a separate set of entities. Any combination of owning or managing entities may be partially or wholly public or private. Regulations and the structure of regulatory bodies will also vary, and all these institutional features can also vary between passenger and freight rail or geographically within a single country. In short, there are endless variations in how rail systems can be structured and regulated, and many currently existing rail systems are not entirely privately or publicly operated, even while they may be predominately public or private.

One common classification style for rail systems describes networks as vertically integrated or separated and horizontally integrated or separated. Horizontal separation describes rail networks that are separated geographically, with different owners or operators in different regions. Vertical separation describes separation between ownership and operations, such that one entity might own track infrastructure and others operate lines. These are defined again below:



Vertical Separation: ownership & management are separated. One entity owns rail infrastructure; others operate trains.

Vertical Integration: ownership & management are integrated. A single entity can own rail lines and operate trains on them.



Horizontal Separation: the rail network is geographically segmented. Separate entities own or manage different portions of the rail network, which is divided by region.

Horizontal Integration: the rail network is geographically integrated. The same entities operate nationally.

Different systems may vary and coexist within a single country. For example, the current US rail system is characterized by vertical integration and horizontal separation for freight, but the reverse for intercity passenger rail. This is mirrored in Japan, where the system is vertically integrated and horizontally separated for intercity passenger rail but horizontally integrated for freight. In Japan, private passenger operators own rail tracks and tend to prioritize their own passenger service over freight run by a separate entity. Again, in the US, this situation is reversed. Switzerland provides a contrast to both places—with vertical integration and a single public operator managing the vast majority of its network, both passenger and freight service are successful.

Table III-1. Railroad structure and mode shares for selected counties

COUNTRY	VERTICAL SEPARATION OR INTEGRATION	HORIZONTAL SEPARATION OR INTEGRATION	TRACK OWNERSHIP	OPERATION	APPROX. FREIGHT MODE SHARE[76]	APPROX. PASSENGER MODE SHARE
United States of America	Vertically integrated for freight, primarily vertically separated for passenger	Horizontally separated	Primarily private	Primarily private for freight; primarily public for passenger	37%	0%
Canada	Vertically integrated for freight, primarily vertically separated for passenger	Horizontally separated	Primarily private	Primarily private for freight; primarily public for passenger	62%	(not reported)
Japan	Vertically integrated for passenger, primarily vertically separated for freight	Horizontally separated	Primarily private	Primarily private	7%	32%
United Kingdom	Vertically separated	Horizontally integrated	Primarily public	Primarily private	9%	10%
Korea	Vertically separated	Primarily horizontally integrated	Primarily public	Primarily public	5%	21%
Switzerland	Primarily vertically integrated	Primarily horizontally integrated	Primarily public	Primarily public	40%	17%
France	Primarily vertically integrated	Primarily horizontally integrated	Primarily public	Primarily public	15%	11%
Austria	Primarily vertically integrated	Primarily horizontally integrated	Primarily public	Primarily public	30%	6%
Ukraine	Primarily vertically integrated	Primarily horizontally integrated	Primarily public	Primarily public	70%	(not reported)

The institutions structuring a country's railroad system can vary enormously. While many external factors, including geography and mix of commodities being shipped, also affect mode shares and intensity of rail use, many vertically integrated public systems internationally are extremely successful and see higher modal shares for rail than in countries with primarily privately operated rail systems. While studies on vertical separation have been mixed, many vertically separated systems that do exist have seen instability, inefficiency, and increased costs for both users and the public.[75]

To provide a sense of international variation across rail systems, Table III-1 – Railroad structures and mode shares shows railroad structures and mode shares for a selection of countries.

75. Abbott and Cohen, "Vertical Integration, Separation in the Rail Industry"; Mizutani et al., "Comparing the Costs of Vertical Separation, Integration, and Intermediate Organisational Structures in European and East Asian Railways"; Gómez-Ibáñez, "Open Access to Infrastructure Networks"; UK Department for Transport, "Great British Railways"; ETF, "Lessons Learned from Three Decades of Liberalisation of the European Railways."

76. Mode shares calculated from OECD ITF data using 2019 data. Mode shares refer to percent passenger miles or ton-miles for freight. Note that because OECD data is used for this table, the US mode share will not match values cited elsewhere in this paper, which are calculated from other data sources. "OECD Statistics." The denominators to calculate freight mode shares do not include coastal or ocean freight but do include inland waterways.

HISTORICAL & EXISTING PUBLIC RAIL SYSTEMS

International, historical, and present-day precedents in the US establish the feasibility for publicly owned and operated rail lines.

Within the US, publicly owned passenger lines tend to have a huge proportion of total rail PMT and see far greater investments in improved service and decarbonization compared to routes run on the primarily privately owned rail network. The clearest example is the NEC Amtrak line, which is one of the few Amtrak lines in which tracks are primarily owned directly by Amtrak itself. It is also by far the most-used line in Amtrak's network and not only accounts for nearly half of all Amtrak passenger trips but also provides trackage for eight commuter or regional rail lines.[77] The line serves an estimated 820,000 passengers on 2,163 trains on an average weekday; the majority of those trips—nearly 95%—are with commuter or regional rail operators with which Amtrak shares NEC trackage.[78] This density of passenger service across operators on the Amtrak-owned line contrasts with the sparsity of passenger service on most Class 1 owned tracks.

The NEC also contains nearly every mile of electrified intercity rail in the country and is the only Amtrak route that provides high-speed rail, although only on a portion (less than one-tenth) of its trackage; and even there, traffic and outstanding infrastructure needs impede the Acela from maintaining speeds approaching even the lower-end ranges typical of high-speed rail internationally for significant lengths of time.[79] Nonetheless, the NEC captured 83% of the combined air and rail market along important stretches of this corridor, indicating the potential of improved rail service to shift trips from air to rail in the US.[80] Finally, other Amtrak lines that are partially or largely publicly owned, including the Keystone and Empire Corridors, also tend to have notably higher ridership than most other lines.[81]

In the US, the railroads were also temporarily nationalized during World War I. Nationalization allowed rail cars to be pooled across routes and directed to the nearest repair yard, suggesting how some costs associated with fragmentation of rail systems were reversed with nationalization.[82]

77. Abrams, "FY23 Year End Ridership"; Northeast Corridor Commission, "Northeast Corridor Annual Report: Operations and Infrastructure Fiscal Year 2019."

78. Northeast Corridor Commission, "Northeast Corridor Annual Report: Operations and Infrastructure Fiscal Year 2019."

79. High-speed rail often operates at speeds between 155–220 mph. While Acela trains can reach beyond 155 mph, they do so only in short stretches of the line and average closer to 60-80 mph along common origin-destination pairs.

80. Amtrak, "Amtrak's Northeast Corridor Fact Sheet."

81. Abrams, "FY23 Year End Ridership."

82. Hines, War History Of American Railroads: Economic And Social History Of The World War.

Internationally, many other countries have primarily publicly owned rail systems, including France, Germany, Austria, Ukraine, Switzerland, Australia, China, and India.[83] Other countries, like the UK, have primarily publicly owned rail infrastructure but mostly private operators.

Direct comparisons of rail mode shares across countries should be done with caution, because geography, the mix of commodities being shipped, and other external factors dramatically affect mode share. For example, the level of access to inland and coastal water for domestic shipping can drastically affect mode share, particularly for freight. **Nonetheless, countries with publicly operated rail lines often have more intensely used rail systems relative to private operators.** Ukraine, which has primarily publicly owned rail, moves over 60% of its freight by rail, nearly twice the share currently moved by rail in the US (statistics cited from Ukraine will reflect periods that predate the Russian invasion of Ukraine in 2022).[84] Switzerland, which also has publicly owned and operated rail, achieved the highest ranking in the Rail Performance Index, a metric created by the private consulting group BCG to assess rail performance across European countries, and its rail system also sees the greatest intensity of use among all countries rated for the index.[85] Every other country in the top tier of rail service in BCG's analysis also has primarily publicly operated systems. Notably, both Switzerland and Ukraine are outside of the EU and were therefore exempt from EU directives that mandated policies intended to increase the scope for private rail operators.[86]

Other countries, such as Canada, Australia, and the US, have largely privately operated freight rail, and also have very high mode shares for rail freight. However, both the geography of these countries and the mix of commodities being shipped (all countries are large exporters and movers of coal) help account for the very high freight mode in these places. Both countries also have very low rail mode shares for passenger movement.[87] Ukraine, with its similarly very high rail freight mode share, notably ships a more diverse mix of commodities over a less sprawling land area.

83. While the EU has mandated policies to open rails to competition, this has been implemented differently in different countries, and many countries still have 100% or a large majority of rail traffic still served by the historic public operator. Tomo et al., "Regulation, Governance and Organisational Issues in European Railway Regulation Authorities."

84. International Union Of Railways, "The Modal Share of Rail in Inland Transport and Infrastructure Investment"; "OECD Statistics."

85. BCG, "The 2017 European Railway Performance Index."

86. Many EU countries also comply with these directives while maintaining predominantly public rail ownership and management. See Tomo et al., "Regulation, Governance and Organisational Issues in European Railway Regulation Authorities."

87. International Union Of Railways, "The Modal Share of Rail in Inland Transport and Infrastructure Investment."

Privatized systems in Japan and UK

Where public railroad systems have been privatized, results have been mixed. Some countries that have pursued whole or partial privatization, including the UK and Argentina, have since reversed or partially reversed course due to failures associated with their privatized systems.

Japan, which took a very different approach to privatizing rail from the UK, has maintained high-quality passenger service on its privately owned intercity network. Some research notes modest improvements in financial metrics post-privatization for passenger rail in Japan but "dismal" results for freight service.[88] While Japan has maintained its excellent passenger service post-privatization, it is also not clear that privatization was necessary to address the challenges facing the former public operator, and privatization there was also paired with thoughtful and enforced regulations, including fare regulation.[89]

In the UK, railroad operation was privatized in the 1990s. Rail infrastructure was also initially transferred to private owners but has since largely shifted back to public ownership following major financial difficulties faced by the private owners. Now, the UK system is characterized by primarily public infrastructure ownership but primarily private operators. This form of privatization was associated with increased public subsidies for rail operators and higher passenger ticket prices.[90] The new system in the UK meant a high degree of fragmentation—different rail operators would have to coordinate with each other, the public rail owner, and their customers.

Reforms intended to make room for competition also complicated the system, dramatically increasing transaction and coordination costs, making the system more confusing for users, hindering efforts to modernize the system, and increasing the difficulty of holding parties accountable for failures within the fragmented system.[91] A major report from the Organization for Economic Cooperation and Development (OECD) collects many stakeholder complaints that similarly emphasize frequently costly coordination issues that arise from fragmented systems, particularly when ownership and management of rail tracks are separated. With separate parties owning and operating trains, coordination costs of managing traffic, settling disputes, establishing

88. Ito and Krueger, Governance, Regulation, and Privatization in the Asia-Pacific Region.

89. Ito and Krueger.

90. ETF, "Lessons Learned from Three Decades of Liberalisation of the European Railways."

91. UK Department for Transport, "Great British Railways"; Gómez-Ibáñez, "Open Access to Infrastructure Networks."

maintenance standards for both parties, and other issues all add complexity and costs.[92] Now, the incoming Labour government plans to nationalize train operators, and a pre-existing plan from the UK Department of Transport already sought to increase the role of a single public entity in coordinating and operating the system.[93] In Argentina, privatization was reversed in 2015.

Notably, privatization took very different forms in the UK and Japan. In the UK, privatization was pursued through "vertical separation," in which public ownership of the tracks was maintained and operations were taken over by a variety of private entities. In Japan, privatization meant "horizontal separation" of the rail system, with the formerly public network divided by region and taken over by separate private operators.

Economies of scope for public and private railroad owners

Examples of rail operators that also invest in sectors—such as tourism and residential real estate, which tend to see benefits from passenger rail investments—have often seen substantial success in the US and internationally. Notably, both public and private rail operators have pursued strategies along these lines.

Railroads in Japan have branched out into these related sectors post-privatization, investing in tourism and residential real estate near passenger stations.[94] In the US, private railroads like Brightline are investing in new, high-speed passenger rail lines while also investing in real estate near stations. This was also common practice among private streetcar operators in prior periods of US history.[95]

However, this strategy is not unique to private operators, and public transit authorities in the US and in many European countries, including Switzerland and Belgium, have also acted to leverage property value increases from passenger rail in this way.[96]

The success of transit operators in leveraging increased real estate values from rail investments also speaks to rail's economic benefits for other sectors of the economy as well as indicating a source of funding for both public and private rail operators.

92. For example, wheel defects in railcars due for maintenance can damage tracks, while poorly maintained tracks can also damage wheels or limit train speeds or weights, leading to potentially costly coordination and conflict management issues. See i.e., OECD, "Structural Reform in the Rail Industry."

93. UK Department for Transport, "Great British Railways."

94. Ito and Krueger, Governance, Regulation, and Privatization in the Asia-Pacific Region.

95. Stromberg, "The Real Story behind the Demise of America's Once-Mighty Streetcars."

96. For US example, see Surico, "When a Transit Agency Becomes a Suburban Developer."

IV. ECONOMIC & SOCIAL BENEFITS REALIZABLE FROM RAILROAD REFORM & PUBLIC OWNERSHIP

As described in the previous chapter, existing conditions in the railroad industry are characterized by:

- **a national rail network mostly divided into large regional monopolies or duopolies;**
- **massively imbalanced outlays of subsidies and public investments that favor on-road and air transportation relative to rail;**
- **reductions in rail freight volume and employment that began decades ago but have accelerated in recent years, particularly with the implementation of PSR across most major railroads.**

This section introduces scenarios for passenger and freight modal shifts that could be realizable from restructuring the institutions governing the railroad sector, including ownership arrangements, regulations, and subsidy allocations. These scenarios then look at the economic, environmental, fiscal, and public health benefits realizable from mode shifts.

