MEASURING THE RATES OF WEIGHT-MILE TAX EVASION IN OREGON

Final Report

RESEARCH

Oregon Department of Transportation

MEASURING THE RATES OF WEIGHT-MILE TAX EVASION IN OREGON

Final Report

by

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16. Abstract: In this report, three methods were selected to estimate WMT evasion rates for 2016-2018: 1) comparison of commercial truck screening data to WMT tax returns, 2) comparison of IRP registration filings to WMT tax returns, and 3) comparison of IFTA filings to WMT tax returns.

Comparison of taxable miles calculated using commercial truck screening data to WMT tax returns for motor carriers resulted in average annual WMT evasion estimates ranging from 8.63 percent to 11.33 percent of total revenue collected from 2016 to 2018. Another approach adopted to estimate WMT evasion was comparison of WMT tax returns to 2018 IRP registration records. This estimation method showed potential WMT revenue evasion rates ranging from 8.13 to 10.66 percent. When we compared the mileage reported in WMT returns to trip distances in Oregon as reported in IFTA returns listing Oregon as a travel jurisdiction, the minimum average annual revenue evasion rate was estimated to be 5.09 percent, and the maximum average annual revenue evasion rate was 7.15 percent throughout the study period.

Estimation using ODOT screening data offers several advantages: 1) these data are collected by ODOT rather than data self-reported by carriers; 2) they are much easier to match with WMT returns than IRP or IFTA data; 3) they provide information on interstate and intrastate vehicle mileage; 4) they make it easier to determine whether a particular vehicle is subject to the WMT tax compared to IRP or IFTA.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
~NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit	(F-32)/1.8	Celsius	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.196	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

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DISCLAIMER

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1.0 LITERATURE REVIEW

This chapter reviews existing research relevant to the Oregon WMT evasion study. There are three major sections of this review. The first section introduces the basic kinds of taxes and fees assessed to motor carriers in most states and discusses the AAMVA Road Test and subsequent research that became the impetus for the imposition of weight-based mileage fees on heavy trucks. The second section reviews tax evasion studies for heavy truck mileage taxes in Kentucky, New York and Oregon, reviews basic evasion concepts, evaluates methodologies, and talks about the strengths and weaknesses of two prevailing research approaches. The last section reviews motor fuel tax evasion studies, explains fuel tax evasion concepts, elaborates on methodologies used to measure them, and summarizes some findings that pertain to International Fuel Tax Agreement (IFTA) in particular.

1.1 COMMERCIAL TRUCK TAXES AND FEES

There are four major categories of taxes and fees assessed on commercial trucks: (1) fuel taxes, (2) weight-mile (or weight-distance) taxes, (3) interstate or intrastate registration fees, and (4) additional permitting and credentialing requirements (Unified Carrier Registration (UCR), OW/OD permits, temporary permits, household goods certificates, intrastate operating authority certificates, highway use fees, etc.). All states and Canadian provinces have fuel taxes on diesel fuels or fossil fuels used by commercial motor vehicles except Oregon. Interstate carriers must track fuel purchases and mileage in each jurisdiction (i.e. U.S. states and Canadian provinces) and file a quarterly tax return with the International Fuel Tax Agreement (IFTA), as their fuel taxes must be apportioned according to vehicle mileage logged in each jurisdiction. This results in the carrier receiving an additional tax bill or tax credits depending on mileage in each jurisdiction. Four states – Kentucky, Oregon, New Mexico, and New York – have a mileage tax on heavy trucks. Such taxes are based on the gross vehicle weight and the amount of mileage traveled in those states for each truck registered with a particular company, although all four states have certain exemptions. Similar to IFTA, motor carriers register with a base jurisdiction but proportionally allocates registration fees to all jurisdictions where the carriers report mileage. All states have some additional permitting and credentialing requirement. The most common credentials and permits are OW/OD permits, temporary permits, and UCR; there is more variation with respect to other credentials.

As with any tax or fee imposed by a government entity, there are always actors (whether individuals or businesses) who will attempt to evade such taxes. Some federal, state and local administrators of these tax and fee programs, as well as members of the trucking industry, have expressed growing concerns about evasion for at least 30 years. Measuring evasion is challenging for several reasons. First, evasion of taxes and fees takes many forms, and researchers and stakeholders conceptualize evasion differently. Second, it is a clandestine activity where non-compliant carriers attempt to conceal non-compliance with federal and state laws and regulations. Third, although the amount and quality of data collected about commercial trucking operations has improved due to technological advances, there are still limitations that complicate many of the assumptions made by current methodologies. Fourth, evasion estimates are significantly different depending on researchers' chosen methodology. The following sections review highway impact and cost allocation studies, weight-mile tax evasion studies, and fuel tax evasion studies to compare the ways in which they conceptualize evasion, the methods used to measure evasion, and the disparate outcomes of various studies.

1.2 IMPACT OF HEAVY TRUCKS ON HIGHWAY INFRASTRUCTURE

The primary purpose of heavy truck taxes and user fees is to provide federal, state, and local agencies with revenues necessary to maintain publicly owned highway infrastructure, particularly infrastructure that is part of crucial, high-traffic freight corridors. Several factors impact pavement durability and performance. Pavement composition, pavement age, the efficacy of drainage systems, construction quality, traffic volume, vehicle loads, and maintenance factors all contribute to the durability of highway infrastructure, and thus the cost of maintenance (AASHTO, 2014; Backlund & Gruver, 1990; Batioja-Alvarez, Kazemi, Hajj, Siddharthan, & Hand, 2018; Batten et al., 2017; Wilde, 2014). Environmental factors in particular can consist of catastrophic weather events, such as hurricanes, or long-term factors such as pervasive extreme weather events caused by climate change (Lu, Tighe, & Xie, 2018; Zhang, Zhong, Martinez, & Gaspard, 2008). Highway agency approaches to deicing or plowing wintry roads also impacts pavement longevity, not to mention the environment (Jackson & Jobbágy, 2005; Shi et al., 2009).

Vehicle load – that is, the weight of vehicle axles making direct contact with the pavement – is a significant contributor to pavement degradation, particularly for heavy trucks, which weigh substantially more than passenger vehicles. Researchers have been testing and modeling the effects of heavy trucks on pavement integrity for decades. The first major study was the American Association of Highway Transportation Officials' (AASHTO's) Road Test, which was conducted in Ottawa, Illinois from 1958 to 1960. Engineers tested both asphalt and concrete pavements. The most significant result was the development of an equivalent single axle load (ESAL) formula, which is used to model pavement damage and estimate the lifecycle of highway segments.

The purpose of the ESAL formula is to estimate pavement damage for a variety of vehicles using the tire load, axle and tire configuration, repetition (or traffic volume), traffic distribution (or use of all traffic lanes), and vehicle speed (AASHTO, 2014; Pavement Interactive, 2008b). When planning the construction and maintenance schedule of highway networks, state and local agencies also need traffic counts, heavy vehicle estimates, estimated traffic growth (for heavy vehicles and passenger vehicle), load equivalency factor (i.e. an average ESAL rating for heavy trucks in the area), and the cumulative ESAL rating for the road. In other words, how many total ESALs can a highway segment handle before it needs to be repaved?

Table 1.1 displays some standard load equivalency factors (average ESALs) for a select number of axle loads and types. These numbers were originally published in the 1993 *AASHTO Guide for Design of Pavement Structures* and republished in a Pavement Interactive article (AASHTO, 1993; Pavement Interactive, 2008a). The chart reports ESAL or LEF (load equivalency factor) for vehicles with variable axle loads or weights, for both single axle and tandem axle vehicles. It also reports the weight per axle in both kilonewtons and pounds, and for both flexible (asphalt) and rigid (concrete) pavements. The LEF is all relative – the 18,000-lb axle converts to exactly one ESAL unit because that was the maximum weight allowed per axle in most states at the time of the AAMVA Road Test. As shown on the chart, pavement impacts for heavy vehicles are exponentially higher than for passenger cars. Although the equations to derive these LEFs are complex, dividing the axle weight by 18,000 pounds (i.e. LEF=1) and multiplying that ratio to the fourth power will yield an approximate estimate for reasonably strong pavement (Pavement Interactive, 2008a). For a flexible pavement example, 30,000/18,000=1.67, and 1.67^4 is 7.7, which is close to the actual value, which is 7.9. The shortcut is meant to give highway engineers a quick way of scoring ESALs given certain pavement parameters (AASHTO, 1993).[1]

Table 1.1: Sample Load Equivalency Factors (from AASTHO 1993, Pavement Interactive 2008)

Axle Type (lbs.)	Axle Load		Load Equivalency Factor (AASHTO, 1993)	
	(kN)	*(lbs.)*	*Flexible*	*Rigid*
Single axle	8.9	2,000	0.0003	0.0002
	44.5	10,000	0.118	0.082
	62.3	14,000	0.399	0.341
	80	18,000	1	1
	89	20,000	1.4	1.57
	133.4	30,000	7.9	8.28
Tandem axle	8.9	2,000	0.0001	0.0001
	44.5	10,000	0.011	0.013
	62.3	14,000	0.042	0.048
	80	18,000	0.109	0.133
	89	20,000	0.162	0.206
	133.4	30,000	0.703	1.14
	151.2	34,000	1.11	1.92
	177.9	40,000	2.06	3.74
	222.4	50,000	5.03	9.07

*Terminal serviceability index (pt) = 2.5
*Pavement structural number (SN) = 3.0 for flexible pavements
*Slab depth (D) = 9.0 inches for rigid pavements

The ESAL/LEF calculations have been criticized in some quarters. A Congressional Budget Office report in 1979 called unmodified ESAL equations into question due to concerns about

1 The terminal serviceability index pertains to the point when pavement is prone to failure. Pavement structural numbers pertain to the composition of asphalt pavements, and the slab depth refers to the thickness of concrete pavements.

their assumptions, the fact that they were based on a small set of pavement samples in a single environmental region, and were applied to a limited number of axle configurations (FHWA, 2013). Consequently, there have been revisions to the AASHTO ESAL calculations. Researchers have more recently developed load spectra calculations as superior alternatives to ESAL calculations. (Pavement Interactive, 2008b; AASHTO, 2014). Most of the data inputs are the same, but the load spectra approach is more complicated and thought to be more accurate. States must take either ESALs or load spectra into account when engaged in highway pavement design, and this includes looking at vehicle classification, axle weights, overall traffic volume, traffic distribution by each lane, and projected traffic growth over the next 10 to 50 years (depending on the type of roadway). Currently, most state highway engineers and researchers still use ESALS and LEFs as part of their pavement damage methodology.