> **“The undersupply of train transportation in the US therefore poses immense financial and opportunity costs for both American businesses and the public.”**

Different modes of transportation for both freight and passengers have different costs to users and pose different levels of external costs on the public. Climate pollution, air pollution, and noise pollution; traffic crashes and congestion; ecological costs; public fiscal costs; private costs for shippers or passengers; and co-benefits for other economic sectors will all vary across modes of transportation. Where these costs can be quantified and compared across modes, rail tends to have far lower public and private costs than on-road transportation or air travel. The undersupply of train transportation in the US therefore poses immense financial and opportunity costs for both American businesses and the public. The modeling in this chapter assigns numbers to some of the costs and missed opportunities posed by the under provision of rail service in the US.

A. MODE SHIFT POTENTIAL

Rail reform and public rail ownership would have the potential to shift:

- over 2,000 billion ton-miles from trucks to rail by 2050
- 100 billion passenger-miles from flights to rail by 2050
- 300 billion passenger-miles from cars, pickup trucks, and SUVs to rail by 2050

To estimate benefits, a base-case scenario and two scenarios for realizable mode shift to rail for both freight and passenger transportation are created. Then benefits can be estimated and compared across scenarios based on mode splits, particularly between trucks and rail for freight and rail, air, and LDVs, which include cars, SUVs, and personal pickup trucks for passenger movement.

These forecast scenarios were modeled to estimate potential passenger and freight shifts. For each category of transportation, the forecast scenarios are characterized as baseline, moderate reform, and ambitious reform. For both passenger and freight movement, the baseline scenario is constructed straightforwardly from official US Department of Transportation (DOT) forecasts and current data, including the FAF, the National Household Travel Survey (NHTS), and growth projections for PMT by mode.

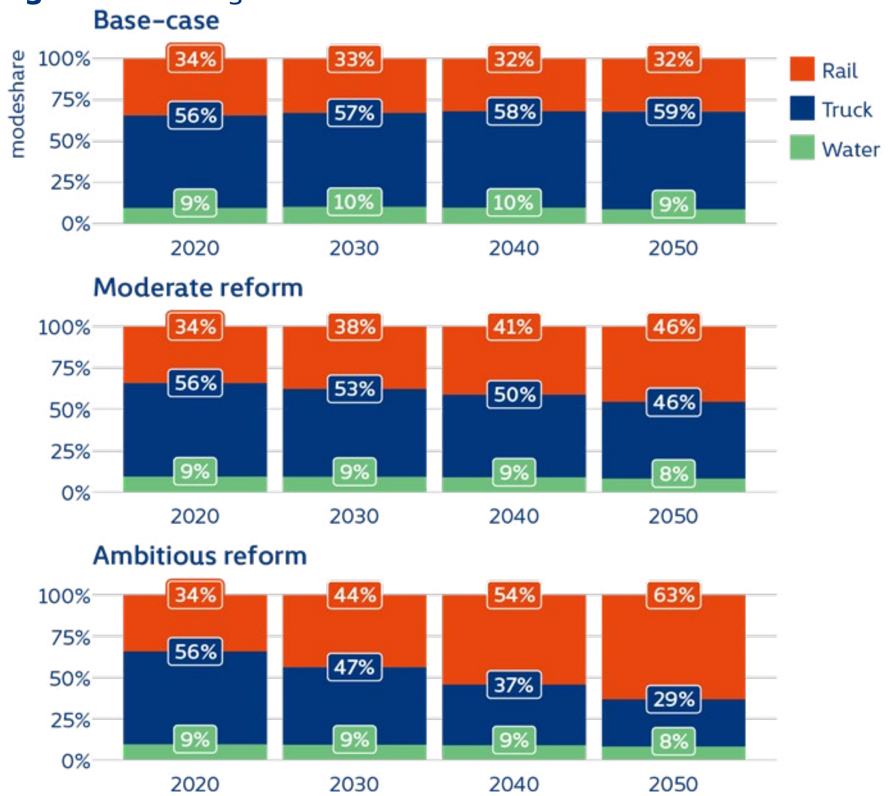
Appendix VI.A in this report provides detail on how these scenarios are parameterized based on current and historical data, existing forecasts from the DOT and BTS, how fleet electrification across vehicle types are built into the models, how multimodal freight is treated, and how these projections compare to existing studies of potential mode shifts in the US and policy targets and mode shares internationally.

Freight

The reform scenarios for freight are built based on historical, thirty-year trends in rail's declining market share among commodity groups for which that historical data is available. The moderate reform scenario reverses the decline of the last thirty years over the following thirty, while the ambitious reform scenario also reallocates nearly all growth that trucking saw in that period to rail.

The modeled reform scenarios employ growth rates across commodities such that total growth in volume by mode is relative to the initial volume of each commodity currently shipped by mode. This means that commodities that are currently shipped by rail in larger proportions see larger growth in volume and vice versa. Basing changes on current volumes builds the suitability of different commodities for different modes of freight transportation by commodity into the model and also incorporates changes in the relative volumes of commodities

Figure IV-1. Freight mode shares across forecast scenarios.



Freight mode share by ton-miles across baseline and reform forecast scenarios
Source: FAF 5.5.1; Author's analysis.

This figure shows how mode shares for freight vary over time by forecast scenario. "Water" refers to domestic waterways. Only domestic freight movements are included in this report's modeling.

over time, as forecasted by BTS. The amount of freight moved by air or pipeline is the same across all freight forecast scenarios as is the total volume of shipped freight by commodity.

The moderate reform scenario yields increases in volume and mode share that are comparable or less than outside estimates from private consultants and government researchers.[97] The ambitious mode shift scenario considers the potential impact of reforms that have not been modeled by other entities, and its potential impact is expectedly greater. This scenario brings rail mode share in the US to over 60% by 2050 (Figure IV-1). This would be an ambitious goal, and the realism and level of ambition of this level of mode shift is discussed below.

Achieving ambitious freight mode shift

As shown in Figure IV-1, the ambitious forecast scenario nearly doubles the freight mode share of rail by 2050, roughly reversing the current proportions by truck and rail. This would bring US mode shares in line with countries that currently rely on rail in the highest proportion, including Canada, Australia, and Ukraine. The achieved mode share in the ambitious forecast scenario is also roughly equal to the global average inland freight mode share for rail in the recent past.[98]

Existing trends and other studies indicate that mode shift in line with this ambitious goal is possible. Analyses both in this report and in external studies focus on agricultural and intermodal freight as major potential growth areas for rail.[99] As noted earlier, intermodal freight has been a rare growth area for rail in the recent past, and Figure IV-2 shows how multiple-mode freight is much more diverse by commodity type (and much less heavily reliant on coal and fossil fuels) than freight that goes by rail alone. BTS data indicate that most ton-mileage attributed to multiple modes goes by rail.[100] This all suggests that both intermodal and other freight that use multiple modes[101] can continue to be a growth area for rail, particularly as coal shipments are expected to continue to decline rapidly.

The ambitious scenario is also ambitious but achievable from the perspective of forecasted haul lengths. Where service is available and reliable, rail tends to be more cost effective than trucking for freight, particularly at distances greater than 300–450 miles.[102] This

97. Zhou, Vyas, and Guo, "An Evaluation of the Potential for Shifting of Freight from Truck to Rail and Its Impacts on Energy Use and GHG Emissions"; Schabas and Bailey, "The Path To Long-Term Shareholder Value For Rail Is Growth."

98. International Union Of Railways, "The Modal Share of Rail in Inland Transport and Infrastructure Investment." However, global rail modal share has been in decline and is now roughly 40%.

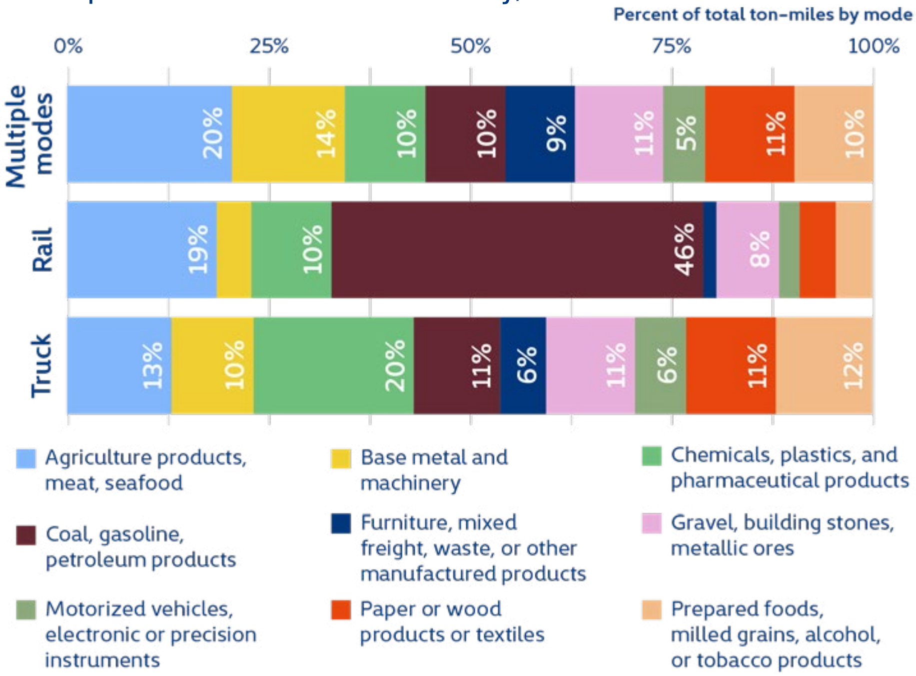
99. Schabas and Bailey, "The Path To Long-Term Shareholder Value For Rail Is Growth."

100. See section in the appendix, "Allocating multimodal freight within the Freight Analysis Framework."

101. Here, "intermodal freight" specifically refers to movement of intermodal containers, while "multiple modes freight" refers to any freight moving by multiple modes on its journey.

102. Rodrigue, Comtois, and Slack, The Geography Of Transport Systems.

Figure IV-2. Breakdown by commodity group for freight by multiple modes or truck or rail only, 2018–2022.

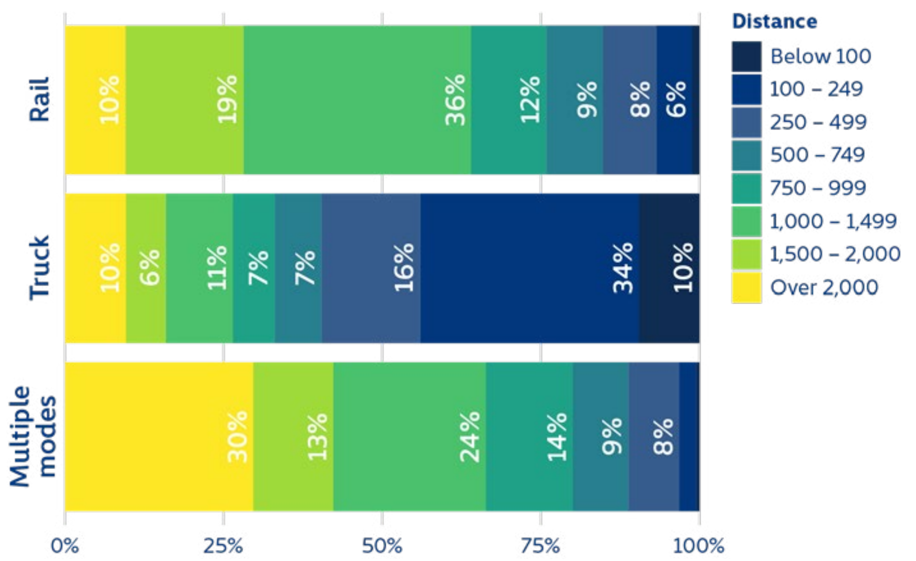


average over 2018–2022.

Source: FAF 5.5.1; Author's analysis

Multiple-mode freight is much more diverse by commodity type—and much less heavily reliant on coal and fossil fuels—than freight that goes by rail alone. BTS data indicates that a very large share of the distance covered by multiple-mode freight is covered by rail. The combination of these facts indicates this as an important opportunity for growing rail's freight mode share.

Figure IV-3. Breakdown by distance band for freight by multiple modes or truck or rail only



Rail tends to be more cost effective than trucking for freight, particularly at distances greater than 300–450 miles, although this is a general rule that can change based on a variety of conditions. Forty to sixty percent of trips solely by truck currently travel above these distance thresholds, indicating room to achieve mode shift in line with the ambitious forecast scenario.

distance is not a hard-and-fast rule and will vary based on the type of commodity and other factors; for example, infrastructural investments and innovations in countries like Switzerland have made rail and cost competitive for much shorter trips as well.[103] In the US, nearly 60% of ton-miles that move by truck are on trips of over 250 miles, and 40% are from trips going over 500 miles (Figure IV-3). BTS forecasts also predict that the average truck distance is set to increase further over time. Shifting the vast majority of truck freight of trips over 300–450 miles would therefore move mode shares to be in line with the ambitious forecast scenario. Adapting techniques and technologies to promote shorter and smaller rail trips could also help shift shorter-distance freight to rail.[104]

"Shifting the vast majority of truck freight of trips over 300–450 miles would therefore move mode shares to be in line with the ambitious forecast scenario."

In the US, nearly 60% of ton-miles that move by truck are on trips of over 250 miles, and 40% are from trips going over 500 miles (Figure IV-3). BTS forecasts also predict that the average truck distance is set to increase further over time. Shifting the vast majority of truck freight trips above 300-450 miles to rail would therefore move mode shares to be in line with the ambitious forecast scenario. Adapting techniques and technologies to promote shorter and smaller rail trips can also help shift shorter-distance freight to rail.

The ambitious forecast scenario is also comparable to goals set internationally by the EU. Most European countries currently have a substantially lower share of freight moving by rail compared to the US. However, the EU has set a goal to increase freight's mode share to 30% by 2030 and 50% by 2050.[105] Given the fact that the size of the US increases the suitability of rail for more freight and a larger share of freight is currently moved by rail in the US, the goal of just over 60% of freight by rail reflects an ambitious goal that is nonetheless in line with international precedent.

Finally, the ambitious forecast scenario would mean substantial changes for the country's domestic freight network and infrastructure. However, massive changes to the country's freight practices and infrastructure will be required either way as we decarbonize freight

103. Green, "Swiss Operators Optimise Short-Haul Railfreight"; Raymond, "Getting Shipments to Change Trains like Passengers Do."

104. Raymond, "Getting Shipments to Change Trains like Passengers Do."

105. Rail Freight Forward, "30 by 2030: Rail Freight Strategy to Boost Modal Shift"; McKinsey, "Bold Moves to Boost European Rail Freight."

transportation. From a technical perspective, shifting as much freight to rail as possible will make the work of decarbonizing this subsector far more straightforward. Decarbonizing trucking will rely on battery-electric vehicles (BEVs) and/or hydrogen combustion trucks. Electric trucks currently do not have the range required to travel the average daily distance currently traveled by regional- and long-haul trucks.[106] BEV trucks take hours to recharge, which would further increase the costs of shipping by truck relative to rail. Truck charging will also be dependent on a mostly unbuilt charging infrastructure. A reliance on BEV trucks will also increase the US' dependence on the "critical minerals" required for large EV batteries, which will take a large ecological toll, increase US vulnerability to price shocks, increase the challenge of decarbonizing other sectors, and would be likely to fuel global conflict related to securing supply chains of these minerals.[107] Hydrogen combustion trucks, an alternative technology to decarbonize long-haul trucking, are not yet on market, and none are yet slated for commercial development for the US.[108] Hydrogen trucks would also require their own separate infrastructure, which is as yet entirely unbuilt.

106. Lowell, Culkin, and M.J. Bradley & Associates, "Medium- & Heavy-Duty Vehicles: Market Structure, Environmental Impact, and EV Readiness."

107. Milovanoff, Posen, and MacLean, "Electrification of Light-Duty Vehicle Fleet Alone Will Not Meet Mitigation Targets"; Riofrancos et al., "Achieving Zero Emissions with More Mobility and Less Mining."

108. Wilson, "Hydrogen-Powered Heavy-Duty Trucks."

In summary, decarbonization of trucking requires mostly undeveloped technologies and entirely new infrastructures, while rail decarbonization is achievable with overhead catenary lines. This is a tested, affordable technology, which also introduces co-benefits (for example, increasing power transmission capacity) and does not increase reliance on "critical minerals" like lithium and cobalt. While very little of the US rail network is currently electrified, other countries have shown how quickly this can be remedied and rail lines switched from diesel to electric. While the scale of change and infrastructural buildout necessary to achieve the ambitious scenario may seem daunting, it is straightforward in many respects in comparison to other potential paths to decarbonizing freight transportation.

"While the scale of change and infrastructural buildout necessary to achieve the ambitious scenario may seem daunting, it is straightforward in many respects in comparison to other potential paths to decarbonizing freight transportation."

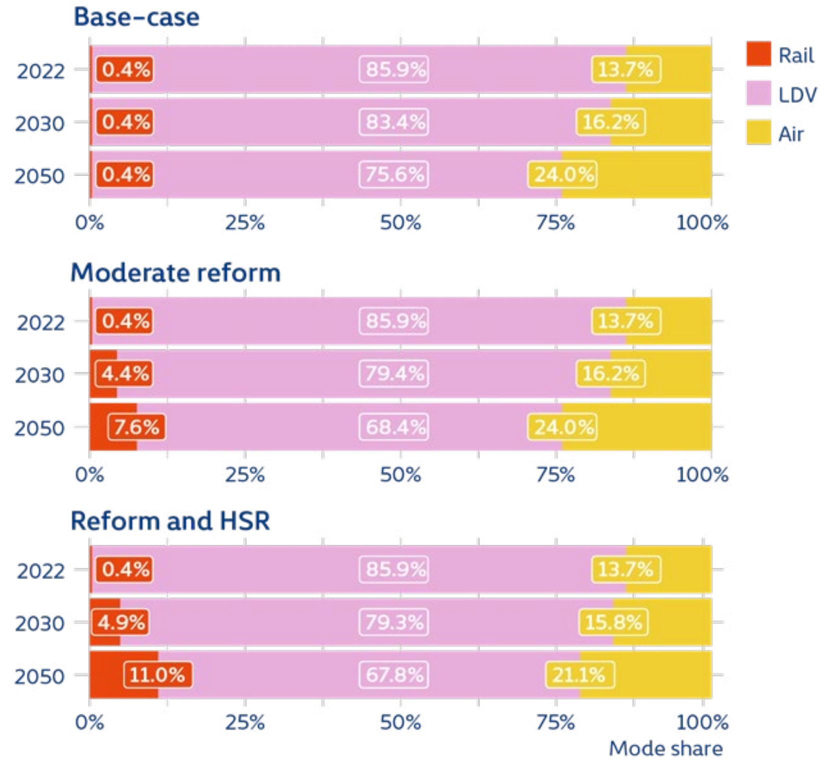
In short, ambitious mode shift is achievable. The mix of freight by commodity type and distances is already suitable for a large-scale shift toward rail. Existing reports from government and private consultants find that mode shift in line with the "moderate reform" scenario in this report is realizable, often with little to no change in existing institutions. The ambitious scenario is in line with goals set internationally to increase rail mode share. With rebalanced subsidies between rail and roads, new investment in rail, and management of rail lines to maximize their use for the public interest, freight mode shift in line with the ambitious forecast scenario presented here is possible.

Passenger

For passenger mode shift, the baseline scenario begins with existing levels of PMT by mode, according to NHTS data, and applies growth rates from the Federal Aviation Administration and Federal Highway Administration to estimate PMT by mode over time.[109]

109. Federal Highway Administration (FHWA), "National Household Travel Survey"; FHWA, "2023 FHWA Forecasts of Vehicle Miles Traveled (VMT)"; Federal Aviation Administration, "FAA Aerospace Forecast: Fiscal Years 2023-2043."

Figure IV-4. Passenger mode shares across forecast scenarios



Source: Author's analysis

This figure shows how mode shares for passenger movement varies over time by forecast scenario.

The moderate reform scenario is built from a gradual shift from LDVs and air to rail, until a portion of all LDV trips over 60 miles and a portion of all flights under 250 miles are transferred to rail. The ambitious reform scenario projects a high-speed passenger rail network built as part of the suite of reforms and reinvestment. The ambitious scenario is therefore parameterized with research on the portion of short-haul flights that can be shifted to high-speed rail (HSR) and shifts a greater portion of flights under a higher distance threshold (750 miles) from air to rail.[110] PMT shifted from flights to rail is also inflated by 30% to account for the fact that rail trips can be less direct than flights.[111] Again, more details on model construction are in the appendix.

Notably, research on the climate impacts of HSR has identified that passenger HSR can reduce emissions in large part by freeing existing rail tracks for freight—and therefore facilitating more modal shift to rail among freight movements—rather than by diverting PMT from highway to rail.[112] This conclusion was reached based on the study of the impacts of HSR in China, where more passengers already move by train, which would be likely to decrease potential emission benefits from passenger mode shift, but this finding underscores how investments in high-speed rail could double as investments to reduce the conflict between passenger and freight needs.

B. AVERTED SOCIAL OR EXTERNALIZED COSTS

Rail has a far lower impact than on-road and air transportation for both passenger and freight movement across all or nearly all these categories.[113] With potential mode shifts for both passenger and rail transit, the differential rates at which external costs are generated can be used to estimate total averted costs realizable from public rail ownership and associated reforms.

These savings are substantial. In dollarized terms, the value of averted costs from realizable mode shifts could average up to about $140 billion a year (in real 2022 USD) and reach $190 billion a year by 2050. This is only the dollarized value of averted externalized costs from

110. Rajendran and Popfinger, "Evaluating the Substitutability of Short-Haul Air Transport by High-Speed Rail Using a Simulation-Based Approach."

111. Miller, "Savings in Per-Passenger CO2 Emissions Using Rail Rather than Air Travel in the Northeastern U.S."

112. Yatang et al., "Impact of High-Speed Rail on Road Traffic and Greenhouse Gas Emissions."

113. Rail has far lower impacts in all categories, except that diesel rail tends more polluting in terms of nonclimate air pollution than LDVs for passenger travel.

mode shift and does not yet account for other economic benefits from a more robust and well-utilized rail system, which are discussed in the following section.

Freight mode shift:

- Rail reform and public rail ownership would have the potential to shift:
- Over 2,000 billion ton-miles from trucks to rail by 2050

...For:

- An average of two thousand lives saved and 70 thousand injuries avoided from fewer crashes,
- 130 million CO2e of avoided carbon emissions,
- Over $10 billion in savings on road repair costs
- Over $11 billion in averted costs in traffic delays

Passenger mode shift

- Rail reforms, especially when paired with investment in high speed rail, has the potential to shift at least:
- 100 billion passenger-miles from flights to rail by 2050
- 300 billion passenger-miles from cars, trucks, and SUVs to rail by 2050

...For:

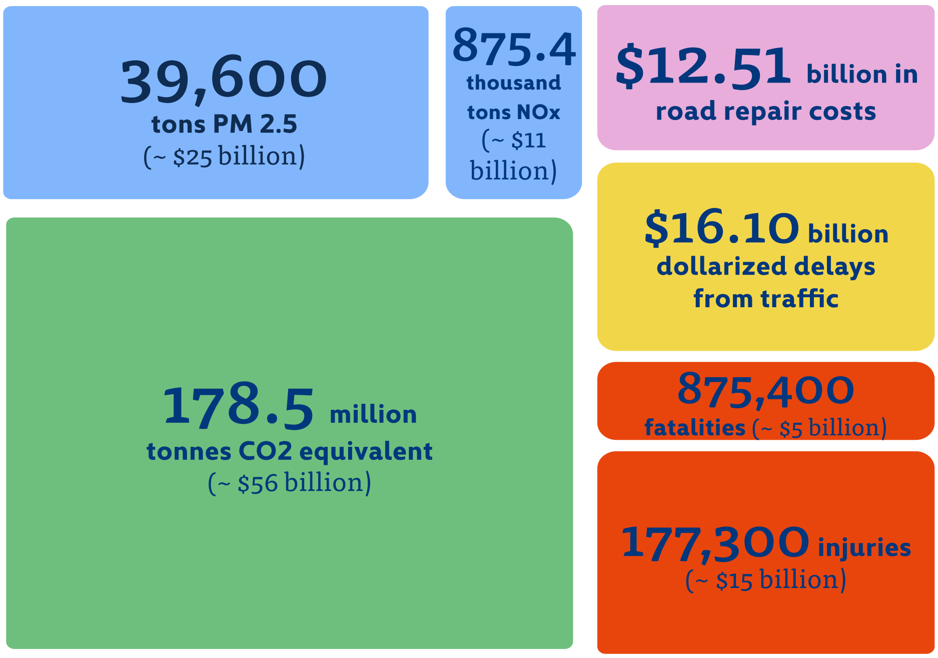
- An average of two thousand lives saved and 110 thousand injuries avoided from fewer crashes,
- 50 million CO2e of avoided carbon emissions,
- $2 billion in savings on road repair costs
- Nearly $6 billion in averted costs in traffic delays
- Substantially reduced radiative forcing from passenger flights. Radiative forcing is a phenomenon associated with air flight that contributes more to climate change than direct greenhouse gas emissions from flights.[114]

(every year)

114. Lee et al., "The Contribution of Global Aviation to Anthropogenic Climate Forcing for 2000 to 2018."

Benefits are realized at differential rates in the modeled scenarios, due to phasing-in of mode shift, electrification across modes, changing mix of freight commodities, and other dynamics captured within the models. In general, benefits will tend to increase over time as mode shift progresses. While the value of averted costs averages $140 billion over the forecast period, it will be higher toward the end of the period, reaching up to $190 billion in annual averted costs by 2050.

Figure IV-5. Annual average averted costs from mode shift to rail, 2025–2050



Boxes are sized by estimated dollarized value of averted costs.

Source: Author's analysis

Rail reform and modeshift has the potential to avert over $140 billiob annually in externalized costs over the next 25 years. Rail travel tends to generate far lower public health, fiscal, and environmental tolls than on-road transportation. When these costs are dollarized, the estimated averted costs from shifting truck and passenger vehicle trips to rail amount to over $140 billion annually, on average. By 2050, these savings could reach $190 billion annually. These are calculated by comparing the baseline and ambitious forecast scenarios.

While most externalized costs from transportation were accounted for to reach this estimate, some were left out—namely land use and ecological impacts, noise pollution, and nonemission climate impacts from air travel. While these are more difficult to quantify or have not been as studied in a US context, they also tend to be greater for on-road or air transportation than rail. Although these costs are not quantified here,they are significant. For example, nonemission radiative forcing from air travel—a phenomenon by which clouds formed from air travel trap heat in the atmosphere—has a greater climate impact than actual emissions from air flights.[115] The omission of these externalized costs means the estimates here do not capture the full extent of benefits realizable from increased use of rail relative to other modes.

115. Timperly, "Explainer."

116. NSC, "Costs of Motor-Vehicle Crashes."

DOLLARIZATION OF IMPACTS

While the estimated dollarized value from averted social costs is very substantial, it is also conservative. To move from social costs across these categories to dollarized values, one must convert costs across dissimilar categories—which include multiple forms of air pollution, deaths from traffic accidents, contributions to climate change, and others—into dollarized terms to serve as a common base of comparison. The Externality Analysis Appendix goes into further detail on the dollarization factors used to quantify these social costs, but they are also discussed here to contextualize the dollarized estimate and establish its conservatism for many of the averted social costs that are modeled.

To move from averted costs to their dollarized value, it's required to convert outputs from their own terms (for example, quantity of CO2e or crash injuries or fatalities) to dollars. Estimates from a variety of sources are used to put all externalities in dollarized terms, but these estimates are subject to assumptions that affect their value. The logic by which dollarized values are derived can be contentious and subject to debate. Multiple approaches to converting something to dollarized terms may be used and get drastically different results. For example, the National Safety Council gives two sets of estimates for dollarizing deaths and injuries from crashes: One focuses on wage and productivity losses, financial costs to the medical system, and other expenses and damages to property. This estimate gives a value of $1.87 million for a traffic death. Another estimate focuses on the cost that someone may be willing to pay to reduce their own risk of death, based on "empirical studies of what people actually pay to reduce their safety and health risks." This "comprehensive cost" of traffic deaths is seven times higher at $13.11 million.[116] Dollarization estimates for this report use the lower estimate, making estimates for the value of averted costs extremely conservative in this category.