Another innovation is mechanistic-empirical pavement design, which addresses other limitations of prior pavement design specifications. Mechanistic-empirical pavement design takes advantage of advances in computer modeling and advanced testing mechanisms, and includes several additional data inputs. Additional data inputs include specific vehicle classifications, additional pavement material parameters, inputs to model material aging and climate characteristics, and additional traffic data (AASHTO, 2014). Several states, including California, Kentucky, Washington state, and Minnesota, have implemented such an approach to pavement design. Overall, the methodology for designing highways and measuring pavement has evolved over time. However, there is longstanding acknowledgement by highway research engineers that heavy trucks place greater stress on highway infrastructure by virtue of greater axle loads, and consequently create more pavement wear than typical passenger vehicles (excluding large busses).

States differ as to how or whether pavement design methodology translates to assessed transportation taxes and fees. Highway cost allocation studies are mechanisms whereby researchers attempt to quantify pavement damage and the associated cost to the state, and compare it with the amount of fees paid by vehicles in a particular class. Many states have updated these studies as data collection technology, data availability, and pavement design methodology has evolved (Hong, Prozzi, & Prozzi, 2010). Most states use incremental or proportional methods. Under the incremental method, vehicle classes are added to the base pavement in a particular sequence to determine how much pavement requirements change when adding particular vehicle class to the pavement equations. Most states use this method, although it has been modified to because of certain limitations (Hong et al., 2010). The biggest limitation is that the order in which the classes are added greatly impact the pavement damage (or needs) estimates. Modified incremental calculations are done backwards, such that vehicle classes are divided into subgroups and are removed iteratively from overall pavement equations to determine the pavement (or load-bearing requirements) for roads based on each subgroup's ESAL contributions (Hong et al., 2010). The proportional method allocates cost based on certain measures or allocators, usually ESALs and vehicle miles traveled and ESALs (Hong et al., 2010).

Hong et al. developed a highway cost analysis test methodology for a pilot study using load spectra data obtained from a weigh-in-motion (WIM) scale in San Antonio, Texas. Using the data along with mechanistic-empirical pavement design techniques, they calculated pavement impacts for heavy trucks classified as Class 4 to Class 12 per FHWA's classification scheme, and estimated maximum allowable traffic volumes for asphalt pavement with thicknesses ranging from 3 to 8 inches. They found that the share of damage heavy trucks decreases as pavement thickness increases; the opposite effect was true for light trucks. Most damage resulted from Class 9 trucks, which are the standard 18-wheel trucks comprising most truck traffic. The share of facility costs – those non-load-related costs fixed due to other infrastructure requirements in addition to pavement – typically increase as the highway functional class decreases. In other words, rural highways and interstates have higher facility costs than arterials, collectors, and local roads (Hong et al., 2010).

Oregon uses an incremental, design-based allocation methodology for bridges and the 2010 National Pavement Cost Model (NAPCOM) for its biannual highway cost allocation studies. One interesting aspect of Oregon's methodology is it estimates both expenditure allocation and revenue attribution of taxes and fees paid by each vehicle class, and researchers develop equity ratios to ensure all users are paying their fair share (Batten et al., 2017). Ultimately, however, allocations are based on revenue allocation rather than expenditure allocation. Expenditure allocation categories include cost categories for maintaining the state's highway infrastructure – modernization, preservation, maintenance, bridge costs, miscellaneous costs, and debt payments on previously issued bonds. Revenue attribution categories include the taxes and fees paid by system users – fuel tax, registration and title fees, weight-mile tax, miscellaneous motor carrier fees, the flat fee alternative to WMT, and the road use assessment fee.

The *Oregon Highway Cost Allocation Study* uses a variety of allocators to determine cost responsibility, and differentiates between common costs and incremental costs. Common costs are those costs shared evenly by all vehicle classes, whereas incremental costs are tiered because of differences in vehicle class factors, such as miles traveled or axle weights. For example, because heavy vehicles have a greater impact on pavement than light vehicles, calculations showed heavy vehicles were responsible for 72.3 percent of preservation costs. Conversely, most modernization costs (i.e. upgrading or building new highway infrastructure) was attributed to light vehicles. Overall, the study allocated 64 percent of cost responsibility and 64.5 percent of fees paid to light vehicles, and 36 percent of cost responsibility and 35.5 percent of fees paid to heavy vehicles. As such, the equity ratio for light vehicles was 1.0076 for light vehicles and .9865 for heavy vehicles (Batten et al., 2017).

Researchers use similar estimation techniques to help states determine cost responsibility for heavy vehicles in other states and jurisdictions. Wilde (2014) developed a cost analysis tool to estimate pavement costs for local roads in Minnesota in cases where the growth of heavy vehicle traffic exceeded forecasted growth expectations, such as distribution centers and warehouses, large industrial parks, hog farms, ethanol plants, etc. The tool was a macros-enable Microsoft Excel spreadsheet that took various user inputs, such as average annual daily traffic, truck traffic, ESALs, and pavement specifications, and calculated the additional unanticipated costs based on differences in projected pavement impacts and actual pavement impacts (Wilde, 2014).

An analysis of the South Carolina Department of Transportation's highway system showed that pavement and bridge damages increased significantly when additional vehicles were allowed to operate above legal weight limits with overweight-over dimensional permits (Dey, Chowdhury, Pang, Putman, & Chen, 2014). The study compared a tiered, axle-based recovery fee to a flat-rate damage fee. Scholars found that not only was South Carolina's current flat-rate damage fee inadequate for current damage costs imposed by overweight trucks on pavements and bridges, but that actual damage varied significantly depending on the axle configuration of the truck. Impacts were such that carriers paying flat fees were overcharged in some circumstances, and undercharged in others. Overall, axle-based fees can be more easily calibrated to actual damage costs (Dey et al., 2014).

In a similar vein, a study of a new Wisconsin law that allows logging trucks to legally haul raw forest products using vehicle combinations up to 98,000 and six axles. The study analyzed the operations of two kinds of log trucks – Class 9 and Class 10. Using ESAL/LEF methodology, the researchers determined that although the average load carried by Class 10 trucks was slightly heavier than for Class 9 trucks, differences in axle configurations resulted in the Class 9 trucks doing more damage than the Class 10 trucks (Owusu-Ababio & Schmitt, 2015). A study of overloaded trucks found that the presence of overloaded vehicles can potentially impact pavement preservation or maintenance cost by more than 100 percent compared to vehicles operating within legal weight limits (Pais, I. R. Amorim, & Minhoto, 2013). In yet another study, researchers developed a model for assessing overweight vehicle damage using Monte Carlo simulations to calculate LEFs and relative damage factors (RDFs) for state DOTs to use when assessing the impacts of overweight trucks. The model was developed using 3D-Move Analysis software, and took gross vehicle weight, axle configuration, axle weight, pavement temperature, and VMT into account to assess the impact of overweight trucks on rutting and fatigue cracking on asphalt pavement. The simulations utilized real-world data from the Nevada Department of Transportation (Batioja-Alvarez et al., 2018). Both studies underscore the importance of incentivizing motor carrier operations that minimize pavement damage whenever possible.

Methodologies for estimating pavement damage continue to evolve, growing ever more sophisticated and expanding beyond the original function, which was primarily to aid highway engineers when designing pavements and developing highway maintenance and preservation plans. Although most states still utilize ESALs and LEFs to estimate pavement damage and allocate cost responsibility, the initial estimates had limitations that researchers are working to address. The use of newer innovations – load spectra, 3D modeling, mechanistic-empirical pavement design, new pavement damage calculations – have improved these models, as have better specified input parameters and state DOT traffic and vehicle classification data. Increasingly, researchers and administrators are interested in using these tools to estimate cost savings and derive more accurate equitable estimates of pavement damage for overweight trucks or heavy trucks generally. The general thrust of recent research into the impact of heavy trucks on pavement is to enhance pavement design and maintenance planning, use research into pavement impacts to incentivize efficient use of resources through pavement preservation and to ensure highway system users are paying their fair share.

Several other states have conducted highway cost allocation studies in recent years. Table 1.2 shows the state, year the study was published, the cost responsibility allocated to passenger vehicles (motorcycles, automobiles and light trucks in FHWA classes 1-3) and heavy trucks and buses (FHWA classes 4-12). It also displays at the share of revenue for highway-related expenditures coming from each group. Oregon's study is the most recent. In the study, Oregon found a cost responsibility of 64 percent for light vehicles and 36 percent responsibility for heavy trucks and buses, which very closely matched the revenue shares of 64.5 and 35.5, respectively (Batten et al., 2017). An Indiana study found similar cost responsibility shares, with 61.3 percent for passenger vehicles and 38.7 percent for heavy trucks and buses. The equity ratios for the Indiana study show operators of passenger vehicles overpaying somewhat relative to their cost responsibility and heavy truck and bus operators underpaying somewhat (Volovski et al., 2015). The outlier study of this group would be the Minnesota study, and not because of its cost responsibility allocation. Researchers determined that passenger vehicle operators were paying 81 percent of the revenue, and heavy truck and bus operators were paying just 19 percent (Gupta, 2012). The Arizona study, while older, provides results more similar to those in Oregon and Indiana in terms of the allocation of cost responsibility and revenue contributions. The authors of the Arizona study developed two models – the standard Arizona Highway Cost Allocation Model (1) and the Simplified Model (2). Both yielded similar outcomes (Carey, 2000).