Similarly, for climate pollution, the dollarized value used in this report is the social cost of carbon (SCC) from the EPA.[117] The SCC is the common approach to put climate pollution in dollarized terms, but it has serious problems.[118] Alternative approaches that could more adequately incorporate nonlinear impacts from climate change (which steeply escalate after 1.5°C of warming) and which recognize how climate change, particularly beyond 1.5°C, entail extreme negative impacts on economic growth and living standards, could result in different dollarized values of carbon emissions.[119] However, the high end of the estimated SCC is used in this report, which may mitigate these issues.

Finally, many impacts are not quantified and so are left out of dollarized estimates of benefits. In particular, noise pollution, land-use and ecological impacts, health impacts from VOCs (a form of air pollution), and radiative forcing from contrail and cloud formation from air flights are not quantified or included in dollarized estimates here. These additional benefits would further increase the value of mode shift.

CLIMATE NECESSITY

Current plans to decarbonize transportation within the US, particularly on a timeline consistent with even 2°C of warming are extremely tenuous, to the point of implausibility. Climate scientists repeatedly warn that even with the transition to EVs underway, we also have to reduce driving and LDV dependence in order to decarbonize personal transportation.[120] Meanwhile, pathways to decarbonized air travel and long-haul trucking depend on rapidly increased uptake of technologies that are still mostly undeveloped, unproven, and/or uneconomical.[121] Given the rapid pace of decarbonization needed; the outsized and growing share of emissions that come from transportation;[122] and the ease with which rail can be decarbonized with safe, proven, and easily deployed technologies (in contrast to trucking and air transportation), increasing freight and passenger transportation by rail is nearly certainly a necessity for decarbonization.

Achieving mode shifts in line with the ambitious forecast scenarios present a massive opportunity to make headway in decarbonizing this sector. On their own, the average annual emissions reductions from

117. Using a discount rate of 1.5% to yield an SCC of $340/tonne CO2e.

118. Stern et al., "A Social Cost of Carbon Consistent with a Net-Zero Climate Goal."

119. "A Social Cost of Carbon Consistent with a Net-Zero Climate Goal."

120. McDonald, "Blog"; Milovanoff, Posen, and MacLean, "Electrification of Light-Duty Vehicle Fleet Alone Will Not Meet Mitigation Targets"; de Blas et al., "The Limits of Transport Decarbonization under the Current Growth Paradigm."

121. DOE et al., "U.S. National Blueprint for Transportation Decarbonization"; Robbins, "Green Hydrogen."

122. McDonald, "Blog"; US Environmental Protection Agency, "Fast Facts on Transportation Greenhouse Gas Emissions."

mode shift to rail estimated here would **cut one-tenth from current sectoral emissions.**[123] By 2050, the total GHG emissions averted through mode shift to rail would reach nearly 5,000 MMT CO2e—equivalent to 2% of the world's remaining carbon budget to maintain a 50% chance of staying within 1.5°C of warming, as of 2023.[124]

MARGINAL BENEFITS AND TIMELINES OF AVERTED COSTS

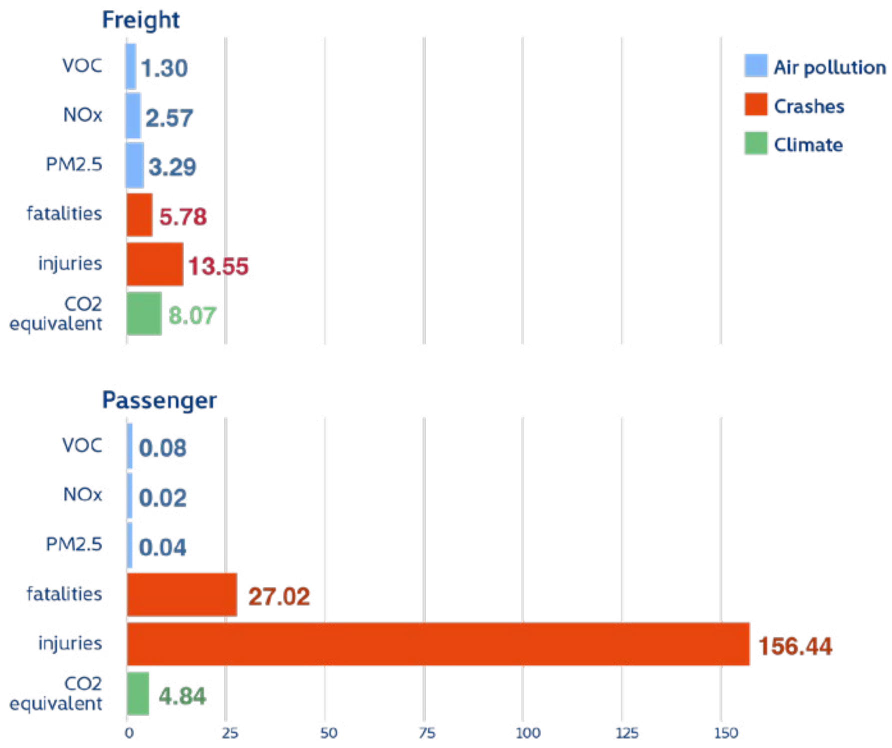
As noted, the models that generated the estimates cited here are detailed in this report's appendices. The figures below show the annual average of averted costs in the ambitious scenario over the next 25 years, marginal avoided costs from mode shift between trucks or LDVs to diesel rail, and timelines of averted costs by category for freight and passenger shift over the forecast period.

"By 2050, the total GHG emissions averted through mode shift to rail would reach nearly 5,000 MMT CO2e — equivalent to 2% of the world's remaining carbon budget to maintain a 50% chance of staying within 1.5°C of warming..."

123. US Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks."

124. Lamboll et al., "Assessing the Size and Uncertainty of Remaining Carbon Budgets."

Figure IV-6. Marginal averted costs from mode shift to rail.



Factor relative to diesel rail
Source: Author's analysis

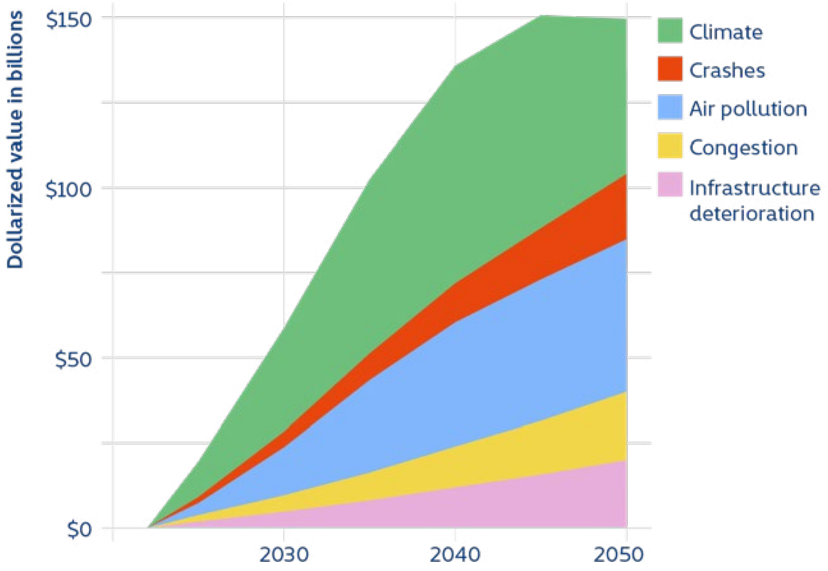
Air pollution, climate pollution & crash deaths and injuries by truck and LDV relative to rail per PMT or ton-mile freight. This chart shows externality generation by on-read transportation relative to diesel rail, per PMT or ton-mile freight. For example, to carry the same number of people the same distance, LDVs will generate nearly five times as much GHG emissions and generate nearly thirty times as many crash deaths relative to rail.

Passenger LDVs generate less non-GHG air pollution than diesel rail per PMT, although rail is more easily electrified. Even diesel rail generates fewer emissions per PMT than single-occupancy EVs, although this would change as electricity production is further decarbonized.[125] Aside from non-GHG air pollution, all examined external costs are orders of magnitude higher for on-road transportation relative to rail—five to eight times higher for carbon pollution and six to 160 times higher for crash deaths or injuries. This underscores the large scale of avoidable death and injury achievable with mode shift to safer modes of transportation.

These comparison factors are based on current average occupancies per vehicle. As rail mode share increases, occupancy per passenger train is likely to increase as well, which would reduce public health and environmental costs further relative to on-road transportation.

125. McGraw et al., An Update on Public Transportation's Impacts on Greenhouse Gas Emissions.

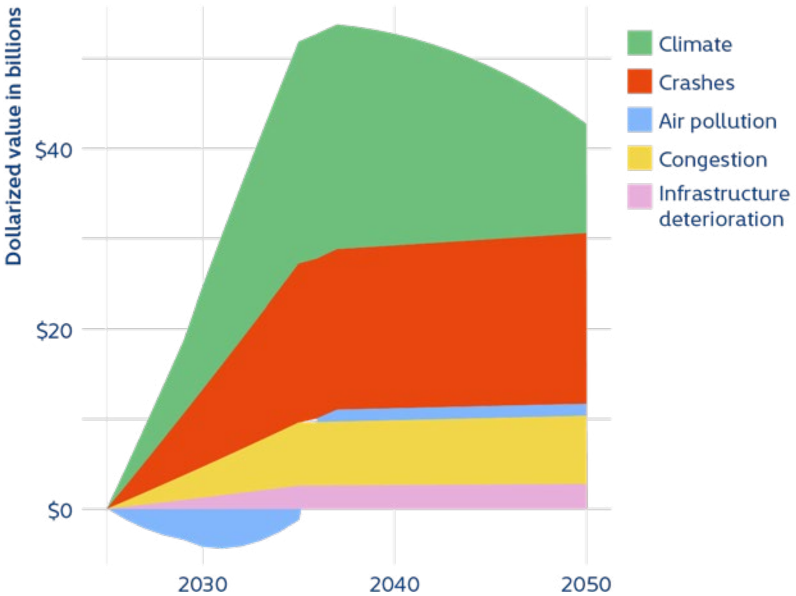
Figure IV-7. Timeline of averted costs from realizable freight mode shifts



Source: Author's analysis

Dollarized annual benefits from averted negative externalities from freight transportation only, ambitious reform scenario vs status quo. Timelines for electrification, mode shift, and the baseline forecasts from BTS and other government agencies affect how averted costs manifest over time. This figure shows how averted costs from freight mode shift break down by category and show up over time in the ambitious scenario.

Figure IV-8. Timeline of averted costs from realizable passenger mode shifts



Source: Author's analysis

Although similar to Figure IV-7, this shows a breakdown of averted costs from passenger mode shift rather than freight. While passenger rail is run on diesel, shifts from LDV trips to rail increase air pollution in the short term, until rail is electrified. All other cost categories substantially favor rail at all times. The climate benefits from shifting passenger trips to rail decrease as the LDV fleet is decarbonized, but they do not reach zero because some air travel is also shifted to rail in the ambitious scenario. Notably, rail can be electrified straightforwardly and rapidly, while the speed of LDV electrification is limited by fleet turnover and plans to decarbonize air travel face major hurdles, discussed in the appendix.

C. ECONOMIC BENEFITS

A large range of economic benefits are realizable from reform and increased investment in rail and mode shift. These would include:

- direct job creation from moving rail cars, laying tracks, and other investments;
- decreased costs for US industries, consumers, and governments;
- increased supply chain resiliency by increasing freight capacity and timeliness;
- Improved economic prospects for both large cities and small towns across the country by increasing economic integration between places, reducing traffic congestion, and spurring development.
- additional jobs indirectly created or induced from all of the above.

Rail reform, increased investment, and mode shift will directly create jobs in railroad transportation and construction. These will create additional jobs indirectly in supplier industries and through spending by newly hired workers. Due to cost differentials between shipping by truck and by rail, increased rail service and availability will bring down costs for US farmers and manufacturers, which would be passed onto consumers in many cases, or increase US export competitiveness in many others. In some major industries—particularly agriculture, which is one of the largest growth sectors for rail in reform scenarios—shipping comprises a substantial and potentially huge portion of costs: up to 40% for the cost of wheat, according to a recent federal study.[126] Transportation costs frequently account for about 10% for other commodities.[127] Reduced costs across industries broadly should therefore be anticipated with improvements in rail service due to lower costs associated with shipping by rail when reliable service is available.[128]

Increased rail service will not only save US businesses money but commuters as well. In the past few years, prices for both personal car ownership and shipping by truck increased massively, with costs for each increasing over 25% since 2020.[129] For US households, car ownership constitutes an immense expense, costing the average American 15%–20% of their total income every month.[130] On its own,

126. Peterson and Choe, "The Effects of Rail Prices on U.S. Agricultural Exports."

127. Rodrigue, Comtois, and Slack, The Geography Of Transport Systems.

128. As noted elsewhere, rail can tend to be three to five times cheaper than truck per ton-mile.

129. DePillis, Lieberman, and Chapman, "How the Costs of Car Ownership Add Up"; DOT and BTS, "National Transportation Statistics (NTS)"; St. Louis Federal Reserve Economic Data, "FRED." See NTS tables "Average Cost of Owning and Operating an Automobile" and "Average Freight Revenue per Ton-Mile" as well as FRED series PCU484484. Costs for rail transportation grew substantially less.

130. Wilson Kea, "How Car Ownership Is Keeping Americans from Financial Stability," Streetsblog USA, March 25, 2024, https://usa.streetsblog.org/2024/03/25/study-how-car-ownership-is-keeping-americans-from-financial-stability.

even ambitious reform that shifts 10% of LDV passenger-miles to rail is unlikely to reduce the need for car ownership for most Americans, but it is likely a necessary policy that, in conjunction with others, could reduce car dependence in the US and therefore help free many Americans from this financial burden.[131]

Governments are also slated to save money from mode shift to rail. Investment in highways and roads are major costs to the US public. The use of highways and roads, particularly by heavy freight trucks, contributes to rapid deterioration of these expensive assets. These costs are highlighted in the previous section as externalized costs—nearly $13 billion a year could be saved due to reduced highway wear and tear from mode shift to rail. Beyond this, averted traffic would not only reduce congestion but also the need for highway capacity expansions, which comprise additional major public costs and put the US transportation sector further off course for decarbonization.[132]

As it brings down prices and saves money for consumers, businesses and governments, railroad reform would also create jobs and spur economic growth through a variety of other channels. Many economic impact studies focus on jobs created from the direct building and operation of new rail lines as well as indirect and induced jobs stemming from input industries and new worker spending.[133] This is largely because established methodologies exist for these employment impacts that can easily be applied when operating budgets for new service or capital investments are known.[134]

However, the economic impacts of new rail lines tend to extend far beyond jobs associated with their mere construction and operation. Rail infrastructure can become essential assets for cities and places, allowing more people to move more efficiently, with less space committed to transportation infrastructure and fewer negative spillovers like traffic unsafety, noise, and air pollution, all of which harm surrounding neighborhoods both from public health and economic standpoints. Put another way, proximity to highways is a major disamenity in urban contexts—highways make living nearby less pleasant and less healthy and reduce the value of surrounding land. In contrast, proximity to transit contributes positively to the health and quality of life for those living nearby and increases the value of surrounding land.

131. Riofrancos et al., "Achieving Zero Emissions with More Mobility and Less Mining."

132. Georgetown Climate Center, "Issue Brief."

133. Mineta Transportation Institute, "The Economic and Environmental Potential of High-Speed Rail."

134. Bess and Ambargis, "Input-Output Models for Impact Analysis: Suggestions for Practitioners Using RIMS II Multipliers."

Passenger rail increases access to job markets, tourism potential, and increases a place's attractiveness for workers and businesses seeking to locate. A study of passenger rail expansion in the Hartford-Springfield region in Connecticut emphasizes how the region missed out on a large number of new jobs, particularly in economically impactful sectors like financial and professional services, due to its passenger rail access lagging behind the region's at large.[135] The subway in New York City is integral to how the city developed, and the subway's capacity to move far more people with far less space than on-road transportation is inseparable from the city's development.[136] Growing bodies of scholarship in urban economics and planning similarly stress how more spatially efficient modes of transportation (such as passenger rail), with smaller negative imprints on surrounding neighborhoods, are essential for regional and place-based economic growth by creating agglomeration economies, shortening commutes, attracting businesses and workers, increasing the desirability and development potential of surrounding land, and freeing up land committed to highway infrastructure for other development.[137] Again, all of these economic impacts can tend to be much larger than the construction and operation of rail lines themselves, although those impacts can receive a great deal of focus in economic impact studies due to the existence of established and transferrable methodologies for estimating them.

Although the potential economic benefits realizable from public rail ownership and other reforms are broad, this report provides estimates on the magnitudes across only a few categories, including job creation within the railroad sector and cost reductions for US industry. Methodological details on how these estimates were generated are provided in the appendices to this report. Many of the other, more place-based potential benefits highlighted above are not quantified as part of this report. Again, this means that total benefits from rail reform, investment, and increased service will be understated by quantitative estimates of impacts here, even while these alone are substantial.

135. AECOM, "The Economic Benefits of Regional Rail Investment in Metro Hartford-Springfield."

136. Mahler, "The Case for the Subway."

137. Glaeser, National Bureau of Economic Research, and Taubman Center for State and Local Government, Agglomeration Economics; Bartholomew and Ewing, "Hedonic Price Effects of Pedestrian- and Transit-Oriented Development"; Bolter and Robey, "Agglomeration Economies: A Literature Review."

COST REDUCTION, EXPORT COMPETITIVENESS, & ECONOMYWIDE JOB GROWTH

- Increasing rail service and frequency can save US shippers an estimated $400 billion annually by 2050 and $100 billion by 2030 (in real 2022 USD).
- Reduced shipping costs can bring down commodity prices. Shipping costs account for an estimated 10%–40% for many commodities, and shipping by rail tends to be three to five times cheaper per ton-mile than shipping by truck.
- Shipping costs tend to be passed onto household consumers and other businesses. Decreased shipping costs would therefore increase export competitiveness of US businesses and decrease costs for US businesses and the public.
- Due to multiplier effects, decreased costs could result in an estimated one million new US jobs by 2030 and four million new jobs by 2050.

Higher shipping costs tend to be passed onto consumers and producers reliant on input goods.[138] Domestic shipping prices impact US export competitiveness in key sectors like agriculture and comprise a major portion (up to 40%, according to a recent federal study) for major agricultural commodities like wheat.[139] In other sectors, transport costs frequently account for 10% of total product costs.[140] Based on the most recent data, shipping by truck tends to be over five times more expensive per ton-mile compared to rail, and truck transportation costs have also been more volatile and subject to inflationary pressures.[141] This cost differential has increased in recent years due to rapid price increases for truck freight; in prior years, trucks have been closer to three or four times more expensive per ton-mile relative to rail.[142]

However, as noted in section II.B, rail service is underprovided due to oligopolistic conditions in the industry and vastly unequal levels of subsidies between modes. As a result, substantially more freight moves by truck than by rail currently, despite the lower financial and economic costs of rail.[143]

Additionally, major reforms including public rail ownership are likely

138. Carriere-Swallow et al., "Shipping Costs and Inflation."

139. Peterson and Choe, "The Effects of Rail Prices on U.S. Agricultural Exports."

140. Rodrigue, Comtois, and Slack, The Geography Of Transport Systems.

141. DOT and BTS, "National Transportation Statistics (NTS)."

142. Austin, "Pricing Freight Transport to Account for External Costs"; DOT and BTS, "National Transportation Statistics (NTS)."

143. BTS, "Freight Analysis Framework"; DOT and BTS, "National Transportation Statistics (NTS)."

to decrease rail shipping prices further for many routes. The current market structure, characterized by large monopolistic or oligopolistic railroads, a fragmented rail network, underinvestment in workforce and infrastructure, and declining frequency and reliability of service increase the cost of shipping by rail relative to what could be achieved in different institutional structures.

Applying current price differentials by ton-mile to total ton-miles of freight by mode across scenarios yields estimates of total cost savings accruing to US businesses and consumers over time. These are shown in Figure IV-9. By 2030, the US economy could be saving in real 2022 US dollars $100 billion in shipping costs per year, $240 billion by 2040, and $400 billion by 2050. For context, many estimates for the total fiscal cost of the IRA are at around $100 billion per year—meaning that averted costs from freight shift alone could pay the costs of the IRA by 2030.[144]

The approach used to move from reform scenarios to realizable averted shipping costs does have uncertainty but is likely conservative. While rail's cost advantage could be eroded by entry into higher-cost markets, many other factors could help rail maintain its cost advantage, including equalization of subsidies by mode, price reductions from ending private oligopolies, efficiencies from integrated rail operation, and increasing costs for trucking from decarbonizing truck freight.

Investments in rail infrastructure and electrification have the potential to decrease operating costs for rail and allow prices relative to trucks to fall further.[145] Rail electrification will allow the mode of transportation to decarbonize with the grid, and it is possible with technology that's already been proven and in use around the world for over one hundred years. In contrast, decarbonization of trucks would require new technologies that are still not economically or technically feasible for long-haul trucking.[146] Long recharge times for battery-electric trucks could also increase shipping costs for trucking. In short, decarbonization of rail is slated to reduce costs relative to trucks further, and decarbonization of trucks will pose new costs and bring the industry to major, unresolved challenges.

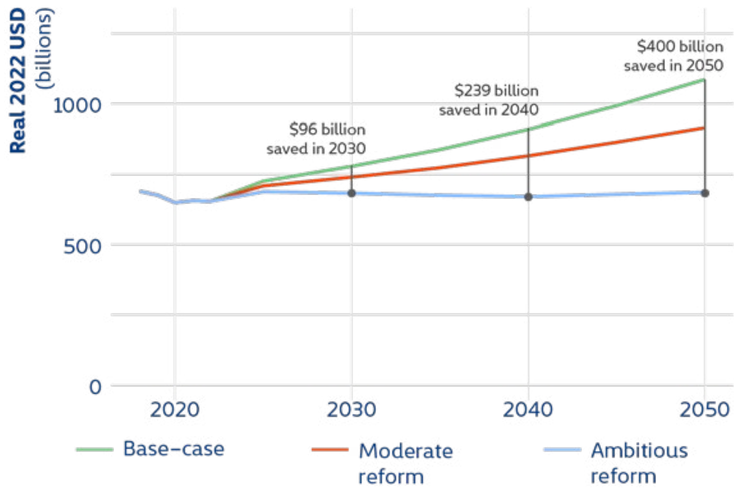
144. Levinson et al., "The Inflation Reduction Act's Benefits and Costs."

145. Moyer and Mazza, Solutionary Rail.

146. Lowell, Culkin, and M.J. Bradley & Associates, "Medium- & Heavy-Duty Vehicles: Market Structure, Environmental Impact, and EV Readiness"; Maynard, "The Challenge of Decarbonizing Long-Haul Trucking."

Averted shipping costs will also have multiplier effects. As costs are decreased for products in competitive industrial sectors, they will tend to either be passed on to domestic US consumers for products consumed domestically or increase US export competitiveness (and help increase investment and market share) for export-oriented US industries. Increased US market share in export industries would add jobs and GDP as businesses in those industries invest and expand their workforce to meet demand. Decreased consumer prices would raise real household incomes relative to higher-cost scenarios and induce jobs through increased household spending.[147]

Figure IV-9. Shipping costs across forecast scenarios



Source: Author's analysis

Shipping freight by rail tends to have lower costs per ton-mile when service is available and reliable. Increasing rail's freight mode share relative to the baseline forecast therefore has the potential to reduce costs for goods throughout the economy. This figure shows how those savings are estimated to increase over time across freight forecast scenarios.

It is difficult to assess how cost savings from decreased shipping costs would break down between households and business reinvestments, but the impacts would be substantial due to the large scale of realizable savings. Under the assumption that 100% of averted shipping costs accrue to households, cost savings by 2030 would result in roughly a million new jobs and $200 billion in increased GDP as a result of multiplier effects.[148] These impacts grow linearly in the IMPLAN model, meaning that estimated new jobs and added GDP would quadruple by 2050, when shipping costs across the economy are reduced by an estimated $400 billion in 2022 USD. Alternate assumptions about how cost savings are passed onto consumers or result in increased output

147. Households would be able to buy more goods due to their higher real incomes, increasing demand and spurring employment across a range of industries.

148. IMPLAN.

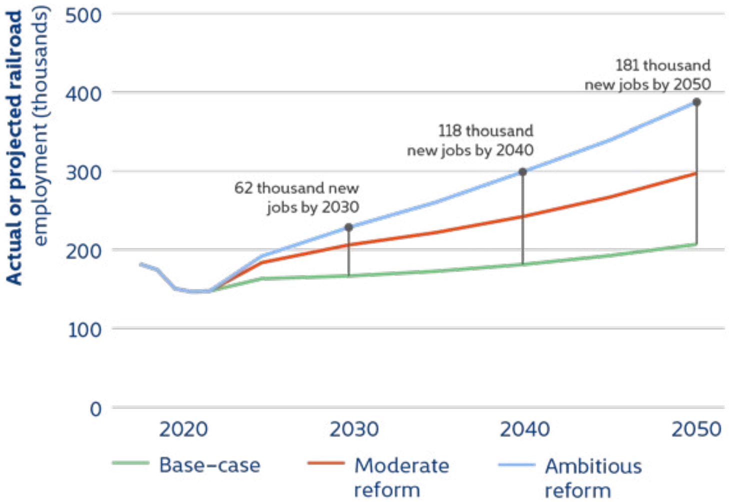
and investment by export industries are not likely to significantly diminish the scale of these benefits because industry reinvestment would also create jobs.

149. St. Louis Federal Reserve Economic Data, "FRED." Series CES4348200001.

RAILROAD INDUSTRY JOB CREATION

All forecast scenarios show increased employment in the railroad sector, but that growth is much larger in the reform scenarios relative to the baseline scenario. Based on increases in freight mode share across reform scenarios, railroad employment is forecasted to increase by 60 thousand by 2030, 120 thousand by 2040, and 180 thousand by 2050 relative to the baseline scenario. Figure IV-10 shows how jobs in railroad employment can be expected over time across scenarios. Appendix VI.A discusses how jobs in the railroad sector are modeled based on forecast scenarios, historical data, and industry trends. If PSR practices around reduced workforce continue to intensify, railroad sectoral employment could be lower in the baseline scenario than modeled here.

Figure IV-10. Railroad jobs across reform scenarios over time



Source: Author's analysis

There are currently 153 thousand workers in railroad transportation in the US. The ambitious reform scenario would see railroad workforce growth of over 150% by 2050, while the baseline scenario sees growth of only 35% (Figure IV-10). The dramatic growth in sectoral employment associated with the ambitious reform scenario may seem dramatic, but similar rates of change have occurred in the recent past, although always in the direction of decline rather than increase.[149]

V. CONCLUSION

Since the Staggers Act of 1980 and the Rail Passenger Service Act of 1970, which built the current regulatory regime for the railroad industry, the Class 1 railroad network has nearly halved in terms of mileage. Across measures, volumes and market share for freight rail have been in decline for decades, while passenger mode share is within a rounding error of 0%. Employment is also falling and, with it, the rail system's resiliency. Shippers dependent on rail have testified to Congress that service "is the worst that it has ever been,"[150] and accusations of railroader collusion from shippers have been mounting, with hundreds of rail shippers represented among the plaintiffs of various lawsuits.