Table 1.2: Cost Responsibility and Revenue Share by Vehicle Class

		Cost Responsibility		**Revenue Share**	
State	***Study Year***	***Autos and Light Trucks***	***Heavy Trucks and Buses***	***Autos and Light Trucks***	***Heavy Trucks and Buses***
Oregon	2017	64.0	36.0	64.5	35.5
Indiana	2015	61.3	38.7	68.5	31.5
Minnesota	2012	62.6	37.4	81.0	19.0
Arizona (1)	2000	64.0	37.0	67.0	33.0
Arizona (2)	2000	66.0	34.0	68.0	32.0

Overall, these studies are remarkably consistent in the manner in which they allocate cost responsibility. The methodologies will have slight variations. The Oregon cost allocation study is by cursory glance the most comprehensive, probably owing to the fact that it gets repeated every two years. Oregon appears to be unique in having the constitutional provision requiring equity in terms of highway cost responsibility and revenue contribution (Batten et al., 2017). The Arizona study was mostly focused on verifying a new cost allocation methodology against a pre-existing model, and found the new model to be a useful an adequate tool (Carey, 2000). Although the report authors acknowledged cost equity issues, it made no recommendations about changes to highway tax and revenue policy. The Indiana study looked at construction, pavement and maintenance costs when figuring its cost allocation costs. It also looked at past highway cost allocation studies in other states, including Texas, Idaho, Nevada, Oregon, Kentucky, and Minnesota. The common thread running through all of these studies is that automobile and light truck vehicle classes are typically overpaying and heavy trucks are typically underpaying relative to the cost allocation share (Volovski et al., 2015). When broken out separately, buses constitute a small share of cost responsibility and revenue, but are very close to equity in most studies when breaking out cost responsibility and revenue contribution. The Indiana study demonstrated that increases in fuel taxes or implementation of a weight-distance tax could improve cost equity. The Minnesota study found that implementation of a weight-distance tax increased efficiency and equity, whereas fuel taxes and registration fees cannot achieve both by themselves (Gupta, 2012). However, neither state has adopted a weight-distance tax in response to these findings.

The primary impetus for states to implement a vehicle mileage tax for heavy trucks has always been one of equity – that is the user who creates the externality bears a fair share of the pavement preservation or maintenance cost. This is why several states conduct highway cost allocation studies. Some researchers contend that a graduated, per-mile fee or tax structure can help states achieve that equity because cost responsibility for heavy trucks increases rapidly by weight, and that a weight-mile tax captures this relationship more accurately than fuel taxes or registration fees (Batten et al., 2017; Martin, Bell, & Walton, 2014; Mingo, Chastain, Mingo, & Cummings, 1996; Weinblatt, Stowers, & Mingo, 1998). However, most of these scholars also note that the existence of a graduated, weight-based structure is not a guarantee of equity. Evasion rates, cost of administration, economic neutrality, and accountability are important factors to consider as well (Denison & Facer, 2005). Others, including trucking industry analyses in particular, emphasize high evasion rates and higher administrative costs for weight-mile taxes relative to fuel taxes (Holtz-Eakin, 1998; ATRI, 2008; ATRI, 2017).

Although states and highway engineers have done significant research to document heavy truck impact on highway infrastructure and develop an equitable cost-sharing revenue structure, administrators and lawmakers recognize the importance of maximizing the economic benefit of federal, state, and local infrastructure by allowing trucks to haul large amounts of commodities without overly burdensome regulation. Such was the logic of the economic deregulation of the trucking industry in the late 1970s and early 1980s – not to mention the simultaneous deregulation of airlines and railroads (Robyn, 1987). Safety regulations have remained a focus. Federal weight limits on interstate highways are 80,000 pounds for gross vehicle weight, with weight limits also applying to certain axle configurations. At least 38 states have state exceptions to federal weight limits, and at least 41 states exempt certain commodities from weight limits. Overweight permits are also generally necessary for oversize and overweight non-divisible loads (FHWA, 2015). Nevertheless, states have taken different approaches to balancing the economic imperative and equitable cost allocation imperative.

1.3 WEIGHT-MILE TAX EVASION STUDIES

Researchers have conducted several heavy vehicle mileage tax evasion studies at various junctures over the last 20+ years for Kentucky, Oregon, and New York (ATRI 2008, 2017; Delcan Corporation, 2011; Forlines, Martin, Keathley, Kissick, & Walton, 2019; Holtz-Eakin, 1998; Cambridge Systematics, Inc. and SYDEC, Inc., 1996; Strathman & Theisen, 2002). None of these studies analyze more than one state's weight-mile tax evasion at a time; rather, they all focus on a single state. The research team did not identify any tax evasion studies for New Mexico's weight-distance tax.

These studies all define evasion somewhat differently. The Holtz-Eakin (1998) study of New York's ton-mile tax (NYTMT) evasion distinguishes between tax avoidance and tax evasion, noting that the former refers to strategic business decisions designed to legally reduce tax liability, whereas the latter is an illegal failure to pay full tax liabilities. Specifically, the Holtz-Eakin study explores failure to purchase a permit or decal, and underreporting travel miles. Two studies by the American Transportation Research Institute (ATRI) conceptualized evasion of NYTMT in a similar manner, comparing reported NYTMT tax mileage and estimated VMT from the Census Bureau's *Vehicle Inventory and Use Survey* and the Federal Highway Administration's VMT estimates for heavy vehicles in New York (ATRI, 2008; ATRI, 2017). Cambridge Systematics, Inc. and SYDEC, Inc. (1996) functionally defined evasion as the amount of underreported and unobserved WMT-eligible trucking operations in Oregon. Unobserved WMT is quantified by measuring the prevalence of trucks on bypass routes, general traffic sampling, urban truck sampling, and refined WMT estimates. In a later study of Oregon WMT evasion, Strathman and Theisen (2002) focus on overloading, and the percentage of overweight vehicles on I-5 before, during and after a construction-related weigh station closure, as well as the impacts on instances of overweight vehicles on bypass lanes. Thus, evasion is defined as the probability overloading, or operating a commercial motor vehicle above legal weight limits.

Forlines et al. (2019) define evasion of Kentucky's weight-distance tax (KYU) somewhat similarly to the Holtz-Eakin, Stowers, and ATRI frameworks for evasion of weight-mile or weight-ton taxes in New York and Oregon. In particular, they define four categories: (1) "No tax return" meant a carrier had a KYU tax license but did not file a quarterly return; (2) underreported mileage meant the aggregate number of estimated KYU miles based on commercial vehicle screening records exceeds the reported mileage on the KYU tax return; (3) "reported 0 miles" meant the carrier had a valid tax license and filed a KYU tax return indicating no operations in the state, but were observed on at least two occasions according to commercial vehicle screening records; (4) "no permit" indicated a truck did not have a valid KYU tax license or a valid temporary permit that would have allowed legal operation in Kentucky.

Given differences in how various scholars have conceptualized or operationalized evasion of heavy vehicle mileage taxes, it is unsurprising that the methods utilized to quantify or estimate evasion are also somewhat divergent. Holtz-Eakin (1998) took several roadside samples of trucks on New York highways to determine what percentage of those trucks failed to display a permit (whether a temporary permit or NYTMT tax license). The analysis assumes NYTMT tax evasion rates are equivalent to the permit display non-compliance rates, and extrapolates missing revenue based on that assumption. The analysts create a ratio based on FHWA VMT estimates and certain assumptions about vehicle weight distributions. The methodologies used in the two ATRI studies is similar. Their analyses compare reported NYTMT miles to VMT estimates provided by ATRI (ATRI). Based on some assumptions made about the distribution of vehicle mileage into various truck weight classes, the analysts compute an estimated tax liability for all VMT miles logged on the state highway system. From there they calculate a ratio of estimated tax liability to paid tax liability to calculate an evasion rate. All three studies concluded there were high rates of NYTMT evasion. Holtz-Eakin estimated the evasion rate was between 32 and 44 percent; ATRI estimated the NYTMT evasion rate to be 49.9 percent in its 2008 study, and 35.1 percent in its 2017 study.

Cambridge Systematics, Inc. and SYDEC, Inc. (1996) engaged in a multifaceted field data collection effort. First, it takes into account differences between WMT reported to Oregon program administrators and mileage estimates based on travel data by other vehicles not subject to WMT. They make adjustments based on traffic counts, classification counts, and Highway

Performance Monitoring System (HPMS) guidelines promulgated by FHWA. To generate a high-end estimate of adjusted miles they added additional factors, such as changes in fuel consumption and other economic indicators. In addition, they examined violation rates at weigh stations, the percentage of commercial truck traffic using weigh station bypass routes, roadside weight enforcement against trucks in urban areas, and audit data from special audits conducted by ODOT. The analysts created an evasion index based on all of the field data collection. They estimate overall WMT evasion to be 3 to 7 percent, with 5 percent the closest approximation.

Strathman and Theisen (2002) focus more narrowly on the question of overloading. They collected data from three weigh-in-motion (WIM) scales – one on I-5, and two on bypass routes. The temporary closure of the Northbound Woodburn scale on I-5 provided a natural experiment of sorts. Investigators collected data to determine the impact on truck volume as well as the prevalence on overloading before, during, and after the scale closure. Data showed low impacts on truck volume, with relatively modest rates of increases in GVW or overloading for all three sites during each study period. Overall, the percentage of overweight vehicles was 3.39 percent for vehicles on I-5. A separate analysis of Oregon's Green Light program found that participating motor carriers were less likely to alter operations than other motor carriers. The authors concluded Oregon's relatively aggressive performance discouraged widespread evasion, and that enforcement activity pertaining to truck weight had little effect on the interstate and international shipping on its crucial I-5 freight corridor.

Forlines et al. (2019) used KYU tax return data, historical screening data from the Kentucky Automated Truck Screening Systems (KATS), historical screening data from PrePass, manually entered historical screening data (ALTS), temporary permits data, and KYU tax returns, and enforcement data. Individual companies screened via KATS, PrePass or ALTS were matched to KYU tax returns and categorized based on the four previously described categories: no tax return, underreported miles, reporting "0" miles, and no account or temporary permit from Q2 2014 through Q3 2015. For the first three categories, the researchers tabulated the number of estimated miles logged in the state based on the location of the screening system. In essence, estimated miles were based on the assumption that a screened truck entered at the nearest port of entry in the direction of its approach and that it was headed to the nearest state border in the direction of departure – a conservative mileage estimate that assumed no departures from major highways. This estimate was further adjusted by the ratio of reported miles to estimated miles for the quarter. The adjusted mileage was then multiplied by the weight-distance tax rate ($.0285 per mile), and penalty and interest were added. To estimate the impact of having no account or temporary permit, researchers assumed each identified vehicle would remit a $40 permit and $25 administrative charge. Cumulative, annualized evasion estimates for all four evasion categories ranged from $6.2 million to $7 million. The study did not calculate evasion rates per se as much as uncollected revenue. However, considering KYU revenue for FY 2015 was $79.1 million, the evasion rate works out to approximately 7.8 to 8.8 percent.

There is a wide divergence in the estimated evasion rates predicted by Holtz-Eakin (1998) and ATRI (2008, 2017) for the NYTMT, and the estimated evasion rates predicted by Cambridge Systematics, Inc. and SYDEC, Inc. (1996) and Forlines et al. (2019) for the Oregon WMT and Kentucky weight-distance tax, respectively. Some of the explanation for the different evasion estimates may be related to differences in evasion between the states. It is possible evasion is higher in New York than in Kentucky or Oregon. Some differences could be related to differences in the heavy truck tax structures or enforcement levels. Another possibility is differences in methodology. The New York studies all compare VMT estimates based on vehicle owner responses to a U.S. Census Bureau survey and compare the survey with industry tax returns reported to each state. The Cambridge Systematics, Inc. and SYDEC, Inc. (1996) study used a variety of mechanisms to measure evasion, and the Forlines et al. (2019) looks at company-level tax returns and commercial vehicle screening records. Both of the latter two studies approached the issue of evasion in manner similar to a trucking company tax audit.

There are certain advantages to taking a VMT, network-level approach examining evasion a la Holtz Eakin and ATRI. If one can derive an accurate assessment of a system-wide estimate of commercial vehicle VMT for a state – collected under circumstances where there were no repercussions in terms of tax or financial liability – and compare it with tax returns, where there are incentives to misrepresent true operations. These estimates consistently turned up mileage estimates higher than those reported by carriers to NYTMT administrators.

Cambridge Systematics, Inc. and SYDEC, Inc. (1996) indicated several reasons why using VMT data tends to result in high-end evasion estimates. They cite work done by FHWA and California that shows vehicle classification equipment has a tendency to overestimate the percentage of trucks that are combination trucks and underestimate single unit trucks; estimates rarely take holiday weekends into account, where the percentage of truck traffic is significantly lower; and that survey-based VMT estimates tend to be less reliable than traffic counts and classification estimates because they are based on owner estimations of miles traveled, which can often times be inaccurate (Cambridge Systematics, Inc. and SYDEC, Inc., 1996). Other studies shared similar reservations about VMT estimates (Mingo et al., 1996; Weinblatt et al., 1998).

The Vehicle Inventory Use Survey is a very comprehensive national survey, with a large sample size and a robust attempt to correct for non-response errors. But there are some significant limitations. While the survey does ask specific questions about vehicle fleets, most of the questions, including specific questions about mileage, pertain to a single registered vehicle, which is the basis for the sample. What is unclear is how these responses translate into fleet estimates for a single company, let alone an entire highway network. While the in-state vehicle estimates are based on a percentage of the overall mileage, out-of-state mileage is only reported at aggregated levels, and apportioned to other states via algorithms. It is unclear how those algorithms work. It is at least plausible that every state is different with respect to mileage apportionment. Apportionment algorithms that take truck registrations into account, for example, need to control for the fact that truck registration numbers (which are high for New York – it was 5^{th} in this study) are driven not just by the size of the trucking economy in the state, but the cost of license plates and associated fees. These issues, along with standard sampling errors, can easily scale up such that the sampling error becomes quite large.

Similar sampling and assumption issues exist with the samples in the Holtz-Eakin study. Essentially, the author took a few roadside samples of trucks to determine how many vehicles were not compliant with the requirement that the NYTMT permit be purchased. However, this was measured by assessing whether the permits were displayed – not whether they were purchased. So, the study assumes that, for example, that an estimated permit display at 26.6

percent yields an equal amount of evasion. This assumption ignores the possibility that carriers often purchase permits or credentials but forget to properly display them. It also does not prove a carrier not displaying a permit failed to remit any taxes. Last, it is not clear how the study accounted for both long-term permits and temporary permits, or merely the former. Failure to account for the latter would almost certainly inflate evasion estimates. Additionally, the share of evasion due to unpurchased permits (24.3-26.6 percent) is higher than underreported miles (11-23.3 percent). The underreported mileage assumptions change drastically depending on the assumptions made about the percentage of 2-axle, 6-tire vehicles are exempt from the NYTMT (80 percent for the lower estimate and 60 percent for the higher estimate).

Assumptions about the nature of NYTMT filing also impacts evasion estimates. The NYTMT has two sets of tax brackets – the gross vehicle weight method and the unloaded weight method. The former method requires carriers to track mileage while loaded and unloaded, and charges variable tax rates depending on the truck load status and its laden/unladen weight. On the other hand, the unloaded weight method only requires total miles and charges a flat rate based on the maximum laden weight of the truck. Both ATRI studies use the gross vehicle weight for its tax liability estimates even while acknowledging most New York carriers file using the unloaded weight method, which entails using a different set of tax rates. Such an estimate requires assumptions to be made about the split between laden and unladen miles. For the analysis, the authors of the ATRI studies use the Schedule I, Table 1.1 weights for all mileage, which increases the estimated tax owed because it implicitly assumes that no truck operates any mileage while unladen.

The ATRI authors correctly point out that the unladen weight methods do not neatly line up with the VIUS categories, and that the unloaded weight method actually has higher rates than the gross vehicle weight for weight brackets up to 66,000 pounds. Using gross vehicle weight instead of the unloaded weight method could have conservatively biased their estimates, especially had they made different assumptions about unladen mileage under the gross vehicle weight method. However, for weights above 66,000 pounds, the unloaded weight method rates are actually lower than the gross vehicle weight method. Given that a very large percentage of commercial vehicle VMT is at those higher weights, it is difficult to adjudicate whether one rate yields more conservative evasion estimates than the other. The biggest issue is that it is not consistent with the tax table most carriers use when filing their taxes. It should be pointed out that the Holtz-Eakin study does in fact use the unloaded weight method for its evasion estimation model.

Another factor that could potentially impact the ATRI assessments is the allocation of VMT to various tax brackets. The VIUS data estimates VMT for trucks is in 3,500-10,000-pound increments, whereas the tax brackets are specified for 2,000-pound increments. Assumptions must be made about how to distribute those miles within each tax bracket. ATRI distributes them evenly, across the corresponding brackets, which is a reasonable approach in the absence of truck registration numbers by weight class. In the 2008 ATRI study the authors specifically give an example where they take the VMT reported for 50,001-60,000-pound trucks and distribute the 204.8 million miles evenly into each weight class such that 50,001-52,000 gets 48.96 million miles, 52,001-54,000 gets 48.96 million miles, and so forth. Depending on the actual distribution of these miles by weight class, the estimates could be high or low. For example, if the actual miles for trucks in the 50,001-52,000-pound range is greater than 48.96 million miles, and the trucks in the 58,001 to 60,000-pound range is less than 48.96 million miles, the assumption would overestimate tax liability. Conversely, if the mileage distribution tends to be heavier near the top of the distribution, the estimate would underestimate tax liability.

Last, all of the studies of New York's ton-mile tax examine aggregated VMT data and reported mileage. However, none of the analysts examine company-level operations to check the validity of their estimates. In other words, it would be helpful to compare the evasion estimates at the system level with the company weight-mile tax returns, historical vehicle screening records, fuel purchases, bills of lading, GPS fleet tracking data, and other data that might be used to forensically construct a picture of operations for companies to derive specific examples. This cross-validation is critical to demonstrate that the macro-level analysis accurately represents the micro-level operations of trucking companies.

The Cambridge Systematics, Inc. and SYDEC, Inc. study takes a multifaceted approach, looking at WMT miles, VMT for other vehicles, fuel purchases, overweight operations, and other factors into its estimation of Oregon's weight-mile tax evasion rate. This approach has a significant advantage in that it estimates evasion from multiple different perspectives. It used a state-specific VMT study to estimate mileage that was conducted on behalf of the highway cost responsibility study as well as the HPMS guidelines developed by FHWA to generate two underreporting models. Forlines et al. (2019) takes advantage of the growing amount of commercial vehicle screening data available in states who install automated vehicle screening systems at weigh stations, on bypass routes and along mainline freight corridors, and curate that data along with preclearance system data and manual observations in a centralized repository. These studies take a bottom-up approach by looking at company-specific activities and tax filings. The approach allows them to provide specific carrier examples for a variety of evasion contexts.

Nevertheless, there are limits to these studies as well. Obviously the Cambridge Systematics, Inc. and SYDEC, Inc. study is well over 20 years old at this point, and part of the impetus to conduct this study is related to the fact that the study is no longer very current. Both the Cambridge Systematics, Inc. and SYDEC, Inc. and Strathman and Theisen to various degrees emphasize the issue of overloading or overweight trucks. Of the nearly 3.9 million commercial vehicle trucks weighed in Oregon during 2018, only 1.23 percent were overweight. These numbers are substantially lower than the samples taken in previous studies. The primary issue of interest is the degree to which carriers are evading taxes due to a failure to file a return, underreporting of miles, reporting "0" miles when there are screening observations, and failure to obtain a temporary permit and file a return. There are also concerns about trucks coming over the Oregon border to purchase fuel, as Oregon does not assess heavy vehicles a gas tax, and failing to report mileage. So the current research emphasis will shift a bit.

Another possible limitation of the Cambridge Systematics, Inc. and SYDEC, Inc. (1996) study is one that will face certain studies utilizing VMT data, which is that VMT are inevitably based on a number of assumptions given the present impossibility of collecting traffic counts on all state roadways at all times. Cambridge Systematics, Inc. and SYDEC, Inc. adjusted the HPMS-based VMT estimates at the time after noticing that truck volumes on weekends and holidays were far lower, seasonal fluctuations in trucking activity, and issues with the vehicle classification counts.

After making adjustments, Cambridge Systematics, Inc. and SYDEC, Inc. downwardly adjusted annual VMT estimates by 26.3 percent. The authors carefully explain the adjustments and the reasoning for making such adjustments. However, these any adjustments or estimates, while they may reduce certain kinds of errors, can also potentially introduce new sources of error.