Private railroads in the US are required by law to give preference to Amtrak over their own trains. But enforcement of this rule is so slim that numerous Amtrak lines still have 50%–80% of their trains failing to meet on-time performance standards.[151] Shortly before the law was put into effect, railroads began shedding assets that could have helped them accommodate more passenger traffic alongside freight, and this shedding of assets continues still.[152] Patterns of recalcitrance by private railroads against improved or expanded passenger service is another example of private railroads refusing all but the most profitable customers.

All of this extends in a textbook manner from monopolistic or oligopolistic market conditions. Oligopolistic industries, particularly in the absence of effective and enforced regulations, will tend to collude to control prices; decrease service to accept only the most profitable customers; and scale back investment, employment, and capacity to accommodate the strategy pursuing only the highest margin customers.

"While some financial metrics, such as operating ratios or asset utilization rates, can be used to argue that this is a form of efficiency, it is also a form of attrition."

While some financial metrics, such as operating ratios or asset utilization rates, can be used to

150. National Stone Sand and Gravel Association, "National Stone, Sand and Gravel Association Comments on Urgent Issues in Freight Service."

151. Green and Miller, "Examining the Effects of Precision Scheduled Railroading on Intercity Passenger and High-Speed Rail Service."

152. Green and Miller.

of efficiency, it is also a form of attrition. In light of the incipient, rapid decline of coal freight—on which private railroads' current strategy has made them largely dependent—the industry is poised for further, less controlled decline, which may soon reach the point of crisis for the sector. In this context, even private management consulting firms are advocating for the industry to pivot from a focus on margins to a focus on growth.[153]

153. Schabas and Bailey, "The Path To Long-Term Shareholder Value For Rail Is Growth."

However, the fundamental pattern of decline and disinvestment is created by the structure of the industry, which is characterized by a set of sprawling, underregulated oligopolies. Definitively reversing this pattern will therefore require changing the governing conditions of the industry. Shifting to public rail ownership and operation and revising the levels of subsidies received by different modes of transportation promise to be the most direct, effective, and decisive paths to reorienting railroads from poor service but high profits to growth, reliability, and resilience.

While increasing competition, as through a vertically separated railroad system, may seem to be an intuitive solution to the oligopolistic conditions that currently characterize the sector, international precedents and empirical research caution against this approach. The UK system of vertical separation, which created systems of franchises and open access, increased the system's reliance on public subsidies while also increasing costs for rail users. In general, fragmentation of rail systems tends to increase complexity and reduce transparency: hindering efforts to modernize, obscuring responsibility when things go poorly, and inducing economic and financial costs. Meanwhile, examples of effective publicly operated rail systems abound, and publicly owned and operated lines in the US, where they do exist, have shown impressive success.

It is not only, or even primarily, shippers and railroad employees who suffer under the current structure of the industry. Alternative modes of transportation, for both freight and passenger service, tend to be more expensive for users and induce far higher costs on the public. For freight, rail tends to be three to five times cheaper per ton-mile compared to trucking. Trucking generates eight times as much GHG pollution, kills six times as many people in crashes, injures fourteen times as many people, and generates three times as much noncarbon air pollution for moving the same tonnage the same distance. Trucking also creates congestion on roads and highways and contributes to their deterioration. These large costs of time, money, and shortened lifespans are offloaded from the trucking industry onto others. For passenger travel, movement by cars, pickups, or SUVs causes twenty-seven times more deaths and 160 times more injuries from crashes relative to diesel rail and creates five times as much GHG pollution for moving the same number of people the same distance. Air travel generates five to six times more carbon pollution than diesel rail per PMT while also contributing substantially to climate change through other, nonemission effects. While rail is already more climate friendly than these other modes of transportation when powered by diesel fuel, it is also far easier to decarbonize entirely.

Meanwhile, cost savings from shipping would help consumers, reduce prices, and improve US export competitiveness for key sectors. Shipping is a substantial portion of costs, often accounting for 10% of product prices, but this share is estimated to reach as high as 40% for some agricultural commodities.[154] Given that rail can achieve much higher levels of cost effectiveness compared to trucking—even while trucking is currently so highly subsidized in comparison to rail—increasing the coverage and quality of rail service is a potentially enormously powerful lever to reduce costs for US businesses and prices for US consumers.

This report models moderate and ambitious mode shift scenarios to estimate realizable benefits from shifting passenger and freight traffic to rail. These can amount to an estimated $190 billion in averted externalized costs by 2050, or an annual average of $140 billion over the next 25 five years. The potential financial cost savings from more efficient shipping are even greater, with the potential to reach $400 billion annual savings across the economy by 2050. Total financial and economic benefits would then be nearly $600 billion—in real 2022 USD annually—by 2050.

"Total financial and economic benefits would then be nearly $600 billion—in real 2022 USD annually—by 2050."

154. Peterson and Choe, "The Effects of Rail Prices on U.S. Agricultural Exports."

The fragmented regional duopolies currently characterizing the railroad industry have created the conditions for the industry's current high profits but atrophied service, safety, and capacity. US businesses, consumers, and the country at large suffer for it.

Railroads are an incredibly safe, effective, and efficient mode of transportation for both freight and passengers. They can serve major public good when they are treated as such—connecting communities to one another, connecting workers to job markets, and connecting productive centers with places to sell their products. Railroads can move people and goods far more quickly and efficiently than other modes of transportation, whether measured in financial, spatial, social, or environmental terms. Public ownership, public investment, and public management of railroads for the public interest would promise to create massive value for the US economy; bring us toward decarbonization; save thousands of lives a year through avoided crashes; and deliver a multitude of other economic, social, and environmental benefits.

VI. METHODOLOGICAL APPENDICES

A. MODE SHIFT & ELECTRIFICATION FORECAST SCENARIOS

To estimate mode shift potentials (and economic and other benefits from mode shift), this report creates three forecast scenarios for mode shift for both passenger and freight transportation. The construction of these forecast scenarios is discussed in this appendix.

THREE SCENARIOS FOR FREIGHT TRANSPORTATION

The BTS provides a forecast of freight volumes by mode, commodity, and origin-destination pair by FAF zone in the FAF database.[155] Figure VI-2 shows how freight volume by mode changes in the BTS forecasts that comprise the baseline scenario. In this scenario, shipped volumes increase for all relatively substitutable modes (rail, truck, and domestic waterway) at differential rates, with growth in truck freight growing faster than rail and water. This means that the baseline scenario entails rail's market share continuing to decline over the next decades.

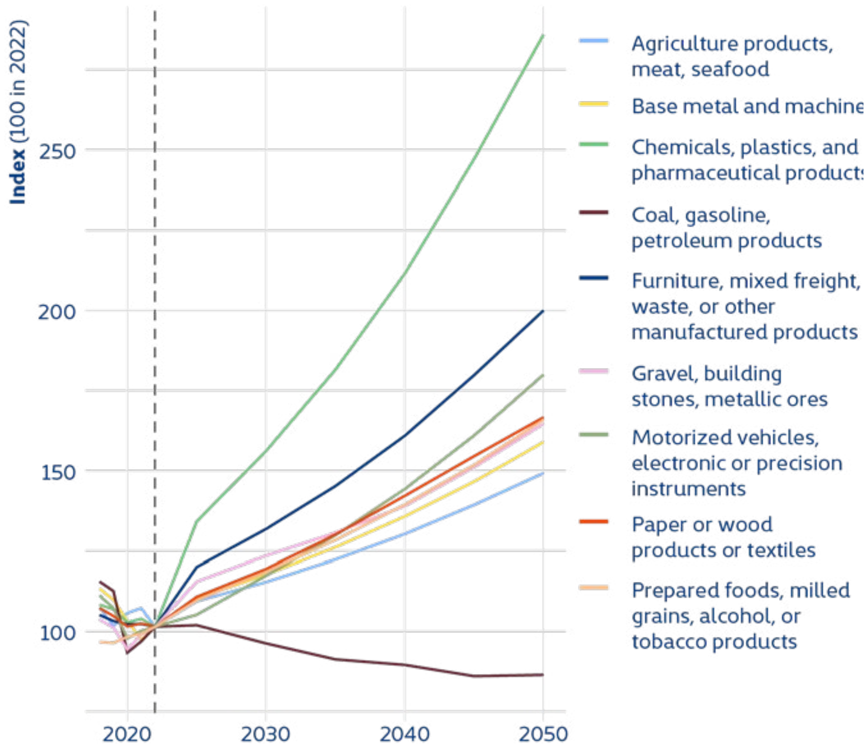
Both freight forecast scenarios are parameterized based on historical trends in freight mode shares. However, historical data is not available for all commodities; higher-quality data on freight volume by mode only goes further back for agricultural freight by tonnage. But agricultural goods are both a major market for freight and a major potential growth sector for rail, so trends in this commodity group are used to inform modeling across commodities.

In particular, growth rates in rail volume are projected across commodities such that agricultural freight would return to 1990 levels by 2050 (the decline of the last thirty years reverses over the following thirty) for the moderate reform scenario, while the ambitious reform scenario uses growth rates that would reverse rail's decline and transfer nearly all growth in agricultural freight by truck over that same period to rail. These growth rates are relative to the baseline BTS FAF

155. BTS, "Freight Analysis Framework."

forecast. Change by mode is phased in linearly over the forecast period, although growth in ton-miles does not change linearly because the mix of commodities is also changing over time in the baseline forecast.

Figure VI-1. Change in freight volume by commodity group in baseline forecasts



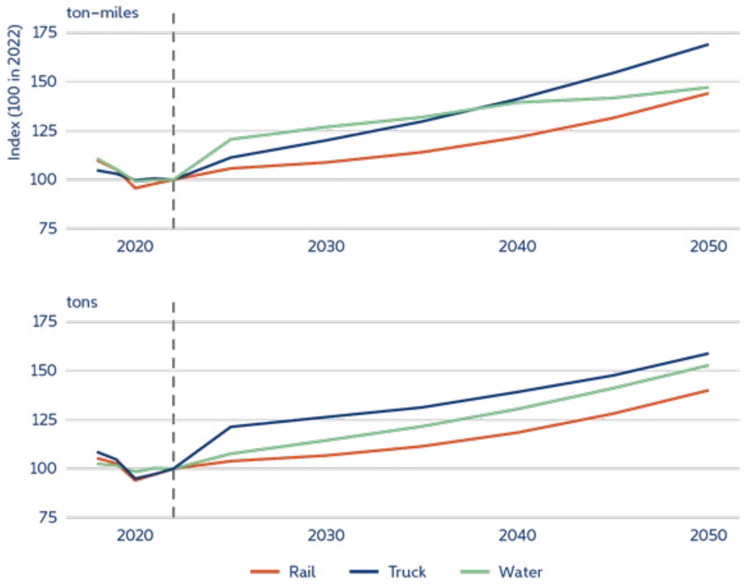
Relative ton-miles shipped by SCTG commodity group in Bureau of Transportation Statistics forecast
Source: BTS FAF 5.5.1, Author's analysis.

Coal and fossil fuel freight is expected to decline relative to other commodity groups. Relative ton-miles shipped by SCTG commodity group in Bureau of Transportation Statistics forecasts. Coal and fossil fuel freight is expected to decline relative to other commodity groups.

These rates of growth or decrease are applied across commodities so that commodities that currently are shipped by rail in low volumes see smaller growth in ton-miles. This is important because the current levels shipped by each mode act as proxies for the relative suitability of different commodities for different freight modes. This means that total growth in rail ton-miles by commodity is relative to current levels for the given commodity in both reform forecast scenarios.

Ton-mile growth in rail by commodity is paired with subtractions in ton-miles by truck. In the event that ton-mileage by truck reaches 0, then ton-miles by inland waterways are transferred to rail so that ton-mileage by mode and commodity is always nonnegative. Air and pipeline are not treated as substitutable with these other modes, and ton-mileage freight by these modes are static across forecast scenarios. Pipeline and air and "other" modes of freight transportation are therefore omitted from plots summarizing forecast scenarios, and freight mode share percentages refer to ton-miles for truck, rail, and water only.

Figure VI-2. Freight volume by mode in baseline forecasts



Ton-miles and tonnage freight by mode relative to 2022, actuals and BTS forecasts
Source: BTS FAF 5.5.1, actuals and forecasts.

Baseline forecasts from the Bureau of Transportation Statistics show truck freight continuing to grow at a faster rate than rail into the future.

Comparison with other forecast scenarios

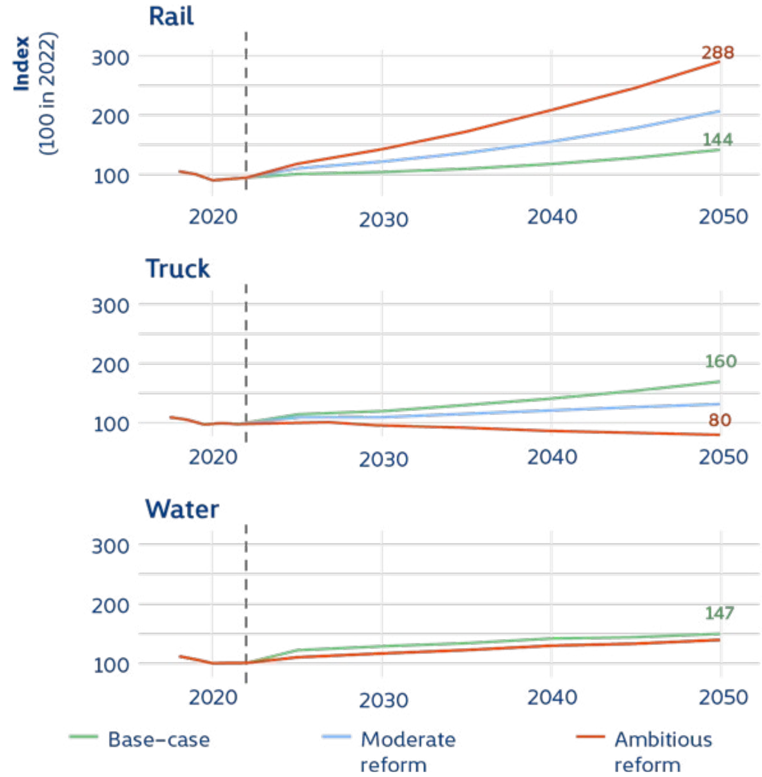
Figure VI-3 and Figure VI-4 respectively show how the scenarios differ in terms of ton-miles by mode relative to 2022 levels and modal split by decade over the forecast period. By 2030, the moderate reform scenario results in a 20% increase in ton-miles by rail, relative to an 8% increase in the baseline forecast scenario, or a 31% increase in revenues in the "mode shift" scenario presented by Oliver Wyman analysis.[156] The moderate scenario also sees a swing of four percentage points from truck to rail by 2030 (comparable to the mode shift potential estimated from Argonne National Laboratory[157]) and a larger swing of about thirteen percentage points by 2050, relative to the base case in that year.