Likewise, Forlines et al. (2019) makes a series of assumptions about mileage estimates that do potentially introduce error into its calculations. First, the estimated miles based on a weigh station observation is fairly simplistic in that just assumes all commercial trucks are simply just passing through Kentucky on the way to another jurisdiction, which is clearly not the case. Many such vehicles have destinations in Kentucky and will log significant miles off of the ports of entry and exit. This issue is partially addressed by the adjusted mileage ratio, which readjusts mileage estimates by dividing the reported mileage by the estimated mileage (see Table 1.3). For example, if a single vehicle was spotted on I-75 at the Laurel County Northbound scale, it is assumed the truck started its taxable route at the Tennessee-Kentucky border and will end at the Kentucky-Ohio border. However, to account for the fact that this method yields far fewer miles than what carriers report. To adjust, the authors multiply the ratio by the estimated mileage. For Q3 2015, that estimate is 111*5.97=662.67 miles. This estimates miles logged by the carrier which go undetected by the screening systems throughout the state.

Table 1.3: Conversion of Observations to Estimated Miles (from Forlines et al. 2019)

Variable	Q2 2014	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Q3 2015
Observations	298,028	631,315	864,418	1,049,418	1,143,067	1,357,959
Reported miles (thousands)	698,200	705,200	684,500	659,500	716,000	713,900
Estimated miles (thousands)	30,705	61,827	84,751	96,007	99,757	119,600
Ratio	22.74	11.41	8.08	6.87	7.18	5.97

One reason the authors prefer annualizing revenue collection estimates based on the latter quarters of the study is that more automated screening systems were implemented, thus increasing the number of observations and thus decreasing the magnitude of the adjusted mileage ratio, which should yield more accurate estimates. Obviously, the method will overestimate mileage for some carriers and underestimate mileage for others. In the end, the authors assume these will roughly cancel each other out. However, if the baseline is reported mileage, this ratio probably slightly underestimates mileage on the whole because in creating the ratio it relies on reported miles for its numerator, which does not account for detected evasion. One possible solution would be to upwardly adjust the reported miles to account for detected evasion.

Studies of heavy truck mileage taxes in New York, Oregon and Kentucky all define evasion somewhat similarly, although the focus is a bit different in some instances. The most common evasion tactic analyzed is underreported tax return miles, unreported mileage, followed by non-compliance with weight requirements. The various methodologies used to generate evasion estimates have rendered vastly different results, with VMT-based studies finding significantly higher evasion estimates than the tax reporting and audit-based studies. The principal advantage of the VMT studies is that it looks beyond self-reported tax filings from industry to generate an independent measure of VMT for heavy trucks. However, VMT estimation parameters involve a complex array of decisions about how to measure total miles traveled, apportion miles traveled to commercial trucks, assign the truck travel to various weight brackets (at least for Oregon and New York), how to account for exempted miles, and various other technical matters. Past VMT estimators have been subject to noticeable errors in terms of vehicle classification, traffic volumes and often rely on limited data. Depending on the assumptions made, the resulting evasion estimations are subject to high levels of volatility. These VMT estimates potentially overstate the true level of evasion, as they tend to yield evasion estimates far higher than what is found in a typical trucking company audit in Oregon or Kentucky.

Analysts are striving to improve VMT methodologies, which is crucial given the renewed focus by states looking to devise vehicle mileage taxes or fees for hybrid and electric passenger vehicles, which currently are not providing much revenue via traditional transportation taxes and fees (Fitzroy & Schroeckenthaler, 2018; Langer, Maheshri, & Winston, 2017; Vavrova, Chang, & Bina, 2017; Zupan, Barone, & Whitmore, 2012). Other analysts are creating new frameworks to improve the estimation of truck trip mileage and the effects of mileage taxes on both trucks and automobiles (Jansuwan, Ryu, & Chen, 2017; Langer et al., 2017; Luechinger & Roth, 2016). Based on our review of weight-mile tax evasion studies, those analyses utilizing VMT data would benefit significantly from verification of system-level estimates by supplementing it with a company-level analysis that demonstrates particular examples of these high evasion estimates.

Other weight-mile studies have taken advantage of increased availability of historical commercial vehicle screening records to estimate evasion. This approach also has limitations, as automated commercial screening technology, preclearance technology, and manually entered truck sightings do not capture all truck activity. Weigh stations are sometimes closed. And there is no infrastructure to monitor commercial vehicle activity on most bypass routes, state routes or rural roads. Turning a screening record into a mileage estimation requires the investigator to make assumptions as well. The fact that the observed mileage is often times lower than the reported mileage means that not everything is captured, and ratios have to be created to equalize the two. These ratios are not adjusted to account for the mean evasion already embedded in the reported mileage, though it does assist administrators and auditors in ferreting out the worst offenders.

However, this approach yields several advantages. First, is that these approaches take advantage of data directly designed to monitor heavy truck activity in order to enforce existing laws and regulations. It captures detailed, vehicle-specific information that can be linked to a specific company, and an array of databases that provide information about registration, tax liability, gross registered weight, vehicle configuration, and other critical data. Second, unlike the VMT model the data can be used to verify and identify evasion by a specific company or owner-operator, which is essential to enforce non-compliance. Third, these methods tend to yield less volatile estimates of evasion, and are more similar to evasion rates found by program administrators and auditors, even though they tend to be slightly higher. Fourth, weight-distance tax receipts can also be validated by comparing VMT on tax filings to IFTA and IRP filings.

1.4 FUEL TAX EVASION STUDIES

Fossil fuel taxes have been an important revenue stream for most state governments for several decades. Oregon is an exception in that heavy trucks do not pay a fuel tax for miles logged in the state. However, this literature has applicability to WMT evasion. As with mileage taxes for heavy vehicles, various stakeholders from both government agencies and industry have voiced concerns about compliance and evasion of fuel taxes. Resulting non-compliance extends beyond the trucking industry or even passenger cars, as not all fuel is exclusively used for highway transportation purposes. It is also used for heating homes, operating non-transportation equipment (such as construction equipment or agriculture implements), trains, boats, barges, and electric generators (U.S. Energy Information Administration, 2018; Weimar, Balducci, Fathelrahman, Whitmore, & Rufolo, 2008). Fuel tax evasion could apply to diesel fuels, gasoline, propane, or any other liquefied fuel product. Consequently, the mechanisms for evasion are more varied and complex than for mileage taxes, which are exclusively the province of highway transportation. Most of the literature is aimed at estimating or quantifying evasion and developing methods to enhance state and federal compliance efforts (AASHTO, 2014; Weimar et al., 2008; Weimar, Balducci, Roop, Scott, & Hwang, 2002).

Weimar et al. (2008) provide a comprehensive review of the various fuel tax evasion methods, as well as a history of evasion. In the 1980s there were a number of tax evasion schemes in response to increased fuel taxes at the state and federal level. The federal government made efforts to shore up these tax collection efforts. The point of taxation for gasoline was moved to the rack (i.e. the point of removal from a terminal or refinery) in 1986 under the Tax Reform Act; the Omnibus Budget Reconciliation Act (OBRA) of 1993 moved the point of taxation to the rack for Diesel Tax to sometime during 1994 (Weimar et al. 2008). One impactful feature of the OBRA law is that it mandated a federal fuel dying program. Federal fuel revenues increased by $1 billion in the year after the program took effect. According to a 1996 report by the Government Accountability Office (GAO), even after controlling for economic growth and increased fuel consumption, investigators determined about $600 to $700 million of the increased collection was due to increased compliance. States saw increased collections as well. States who conformed to OBTA requirements saw large increases, sometimes double-digit percentage increases in tax collections for diesel fuel purchases (Weimar et al., 2008).

Drawing on typology established by the Federation of Tax Administrators (FTA), these methods are organized by the point of taxation in relation to the supply or distribution chain (see Table 1.4). The terminal rack or import is the first point in the distribution chain, where large quantities of fuel are supplied via pipelines or large vessels, and said fuels can be removed at a rack. This is usually where fuel refineries are located. Not all states have terminals, and so the next point is at the wholesale level in most cases, though some refineries sell directly to retailers. The last point of distribution is at the retail level (FTA, 2004).

Table 1.4: Methods of Fuel Tax Evasion (From Weimar 2008, FTA 2004)

	Point of Taxation		
Evasion Technique	***Terminal Rack***	***Wholesale***	***Retail***
Blending	✓	✓	
Bootlegging	✓	✓	
Daisy Chain		✓	
Direct Blending			✓
Direct Bootlegging			✓
Failure to File		✓	✓
False Exemption		✓	
Refund Fraud	✓		
Underreporting		✓	✓

Weimer et al. (2008) go on to describe specific motor fuel tax evasion methods. Blending or direct blending is the practice of adding untraceable or untaxed products to fuel in order to extend the volume and evade taxation. Bootlegging or direct bootlegging occurs when a distributor or retailer purchases fuel in a low-tax state, neglects to fill out export paperwork that is required if fuel is being transported across state lines. A daisy chain involves the creation of several dummy corporations, including falsified paperwork showing taxes as paid after reaching the final company of the transaction chain. A popular technique for organized crime, the daisy chain evasion method involves dissolving the company with the reported liability before tax administrators can work their way through the paper trail. Failure to file is when a business or individual purchases untaxed fuel and fails to file a return. In the motor carrier industry, trucking companies wishing to dodge liability might fail to file an IFTA return. IFTA tax evasion could be perpetrated to avoid partial liability by purchasing fuel in low-tax states and failing to report mileage in a high tax state that require additional tax remittance. Or it could be the company purchased dyed or otherwise untaxed fuel and files no return whatsoever. A false exemption would be to fraudulently claim an exemption from a tax when doing so is illegal. One example of false exemption for fuel taxes is if a motorist or trucking company purchases fuel on a Native American reservation (which is exempt from federal fuel taxes) but the individual or company in question is not an enrolled member of the Native American Tribe (Weimar et al., 2008). Refund fraud is where a terminal refunds tax dollars to a purchaser who claims the fuel will be used for a tax-exempt purpose, as is the case with dyed fuel in most states. Underreporting is using false mileage reports to underreport overall miles, or potentially underreporting the number of miles in states with high fuel taxes and over reporting the number of miles in states with low fuel taxes (Weimar et al., 2008).

Table 1.4 addresses most fuel tax evasion mechanisms, although we should further elaborate on two additional components of motor fuel tax evasion previously mentioned in passing. Not all studies have each evasion method within their scope, but identifying the evasion methods is helpful. In the early 1990s, there was widespread fraud pertaining to untaxed motor fuels and wholesalers. In addition, there was little uniformity in terms of how states apportioned heavy truck fuel taxes. Some states had entered cooperative agreements, whereas others had not. The

Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 created IFTA and ordered all states to participate by 1996 or be faced with a loss of federal highway funding (Weimar, 2008). In addition, the Omnibus Budget Reconciliation Act of 1993 (OBRA) moved federal motor fuel tax liability from wholesalers to the terminal, and mandated a federal dyed-fuel program to reduce evasion pertaining to non-taxed fuel. These changes had significant impacts on fuel tax evasion efforts (Denison & Hackbart, 1996; Weimar et al., 2008). It became harder to evade fuel taxes at the terminal level or with all untaxed fuel dyed, which made it much easier for enforcement to check and see if a motor carrier was using dyed fuel. The IFTA Agreement also mandated that all participating jurisdictions audit an average 3 percent of their accounts per year.

Historically, most fuel tax evasion studies have relied on one of six methods: (1) literature review, (2) audit review, (3) border interdictions of illegal fuel supplies, (4) surveys of fuel tax administrators, (5) comparisons of fuel supply numbers and the number of taxed gallons, and (6) econometric models (Weimar et al., 2008). An FHWA study of federal gasoline and diesel tax evasion using the literature review method estimated federal gasoline tax evasion at $466.1 million to $1.09 billion (evasion rate of 3 to 7 percent), and a $645.2 million to $1.08 billion (evasion rate of 15 to 25 percent) for federal diesel fuel (FHWA, 1992). A joint study by the Council of State Governments and the Council of Governor's Policy Advisors used multiple methods to derive cumulative estimates for gasoline and diesel tax evasion. The literature review method estimate was $1.5 billion; the tax administrator survey was $1.2 billion; and the econometric analysis yielded an estimate of $952 million, thereby reinforcing the influence methodology plays on estimates (CSG & CGPA, 1996). Another econometric study of all 50 states reported similar evasion amounts to the CSG & CGPA study (Eger & Hackbart, 2001). Mingo et al. (1996) used econometric analysis to predict the evasion rate in Oregon should the state adopt a diesel tax for heavy vehicles (Oregon currently has no such tax). They estimated a 24-cent diesel tax would result in 24-percent non-compliance, with estimated evasion rising continuously at various hypothetical tax rates. Such a tax was never implemented in Oregon for heavy vehicles. Industry members have criticized the estimate provided by Mingo et al as being unrealistic given that most fuel tax collection for heavy trucks occurs at the rack.

One method of investigation that yielded problematic results was the comparison of fuel supply numbers and taxable gallons. Weimar et al. reviewed several studies that attempted to use various data sources and collection techniques, and found the results were inconsistent. In one study looking at jet fuel tax evasion, dataset discrepancies between the Federal Aviation Administration's jet fuel consumption data and the Energy Information Administration's petroleum supply data made it impossible to determine whether the differences in fuel supply and consumption are due to tax evasion or differences in estimation or data collection efforts (KPMG Consulting, 2001; Weimar et al., 2008).

More recently, researchers investigating fuel tax evasion have shown increasing interest in the error, omission, and evasion framework (EOE), which can be used to measure the total evasion in any state fuel tax structure. Proponents of the framework point out that states with better databases, enforcement and compliance systems will be able to generate more accurate analysis with such methods than states without quality data, compliance and enforcement mechanisms (Weimar et al., 2008). Essentially, the framework was viewed as a preferable alternative to the Simultaneous Equation Approach (SEA), which relies on VMT data to derive estimates of fuel consumption. An earlier study prepared for the Oregon Department of Transportation concluded that FHWA VMT was not accurate enough to estimate EOE for individual states (Evans, 2000; Weimar et al., 2008). The scholars develop three approaches for using EOE to estimate fuel tax evasion: a simple average approach using audit and inspection data, a fuel tracking system to follow fuel from terminals to taxpayers, and a system for estimating evasion due to presence of Native American fuel outlets. Estimating evasion of fuel taxes is not relevant for purposes of this study, but the methods developed could be adapted for estimates of WMT evasion.

Motor carrier evasion of IFTA taxes has not typically been the focal point of most studies, but there are exceptions. A 2006 investigation of Montana's fuel evasion rates used the EOE framework to look at IFTA fraud, among other evasion techniques (Balducci et al., 2006). Examining motor carrier audits, Balducci et al. (2006) determined that in 2004 there was about 10.5 million gallons worth of IFTA evasion for diesel fuel, or about $2.92 million uncollected revenues. Total diesel fuel evasion for all evasion schemes was about 43.4 million gallons, or roughly 16.3 percent of all diesel gallons consumed. Evasion of gasoline was much lower, as just 2.1 percent (Balducci, 2006). Audit reviews of Montana IFTA for 2002-204 showed that 3.55 percent of accounts were audited, and that net collections for 157 audits were $907,720 (Balducci, 2006).

Eger and Hackbart (2001) summarized a few other older studies of state fuel tax evasion, but none of them looked exclusively at IFTA, but evaluates tax evasion more broadly. A 1992 study estimated New Jersey was losing $40 million in revenue annually due to the cumulative effect of several types of fuel tax evasion; another study of Kentucky during the 1990s estimated losses between $14 to $20 million (Eger and Hackbart, 2001). In absence of many studies quantifying evasion specific to IFTA tax fraud, researchers have taken other approaches to adjudicating the In the years after IFTA's initial implementation, two other studies examined issues pertinent to the equity and efficacy of IFTA as a multijurisdictional tax agreement between the U.S. states and the Canadian provinces, as well as its adequacy in (Denison & Facer, 2005; Yusuf & O'Connell, 2012). Denison and Facer (2005) evaluate IFTA's performance through the prism of tax principles, state perspectives and industry perspectives. They conclude it does occupy several critical tax principles, including fairness, equity, and economic neutrality given the interjurisdictional agreement and apportionment of fees. Having multiple jurisdictions monitoring and possibly auditing company returns gives states a greater availability to hold tax evaders accountable. Although fuel taxes are somewhat inelastic and stable revenues sources now, this assumption may not hold, as fuel efficiency continues to improve and hybrid and electric commercial vehicles begin to proliferate on U.S. highways. There are also lingering questions about the efficacy of the audit system (Yusuf & O'Connell, 2012). As with mileage taxes, IFTA relies on carriers' record keeping. If there are not a sufficient number of audits, fraud may increase. Eger and Hackbart (2005) found that more frequent auditing increases IFTA tax revenues, even though the state survey by Yusuf and O'Connell showed states had mixed feelings on the value of administering IFTA tax audits (Eger & Hackbart, 2005; Yusuf & O'Connell, 2012).

Although Oregon does not levy a motor fuel tax on heavy vehicles, this literature is an important analog to the mileage tax evasion studies for heavy trucks. As with the mileage studies, the estimated amount of evasion depends on how evasion is defined, the quality of data available, and the methodology or model chosen to measure it. There are far more evasion methods for fuel tax than heavy mileage tax, as there are more potential evaders. Terminals, wholesalers, retailers, trucking companies, passenger motorists, and elements or organized crime can all participate in fuel tax evasion schemes, whereas trucking companies and drivers are practically the only entities who can commit heavy mileage tax evasion. State and federal governments have tried to curb fuel tax evasion over the last 25 years by requiring non-taxable fuel to be dyed, moving tax liability from wholesalers to terminals in some states, and through the creation of IFTA. Models that compare fuel purchases to supply lines have been problematic, as different agencies define fuel movements and purchases differently when tracking them in their various databases. This is reminiscent of some of the issues with VMT models of heavy fuel tax evasion. Literature reviews and survey-based evasion estimates also have limits, as they rely on existing information or somewhat imprecise measurements. Audit reviews and econometric models have been the most promising types of fuel tax evasion estimates thus far, particularly those utilizing the EOE framework.

There have been few studies that quantify IFTA fuel tax evasion in particular. This is not directly relevant to this study, as Oregon does not levy IFTA taxes. However, it provides an opportunity to conduct an econometric analysis of discrepancies between the weight-mile tax miles and IFTA tax miles reported on tax returns submitted by carriers operating in Oregon. If anything, the lack of a fuel tax should give carriers an incentive to correctly report Oregon miles – some may even over report Oregon miles such that underreporting in other jurisdictions is possible. Nevertheless, the IFTA (as well as IRP) mileage reports give researchers an additional mechanism to compare motor carrier WMT miles.

1.5 TOLLING

Another source of transportation revenue generated from trucking industry activity and assessed in the form of fees is collected via tolling. Tolling is different than fuel taxes, mileage taxes, and credential and permitting fees in that it applies to select roads and bridges, and is typically implemented on a case-by-case basis rather than as statewide policy. It also applies to non-commercial vehicles. Tolling is administratively costly, as states or tolling authorities must either operate toll booths or engage in collection efforts for unpaid electronic tolls. Davis et al. (2018) found that while tolling can accelerate the implementation of crucial infrastructure projects, there are tradeoffs. Toll roads create traffic diversion for people who wish to avoid the tolls, putting more duress on alternate routes without tolls. Users – particularly new users or sporadic travelers from another state or region – may not understand the requirements or how to pay, which means states must engage in protracted efforts to create awareness and collect fees. They are more costly to collect than other sources of funding (Davis et al., 2018).

There are also equity issues. A study of Spanish motorists shows that socioeconomic characteristics have little to do with whether individuals had electronic tolling tags – ownership of tags was more a byproduct of geography than anything else. Given the constraints of time, business and individual motorist demand for tolling appears inelastic and unrelated to ability to pay. This means tolling creates equity issues for low-income users (Heras-Molina, Gomez and Vassallo, 2017). Another paper by Poole (2016) argues that tolls may be the "least-bad" funding mechanism necessary in order for the trucking industry to get much needed infrastructure improvements nationally. The author does acknowledge the lack of popularity of such an option with industry members, but does not entirely grapple with the underlying issues. Some issues not addressed are the feasibility of tolling rural and low-use roads, the equity concerns of the trucking industry (i.e. what trucking companies pay vs. passenger vehicles in tolling situations), or the inequitable geographic impact for trucking firms located near tolling-based infrastructure, Nevertheless, tolling is beyond the scope of this research study.