156. Schabas and Bailey, "The Path To Long-Term Shareholder Value For Rail Is Growth."

157. Zhou, Vyas, and Guo, "An Evaluation of the Potential for Shifting of Freight from Truck to Rail and Its Impacts on Energy Use and GHG Emissions."

Given that the Argonne study does not assume any shifts in institutional structures and the Oliver Wyman analysis only assumes a change in managerial strategy for railroads, these comparisons indicate that the moderate mode shift scenario here is, in fact, quite moderate—and deep reforms and rebalanced subsidies across modes would very likely achieve more than what is estimated in this scenario.

Figure VI-3. Freight volume relative change by mode across scenarios



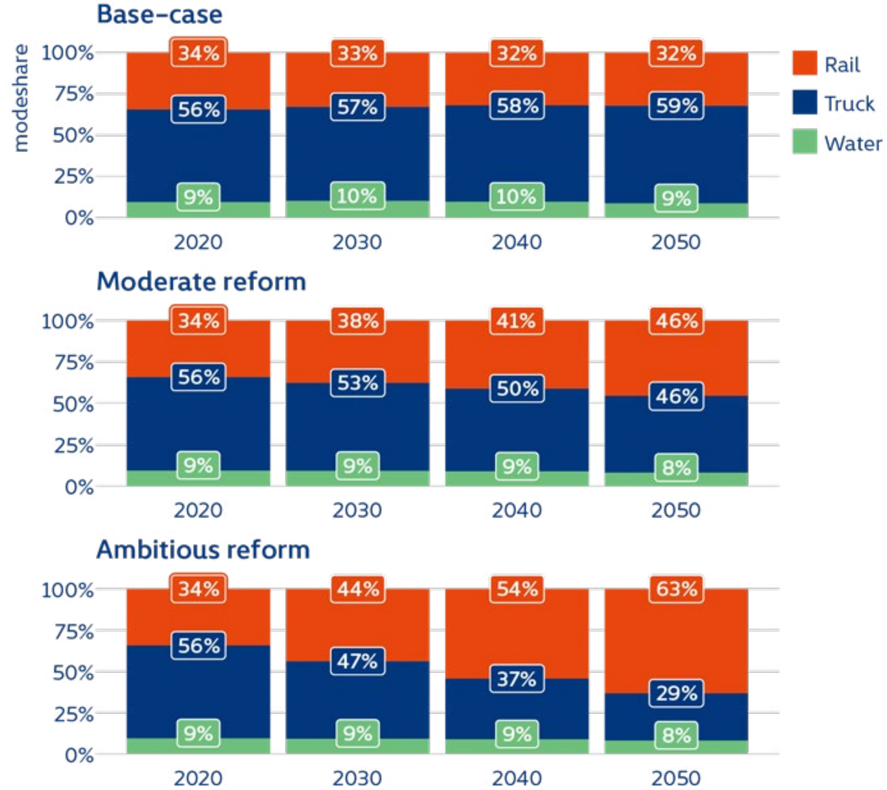
Relative ton-miles shipped by mode, across three forecast scenarios

Source: BTS FAF 5.5.1, Author's analysis

The ambitious scenario can reflect most significant institutional changes to deliver greater mode shifts to rail. As noted, the ambitious scenario also has freight modal shares shifting such that gains that had accrued to trucks over the last thirty years is also shifted to rail over the following thirty years. Again, the results of this scenario alongside the moderate and baseline scenarios are shown in Figure VI-3 and Figure VI-4. Unlike the moderate scenario, total volumes shipped by truck decline over time in this ambitious scenario, and some freight is also shifted from water to rail. Total ton-miles by rail nearly triples by 2050 in this scenario, compared to 44% growth in the baseline scenario. The shift in ton-miles results in more substantial swings in mode shift: by over 10 percentage points by 2030 compared to the base case and by over 30 percentage points by 2050. As shown in Figure VI-4, this results in a mode share of 63% of all freight moved by rail by 2050 and 29% moved by truck—roughly reversing the splits between these modes in this year in the baseline scenario. This mode share for rail is in line with levels seen currently in countries that lead in freight modal share by rail; is it also comparable to the goal in the EU to move 50% of freight by rail by 2050.[158]

158. International Union Of Railways, "The Modal Share of Rail in Inland Transport and Infrastructure Investment"; McKinsey, "Bold Moves to Boost European Rail Freight."

Figure VI-4. Freight mode share by scenario



Source: FAF 5.5.1; Author's analysis.

Allocating multimodal freight within the Freight Analysis Framework

The Freight Analysis Framework (FAF) database from BTS provides the baseline forecast from which all forecast scenarios are constructed and is otherwise drawn on throughout this report. FAF data has "Multiple modes & mail" as a category for freight movement that comprises a substantial portion of total ton-miles moved: With air and pipeline freight excluded, rail accounts for 24% of freight by ton-miles; trucks account for 55%, water accounts for just under 9%; and multimodal freight accounts for 13%.[159]

To model ton-miles by mode across the forecast scenarios it was necessary to allocate the "multiple modes" category. Comparisons with BTS National Transportation Statistics (NTS) tables provided basis for this allocation.[160] Total ton-miles by years for which both datasets are complete (2018-2021) are within 1-2% of one another. Allocation factors were therefore derived from comparison between the two datasets that could attribute ton-mileage by "multiple modes & mail" in FAF across other modes and ton-mileage by mode would roughly match reported totals in the NTS table 1-50. These allocation factors are then used in forecast years as well to allocate freight by multiple modes & mail across rail, air, truck, and water. Specifically, 90% of ton-mileage by "multiple modes & mail" were allocated to rail; 5% were allocated to truck; 4% to water; and 1% to air. The high proportion of ton-mileage by rail for multimodal shipping also highlights the importance of this market segment for rail freight.

ELECTRIFICATION AND DECARBONIZATION TIMELINES

For rail (both freight and passenger), trucks, and passenger LDVs, forecast scenarios include fleet electrification and decarbonization parameters that affect GHG emissions and air pollution over time. Different electrification timelines are used for different modes, and rail electrification timelines vary between baseline and reform scenarios.

On-road electrification. LDV electrification timelines are from a fleet turnover and electrification model from researchers from University of California, Davis and the Climate and Community Project.[161] No forecasts for truck decarbonization over time were found, but one estimate from McKinsey anticipated that 75% of trucks would be decarbonized by 2050.[162] The LDV electrification timeline was therefore scaled by 75% to approximate a truck electrification timeline. Notably, both timelines are informed by policy goals and are not guaranteed to be achieved. In fact, given that less than 1% of trucks currently are electric and a number of technical and economic obstacles to truck electrification are still unresolved, the decarbonization timelines for on-road transportation, especially for trucks, are likely faster than what

159. "Other" also comprises less than 0.2%. Totals may not sum due to rounding.

160. DOT and BTS, "National Transportation Statistics (NTS)."

161. Riofrancos et al., "Achieving Zero Emissions with More Mobility and Less Mining."

162. Breiter, "Powering the Transition to Zero-Emission Trucks through Infrastructure."

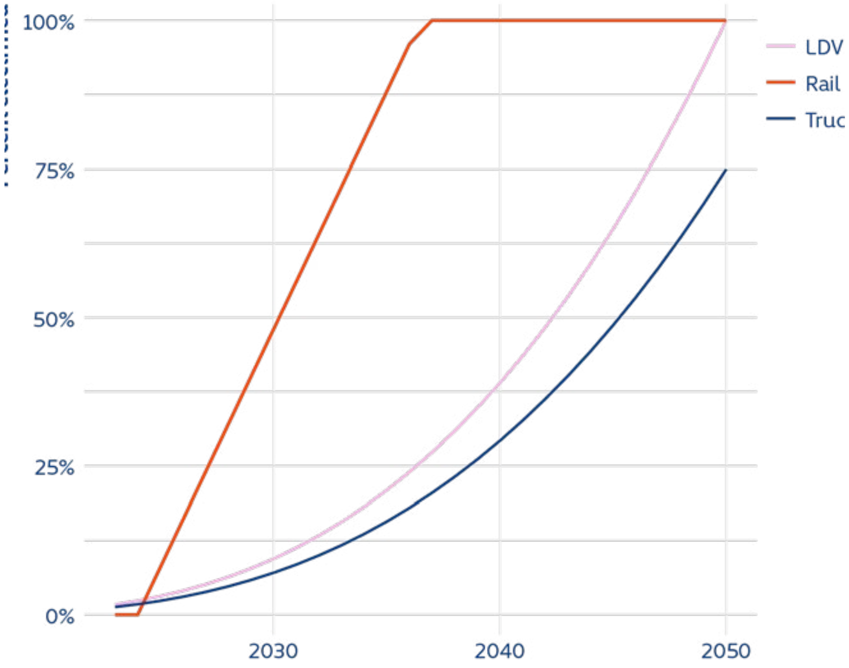
will actually be achieved. This reflects a conservative assumption from the perspective of estimating benefits from averted air and carbon pollution from mode shift to rail.

Rail electrification. Historic trends in countries that moved to electrify their rail networks on ambitious timelines were used in the reform scenarios, while rail remained unelectrified and diesel-powered in baseline scenarios. India electrified roughly 8% of its total rail network year after year from 2016–2022.[163] Other countries increased electrification by similar proportions within a single year but did not maintain the trend year after year. The electrification rate of 8% per year, an ambitious but precedented rate, is used to project rail electrification in the reform forecast scenarios. Electrification begins in 2025 in these scenarios. Because private railroad owners have not made progress electrifying their networks, rail electrification is left at 0% in the baseline scenarios.[164]

163. OECD, "OECD Data Explorer."

164. Notably, where electrified rail does exist in the United States, it is in publicly owned rail corridors like the Northeast Corridor.

Figure VI-5. Electrification timelines by mode, reform scenarios



Source: Climate + Community Project, "Achieving Zero Emissions with More Mobility and Less Mining"; OECD ITF indicators; McKinsey, "Powering the transition to zero-emission trucks through infrastructure"; Author's analysis.

In the reform forecast scenarios, electrification timelines by mode were used as shown below. In the baseline scenario, trucks and LDVs are decarbonized on the same timeline as in the reform scenarios, but rail remains at 0% throughout the forecast period to reflect a continuation of the current lack of plans or progress in electrifying rail.

Air decarbonization. No forecasts or timelines for air travel electrification or decarbonization were found. Extant strategies to eliminate emissions from air travel remain controversial and may not actually reduce emissions, and efforts to implement them have not even begun in the US.[165] The share of decarbonized air travel was therefore left at 0% over time for all forecast scenarios.

The timeline for electrification by mode is shown in Figure VI 5.

B. EXTERNALITY ANALYSIS

Rates of externality generation by ton-mile or passenger-mile were gathered across sources and put into standard units. Estimates were benchmarked against one another when multiple estimates were found to verify the realism of estimates. Some sources for benchmarks were estimated for other countries; other times, multiple estimates in a US context were compared, with one estimate selected based primarily on the methodology underlying the source. The "Handbook on the External Costs of Transport," released by the EU Commission, was used to benchmark and assess estimates in the US context, although only estimates formulated in a US context are used in modeling.[166]

Often different federal agencies had slightly varying estimates for the US context, in which case decisions were made based on the methodology of each source, how recent it was, and how estimates compared to additional outside estimates. Notably, the lower-end estimates for truck-based negative externalities were often used. For example, air pollution factors from the US Environmental Protection Agency's (EPA) SmartWay Shipper tool were used, which suggested that trucks are significantly less polluting than was found in a 2011 GAO report on the externalized costs of freight. The EPA source was used because it was a more recent estimate and provided more detail on methodology and types of pollution generated.[167]

For on-road transportation, PM2.5—an important form of air pollution from a public health standpoint—can come from exhaust and the burning of fossil fuels (especially diesel), but it can also come from deterioration of road, tires, and brakes. Non-exhaust sources of on-road PM2.5 exceed emissions from exhaust, according to available estimates.[168] For PM2.5 for electric heavy-duty trucks, PM2.5 emissions

165. Most stated pathways for air travel decarbonization rely on biofuels. Production of biofuels for aviation has not yet begun in the US, and biofuels have negative climate impacts through land use and energy requirements. Airplanes running on biofuels still contribute to warming through nonemission radiative forcing. For a study on the negative climate impacts of biofuel production through land-use requirements, see Lark et al., "Environmental Outcomes of the US Renewable Fuel Standard."

166. European Commission, Directorate General for Mobility and Transport, and CE Delft., Handbook on the External Costs of Transport.

167. US EPA, "2023 SmartWay Online Shipper Tool: Technical Documentation"; GAO, "Surface Freight Transportation: A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments That Are Not Passed on to Consumers."

are scaled to 75% of diesel heavy-duty trucks, based on the modeled breakdown from the National Renewable Energy Laboratory, which estimates about one-quarter of heavy-duty truck PM2.5 emissions are from exhaust, while the remaining proportion is due to tire and brake wear.[169] The PM2.5 emission factor for electric LDVs is kept the same as combustion-engine LDVs, based on research that PM2.5 emissions may either increase or decrease with electrification due to factors like vehicle weight and size but will not be eliminated.[170]

The externality generation factors by mode are shown in Table VI-1 below. The source for each estimate is provided in the footnote each time it appears for the first time. For example, the same injury and fatality rates are used for the decarbonized and fossil fuel equivalents of each mode, so the source is not included when the same estimate appears twice.