2.0 OREGON WMT RESEARCH DATA AND METHODOLOGY

As stated in Chapter 1, there have been multiple approaches to WMT evasion estimation. This chapter provides a synopsis of the data and the methods used to evaluate weight-mile tax evasion in Oregon. Evaluating weight-mile tax evasion requires the acquisition and preparation of several different kinds of data. This chapter is comprised of two major sections. The first section focuses on the necessary data inputs to conduct the analysis. In particular, it describes WMT tax return data, commercial vehicle screening data, temporary pass data, Oregon commercial vehicle inspection data, IFTA return data, IRP return data, and VMT data. The second section focuses on the methodology for detecting and quantifying Oregon WMT evasion. It provides three approaches to estimating evasion. The first evasion method approach compares the company-level mileage reports with screening data and mileage estimation factors. The second evasion method approach compares WMT tax report mileage to the IFTA return mileage. The third evasion method approach compares WMT tax report mileage to the IRP return mileage.

Here we summarize the data sources to be used for the WMT evasion estimation analysis. The data sources include WMT tax return data, temporary passes, and historical commercial vehicle screening data, inspection data, enforcement activities, IRP filings, and IFTA filings.

2.1 WMT TAX RETURN DATA

In Oregon, motor carriers operating commercial vehicles above 26,000 pounds are required to declare a registered weight and taxable weight for each truck in their fleet. The WMT mileage rate is applied to each vehicle depending on its weight. ODOT officials provided KTC with WMT return data from 2016 through 2018. Oregon WMT tax rates are adjusted periodically as the state's Highway Cost Allocation Study updates its estimates for revenue share and costs incurred for the highway system due to highway activity estimates for each vehicle class. These requirements were ratified by Oregon voters in the 1999 special election, which added the requirement under Article IX, Section 3a(3) of the Oregon constitution. The section reads:

"Revenues … that are generated by taxes or excises imposed by the state shall be generated in a manner that ensures that the share of revenues paid for the use of light vehicles, including cars, and the share of revenues paid for the use of heavy vehicles, including trucks, is fair and proportionate to the costs incurred for the highway system because of each class of vehicle. The Legislative Assembly shall provide for a biennial review and, if necessary, adjustment, of revenue sources to ensure fairness and proportionality. The Legislative Assembly shall provide for a biennial review and, if necessary, adjustment, of revenue sources to ensure fairness and proportionality."

The biennial Highway Cost Allocation Study results can trigger these constitutionally mandated tax and fee changes as often as every two years, including the WMT. ODOT provided WMT rates by weight class for the duration of the study period. Rates changed in 2010 but remained the same until the end of 2017. A new set of rates were issued for 2018 to 2019. The former rates were applicable in 2016 and 2017 while the latter applied in 2018. Tables 2.1 and 2.2 display the historical WMT rates for 2010 through 2017, and 2018 through 2019. Table 2.1 shows the WMT rate per mile for trucks beginning at 26,001 up to 80,000 pounds. It should be noted that trucks can declare at higher weights and legally operate after purchasing either a single or annual oversize/overweight permit on approved routes. As shown in Table 2.2, the WMT applies to these vehicles as well; however, those rates are more complex because in addition to the weight class, the axle configurations are also taken into account when setting rates.

Table 2.1: Historical Weight Distance Tax Rates by Weight Class (80,000 lbs. or less)

Weight Group		Rates (in $)	
Low	***High***	***2010-2017***	***2018-2019***
26,001	28,000	0.0498	0.0623
28,001	30,000	0.0528	0.0660
30,001	32,000	0.0552	0.0689
32,001	34,000	0.0576	0.0721
34,001	36,000	0.0599	0.0749
36,001	38,000	0.0630	0.0787
38,001	40,000	0.0654	0.0817
40,001	42,000	0.0677	0.0847
42,001	44,000	0.0702	0.0878
44,001	46,000	0.0726	0.0907
46,001	48,000	0.0749	0.0937
48,001	50,000	0.0774	0.0968
50,001	52,000	0.0803	0.1004
52,001	54,000	0.0833	0.1041
54,001	56,000	0.0864	0.1080
56,001	58,000	0.0900	0.1125
58,001	60,000	0.0941	0.1177
60,001	62,000	0.0990	0.1237
62,001	64,000	0.1045	0.1306
64,001	66,000	0.1104	0.1380
66,001	68,000	0.1183	0.1478
68,001	70,000	0.1266	0.1583
70,001	72,000	0.1350	0.1687
72,001	74,000	0.1427	0.1783
74,001	76,000	0.1500	0.1875
76,001	78,000	0.1572	0.1966
78,001	80,000	0.1638	0.2048

Table 2.2: Historical Weight Distance Tax Rates by Weight Class (More than 80,000 lbs.)

		5 Axles		6 Axles		7 Axles		8 Axles		9 Axles	
Weight Group		Rates (in $)		Rates (in $)		Rates (in $)		Rates (in $)		Rates (in $)	
Low	*High*	*2010-2017*	*2018-2019*	*2010-2017*	*2018-2019*	*2010-2017*	*2018-2019*	*2010-2017*	*2018-2019*	*2010-2017*	*2018-2019*
80,001	82,000	0.1692	0.2115	0.1548	0.1934	0.1447	0.1808	0.1374	0.1718	0.1296	0.1620
82,001	84,000	0.1747	0.2183	0.1572	0.1966	0.1470	0.1838	0.1392	0.1740	0.1313	0.1642
84,001	86,000	0.1799	0.2249	0.1609	0.2011	0.1494	0.1868	0.1409	0.1762	0.1332	0.1665
86,001	88,000	0.1860	0.2325	0.1643	0.2054	0.1518	0.1897	0.1434	0.1793	0.1350	0.1687
88,001	90,000	0.1932	0.2415	0.1686	0.2107	0.1543	0.1928	0.1458	0.1822	0.1374	0.1718
90,001	92,000	0.2016	0.2520	0.1734	0.2168	0.1565	0.1956	0.1482	0.1852	0.1398	0.1748
92,001	94,000	0.2107	0.2633	0.1782	0.2227	0.1590	0.1987	0.1505	0.1882	0.1417	0.1771
94,001	96,000	0.2202	0.2753	0.1836	0.2295	0.1620	0.2025	0.1530	0.1913	0.1439	0.1799
96,001	98,000	0.2304	0.2881	0.1902	0.2378	0.1656	0.2070	0.1555	0.1944	0.1464	0.1830
98,001	100,000			0.1973	0.2467	0.1692	0.2115	0.1584	0.1980	0.1488	0.1860
100,001	102,000					0.1728	0.2160	0.1620	0.2025	0.1513	0.1891
102,001	104,000					0.1764	0.2205	0.1656	0.2070	0.1543	0.1928
104,001	106,000					0.1811	0.2264	0.1692	0.2115	0.1572	0.1966

Under Oregon state law, there are some exceptions to the typical WMT for trucks hauling certain commodities. Rather than pay a mileage-based tax based on weight and/or axle configuration, those hauling the following commodities can elect to pay a flat fee:

- Logs, poles, piling, or peeler cores.
- Wood chips, sawdust, bark dust, hog fuel, or shavings.
- Vehicles equipped with dump bodies hauling sand, gravel, rock, dirt, debris, cinders, asphaltic concrete mix, metallic ores, and concentrates, or raw non-metallic products, whether crushed or otherwise, when moving from mines, pits or quarries if the transportation of these commodities is associated with a highway or other construction project.
- Farm vehicles when operating intrastate, for-hire under a Permit granted under ORS 825.102, and with a combined weight of less than 46,000 pounds.

The annual flat fees are paid in equal monthly installments. Fee amounts are specified under ORS 825.480. Carriers must pay flat fees based on a vehicle's heaviest declared solo weight. Flat fees are assessed beginning at 26,100 pounds and extend in 100 pound increments to 105,500 pounds. Trucks hauling loads heavier than that can be declared at combined weights between 82,000 and 105,500, but are also assessed an annual extended weight permit. There fee constructs are the same for each commodity, but each commodity has a different rate schedule. In particular there are rates for dump trucks, log trucks, and wood chip trucks. For 2018 and 2019, the fees for dump trucks and log trumps are the same, calculated at $.76 per month at 100 pounds and at to $606.67 for an 80,000-pound truck, for example. Wood chip fees are somewhat higher, starting at $3.07 at 100 pounds and going up to $2,453.33 for an 80,000-pound truck. Comprehensive tables with past, present and future flat fee rates is available at https://www.oregon.gov/ODOT/MCT/Pages/FormsandTables.aspx. Flat fee truck mileage constitutes less than 1 percent of filers in each year for which data is available.[2]

There are three types of returns analyzed for the study – monthly returns, quarterly returns, and temporary WMT passes. Most carriers file monthly WMT tax returns, where they report Oregon mileage and taxes at the vehicle level. Filers supply the company name, Oregon account number, base plate number, base state, VIN, registered weight, and taxable weight. Some companies provide multiple taxable weights for a specific vehicle that will depend on use of rates for over and under 80,000 pound operations, as well as number of axles for declared weights over 80,000 pounds. The carrier also supplies a mileage total and a reported tax total that is to be paid. Quarterly tax returns work the same way, except they only have to be paid once every three months. If carriers want to file quarterly, they must have a 12-month filing history with no suspension of their WMT account, no IFTA license revocation, no more than 25 percent of WMT reports filed late, no use of a repayment plan, or delinquency in payment of over

[2] Carriers may also be assessed a Road Use Assessment Fee (RUAF) if they are transporting non-divisible loads more than 98,000 lbs. Examples include a bulldozer, steel plates, crane, and an excavator.

dimensional permit fees or road use assessment fees. To qualify for quarterly filing a carrier must also not have any WMT audit with a net adjustment exceeding 15 percent of the original filing amount during the last 36 months. The other option – although not a long-term option – is to obtain a temporary pass that allows legal operation in the state without first setting up a tax account. Oregon statutes and regulations require carriers to establish a permanent account if routinely traveling in the state. ODOT's Commerce and Compliance Division (CCD) limits the number of temporary passes a carrier can obtain before establishing a permanent account – a maximum of five temporary passes for one unit and 35 in a rolling 12-month period for an account. Carriers must also provide the specific vehicle information, including weight declaration and axle counts for declared weights above 80,000 pounds. It also requires the carrier to estimate WMT mileage and pay a $9 fee for the pass. Additionally, a company that exceeds its estimated WMT mileage can call and add miles to the pass within the 10-day period and pay the additional WMT taxes owed.