Dollarization factors

A discussion of the dollarization factors used are in the body of the report. Table VI-2 – Dollarization factors shows all factors used and their source. The SCC estimated by the EPA using a near-term discount rate of 1.5% is used. The dollarized value of injuries and fatalities from transportation crashes and accidents is taken from the National Safety Council, using "economic costs" rather than "comprehensive costs," which are much higher. This means the approach to dollarizing costs of lost lives and serious injuries from traffic crashes is a conservative one.

Finally, although potential averted emissions of VOCs are calculated, averted VOCs are not dollarized, because their health impacts can vary widely, and are therefore not included in many summaries of benefits from mode shift.

168. Fussell et al., "A Review of Road Traffic-Derived Non-Exhaust Particles."

169. Ravi et al., "LA100 Equity Strategies. Chapter 11."

Table VI-1. Marginal externalities factors

TRANSPORTATION CATEGORY	MODE	DECARBONIZED	EXTERNALITY CATEGORY	EXTERNALITY	MARGINAL GENERATION	UNIT PER ONE MILLION TON-MILES OR PASSENGER-MILES
Freight	Rail	F	Climate	CO2 equivalent	21.2296[171]	tonnes co2 equivalent
		F	Crashes	Injuries	4.98E-03[172]	injuries
		F	Crashes	Fatalities	3.67E-04[173]	fatalities
		F	Air Pollution	PM2.5	0.009038953[174]	tons
		F	Air Pollution	NOx	0.3193396[175]	tons
		F	Air Pollution	VOC	0.01102311[176]	tons
		F	Congestion	Traffic congestion	0	dollars
		F	Infrastructure deterioration	Infrastructure deterioration	0	dollars
		T	Climate	CO2 equivalent	0	tonnes co2 equivalent
		T	Crashes	Injuries	4.98-E-03	injuries
		T	Crashes	Fatalities	3.67E-04	fatalities
		T	Air Pollution	PM2.5	0	tons
		T	Air Pollution	NOx	0	tons
		T	Air Pollution	VOC	0	tons
		T	Congestion	Traffic congestion	0	dollars
		T	Infrastructure deterioration	Infrastructure deterioration	0	dollars

170. OECD, “The Implications of Electric Vehicle Uptake for Non-Exhaust Emissions.”

171. US EPA, “GHG Emission Factors Hub.”

172. DOT and BTS, “National Transportation Statistics (NTS).”

173. DOT and BTS.

174. US EPA, “2023 SmartWay Online Shipper Tool: Technical Documentation.”

175. US EPA.

Table VI-1. Marginal externalities factors (cont'd)

TRANSPORTATION CATEGORY	MODE	DECARBONIZED	EXTERNALITY CATEGORY	EXTERNALITY	MARGINAL GENERATION	UNIT PER ONE MILLION TON-MILES OR PASSENGER-MILES
Freight	Truck	F	Climate	CO2 equivalent	171.4056[177]	tonnes co2 equivalent
		F	Crashes	Injuries	6.74E-02[178]	injuries
		F	Crashes	Fatalities	2.12E-03[179]	fatalities
		F	Air Pollution	PM2.5	0.02976241[180]	tons
		F	Air Pollution	NOx	0.8201196[181]	tons
		F	Air Pollution	VOC	0.01433005[182]	tons
		F	Congestion	Traffic congestion	9,714.207[183]	dollars
		F	Infrastructure deterioration	Infrastructure deterioration	9,714.207[184]	dollars
		T	Climate	CO2 equivalent	0	tonnes co2 equivalent
		T	Crashes	Injuries	6.74E-02	injuries
		T	Crashes	Fatalities	2.12E-03	fatalities
		T	Air Pollution	PM2.5	0.02976241	tons
		T	Air Pollution	NOx	0.8201196	tons
		T	Air Pollution	VOC	0.01433005	tons
		T	Congestion	Traffic congestion	9,714.207	dollars
		T	Infrastructure deterioration	Infrastructure deterioration	9,714.207	dollars

176. Cambridge Systematics, "Transportation Investment Strategy Tool Documentation."

177. US EPA, "GHG Emission Factors Hub."

178. DOT and BTS, "National Transportation Statistics (NTS)."

179. DOT and BTS.

180. US EPA, "2023 SmartWay Online Shipper Tool: Technical Documentation."

181. US EPA.

182. Cambridge Systematics, "Transportation Investment Strategy Tool Documentation."

183. GAO, "Surface Freight Transportation: A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments That Are Not Passed on to Consumers."

Table VI-1. Marginal externalities factors (cont'd)

TRANSPORTATION CATEGORY	MODE	DECARBONIZED	EXTERNALITY CATEGORY	EXTERNALITY	MARGINAL GENERATION	UNIT PER ONE MILLION TON-MILES OR PASSENGER-MILES
Passenger	Rail	F	Climate	CO2 equivalent	58.504[185]	tonnes co2 equivalent
		F	Crashes	Injuries	3.28E-03[186]	injuries
		F	Crashes	Fatalities	3.28-04[187]	fatalities
		F	Air Pollution	PM2.5	0.08202899	tons
		F	Air Pollution	NOx	2.50811594	tons
		F	Air Pollution	VOC	0.13478261	tons
		F	Congestion	Traffic congestion	0	dollars
		F	Infrastructure deterioration	Infrastructure deterioration	0	dollars
		T	Climate	CO2 equivalent	0	tonnes co2 equivalent
		T	Crashes	Injuries	3.28E-03[188]	injuries
		T	Crashes	Fatalities	3.28-04[189]	fatalities
		T	Air Pollution	PM2.5	0	tons
		T	Air Pollution	NOx	0	tons
		T	Air Pollution	VOC	0	tons
		T	Congestion	Traffic congestion	0	dollars
		T	Infrastructure deterioration	Infrastructure deterioration	0	dollars

184. GAO.

185. US EPA, "GHG Emission Factors Hub."

186. DOT and BTS, "National Transportation Statistics (NTS)."

187. DOT and BTS.

188. DOT and BTS.

Table VI-1. Marginal externalities factors (cont'd)

TRANSPORTATION CATEGORY	MODE	DECARBONIZED	EXTERNALITY CATEGORY	EXTERNALITY	MARGINAL GENERATION	UNIT PER ONE MILLION TON-MILES OR PASSENGER-MILES
Passenger	LDV	F	Climate	CO2 equivalent	282.9227	tonnes co2 equivalent
		F	Crashes	Injuries	5.13E-01	injuries
		F	Crashes	Fatalities	8.87E-03	fatalities
		F	Air Pollution	PM2.5	0.002939497	tons
		F	Air Pollution	NOx	0.060994559	tons
		F	Air Pollution	VOC	0.010288239	tons
		F	Congestion	Traffic congestion	415,430.7[190]	dollars
		F	Infrastructure deterioration	Infrastructure deterioration	9.640.683	dollars
		T	Climate	CO2 equivalent	0	tonnes co2 equivalent
		T	Crashes	Injuries	5.13E-01	injuries
		T	Crashes	Fatalities	8.87E-03	fatalities
		T	Air Pollution	PM2.5	0.02939497	tons
		T	Air Pollution	NOx	0	tons
		T	Air Pollution	VOC	0	tons
		T	Congestion	Traffic congestion	415,430.7	dollars
		T	Infrastructure deterioration	Infrastructure deterioration	9.640.683	dollars

189. DOT and BTS.

Table VI-1. Marginal externalities factors (cont'd)

TRANSPORTATION CATEGORY	MODE	DECARBONIZED	EXTERNALITY CATEGORY	EXTERNALITY	MARGINAL GENERATION	UNIT PER ONE MILLION TON-MILES OR PASSENGER-MILES
Passenger	Air	F	Climate	CO2 equivalent	320[191]	tonnes co2 equivalent
		F	Crashes	Injuries	0.00E+00	injuries
		F	Crashes	Fatalities	1.00E-04	fatalities
		F	Air Pollution	PM2.5	0	tons
		F	Air Pollution	NOx	0	tons
		F	Air Pollution	VOC	0	tons
		F	Congestion	Traffic congestion	0	dollars
		F	Infrastructure deterioration	Infrastructure deterioration	0	dollars

Table VI-2. Dollarization factors

EXTERNALITY CATEGORY	EXTERNALITY NAME	UNIT PER ONE MILLION TON-MILES OR PASSENGER-MILES	DOLLARIZED VALUE PER UINT
Climate	CO2 equivalent	tonnes CO2 equivalent	340[192]
Crashes	Injuries	injuries	97,500[193]
	Fatalities	fatalities	1,869,000[194]
Air Pollution	PM2.5	tons	523,457[195]
	NOx	tons	7,788[196]
	VOC	tons	NA
Congestion	delays from traffic	dollars	1
Infrastructure deterioration	pavement wear	dollars	1

190. Cambridge Systematics, "Transportation Investment Strategy Tool Documentation."
191. Horvath and Chester, "Environmental Life-Cycle Assessment of Passenger Transportation An Energy, Greenhouse Gas, and Criteria Pollutant Inventory of Rail and Air Transportation."
192. US EPA, "EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances."
193. NSC, "Costs of Motor-Vehicle Crashes."
194. NSC.
195. Wolfe et al., "Monetized Health Benefits Attributable to Mobile Source Emission Reductions across the United States in 2025."
196. Wolfe et al.

C. RAILROAD JOBS ANALYSIS

To estimate new jobs in the railroad sector directly created through expanded freight service, a linear model that associates ton-mile freight by rail and railroad sectoral employment was created. The model then allowed predictions for railroad industry employment based on different levels of ton-miles moved by rail across forecast scenario.

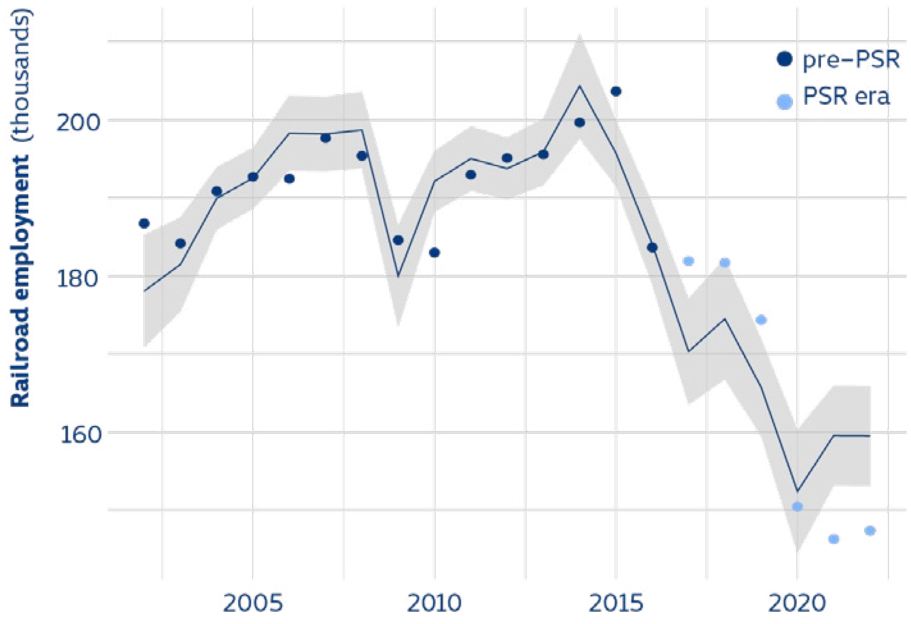
Specifically, correlations between ton-mileage freight, PSR implementation, and sectoral employment found in this model were used to estimate sectoral employment across the forecast scenarios. In the baseline scenario, the PSR implementation dummy stayed at one, which means that strategies to reduce workforce associated with PSR were retained throughout the forecast period in the baseline scenario. In the two reform scenarios, the PSR implementation dummy became zero.

Variations of the model were created that included dummies for PSR implementation across most Class 1 railroads, lagged freight volumes, or a dummy for the pandemic, but the model that was chosen only includes million ton-miles and a PSR implementation dummy. Railroad sectoral employment in thousands is the dependent variable. The model was estimated over data from 2002 to 2022. The adjusted R-squared is 0.8151. Coefficient estimates and p-values are shown in Table VI-3; residuals were plotted to check for autocorrelation with no pattern apparent. Figure VI-6 shows how predictions from the model compare to actuals over the fitted period.

Table VI-3. Model coefficients and p-values for railroad jobs model

Term	Estimate	std Error	p factor
(Intercept)	63.0463	26.9955	0.0313
million ton miles	0.0001	0	0.0001
psr dummy	-20.5672	3.7931	0

Figure VI-6. Estimated and actual railroad employment over data fit period



Source: BTS FAF 5.5.1, Author's analysis.

A model fitted with historical data is used to estimate new railroad jobs achievable through modeshift and reform. The lavender line shows estimated railroad jobs over fitted data.

D. COST REDUCTION ANALYSIS

Total averted shipping costs were calculated straightforwardly from differentials in ton-mileage by mode across forecast scenarios and cost differentials by mode. Costs by mode per ton-miles were used from 2022, based on BTS NTS data, Table 3-21.

The discussion of economic benefits of cost reduction notes that reduced shipping costs will tend to increase export competitiveness of US industries and/or reduce costs for US consumers. Reduced costs would allow US producers to see increased international competitiveness, particularly in sectors like agriculture where shipping from sites of production to international ports comprises a meaningful share of costs. In competitive sectors where goods are consumed domestically, US consumers would see savings from reduced costs.

Both of these outcomes would result in increased jobs due to multiplier effects. Increased production in some sectors would create new direct jobs in those sectors as well as indirect jobs in supplier industries and induced jobs from increased household spending. Decreased costs for US households would increase effective disposable income, which would induce jobs from increased household spending.

It is outside the scope of this report to estimate how these effects would break down or which effect would predominate. However, based on the assumption that 100% of shipping savings would be passed onto US consumers in the form of lower prices, increased spending would generate an estimated one million new US jobs by 2030 and four million new jobs by 2050. Alternate sets of assumptions would also result in job growth, but these scenarios are not modeled precisely. Job growth estimates from reduced prices were modeled using IMPLAN economic modeling software.

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