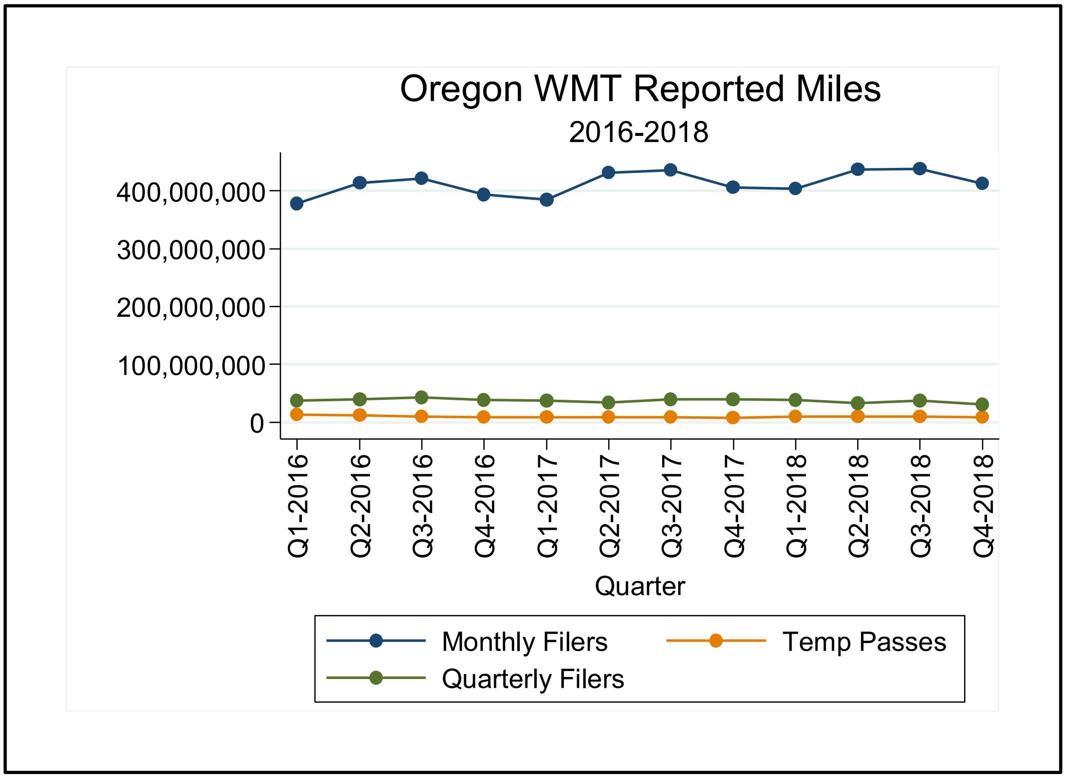
Table 2.3 displays the distribution of WMT return types from 2016 to 2018. For each year, the total number of WMT records in each category are reported and the overall percentage for returns that year is reported. Percentages are rounded to the nearest hundredth so there are small discrepancies in the percentages. The vast majority of tax records filed with ODOT during each year are monthly tax returns. Most carriers file WMT returns monthly, and given the greater frequency of monthly WMT reporting requirements, it is unsurprising that monthly WMT reports account for the vast majority of returns. About 90 percent of Oregon's WMT tax records between 2016 and 2018 were monthly returns. Quarterly returns were the next-most-common, comprising about 4-6 percent of the returns. Temporary pass-related returns are the least common overall, likely because the $9 fee and lack of a WMT account is much less efficient and more costly. However, it may be preferable to new motor carriers unaware of Oregon's requirements or carriers who operate in the state infrequently.

Table 2.3: Number of WMT Tax Returns Filed by Type, 2016-2018

Year	Type	Freq.	Percent
2016	Monthly	2,186,569	89.41
	Pass	120,478	4.93
	Quarterly	138,475	5.66
	Total	2,445,522	100.00
2017	Monthly	2,335,597	91.67
	Pass	93,615	3.67
	Quarterly	118,508	4.65
	Total	2,547,720	100.00
2018	Monthly	2,642,697	91.83
	Pass	106,709	3.71
	Quarterly	128,454	4.46
	Total	2,877,860	100.00

Based on the tax returns, it is possible to calculate the quarterly mileage reported by carriers for original returns filed between 2016 and 2018. The data does not include amended returns or post-audit adjustments. However, the analysis in Chapter 3 will incorporate those adjustments when estimating total evasion. To sort non-quarterly filers into a quarter, some adjustments were made. Monthly filers were assigned to a corresponding quarter based on a month and year, and all mileage during each three-month period was combined into the corresponding quarter. Temporary passes were somewhat more complicated. The WMT database with temp passes includes the validation date, or date the pass was requested. This can differ from the effective date for a pass, though the two dates are the same in about 80 percent of the cases. Consequently, some passes issued near the end of a quarter may have an effective date starting in the next quarter. However, the mileage associated with those passes is counted toward the issuance date. For example, a pass issued on 9/30/2016 with an effective date of 10/1/2016 will be counted as part of Q3 2016 instead of Q4 2016. We note such a discrepancy for the sake of transparency, even though it does not significantly impact the quarterly mileage totals.

Figure 2.1 displays the quarterly mileage totals based on individual WMT returns, including monthly returns and reported mileage related to temporary passes. The second figure takes out monthly returns to make the scale for quarterly and pass-based mileage reports easier to interpret. Based on the data in Table 2.3, it comes as no surprise that the vast majority of mileage comes from monthly filings given that the vast majority of returns are filed monthly. On average, more than 412 million WMT miles are reported each quarter by motor carriers filing monthly returns (about 137.6 million WMT miles per month) from 2016 to 2018. Quarterly WMT filers post the second-most mileage of any other reporting type. The average number of WMT miles reported on quarterly returns was about 37.6 million per quarter from 2016 to 2018. Although mileage totals for monthly filers trended up during the study period, the mileage totals for quarterly filing declined somewhat, as evidenced by the bottom graph in Figure 2.1. Overall, carriers filing mileage associated with temporary passes claim about 9.6 million miles per quarter. Total WMT mileage reports increased from 1.81 billion to 1.84 billion from 2016 to 2017, and from 1.84 billion to 1.87 billion from 2017 to 2018. Note that these figures do not include mileage reported by carriers paying flat fees. Flat fee carriers do not pay a mileage tax but a flat rate. Flat fee carriers are not required to report mileage, although many carriers choose to do so. Nevertheless, those mileage reports constitute a small portion of overall mileage and are outside the scope of the WMT evasion analysis.



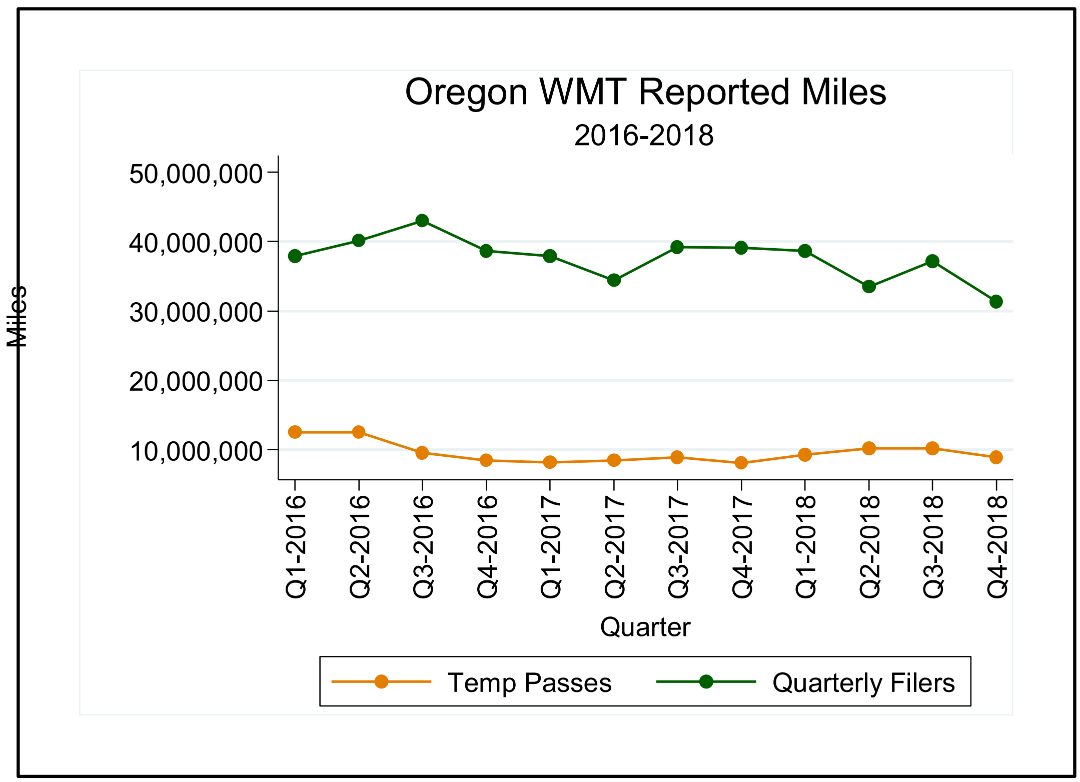


Figure 2.1: Oregon WMT mileage reported by quarter, 2016-2018

Figure 2.2 reports the quarterly WMT revenue collected by ODOT by quarter from 2016 through 2018 from original tax filings. The blue bars correspond to monthly filers, the orange to quarterly filers, and the green to taxes paid by those who obtain a temporary pass before establishing a tax account and filing tax reports. The data patterns are similar to those corresponding to the number of returns filed and the number of miles reported. Most of the revenues come from monthly filers. Monthly filer revenue averaged nearly $69 million per quarter, or $23 million per month during the analysis period. Quarterly WMT returns generate roughly $24.6 million per quarter. The least revenue is generated by carriers making use of temporary passes, which yields about $1.6 million per quarter. Note however that revenues are not static. Revenue increased significantly in 2018, jumping from $284.1 million to $357.5 million, largely as a result of WMT rate increases, but also to a lesser degree because of increases in reported mileage.

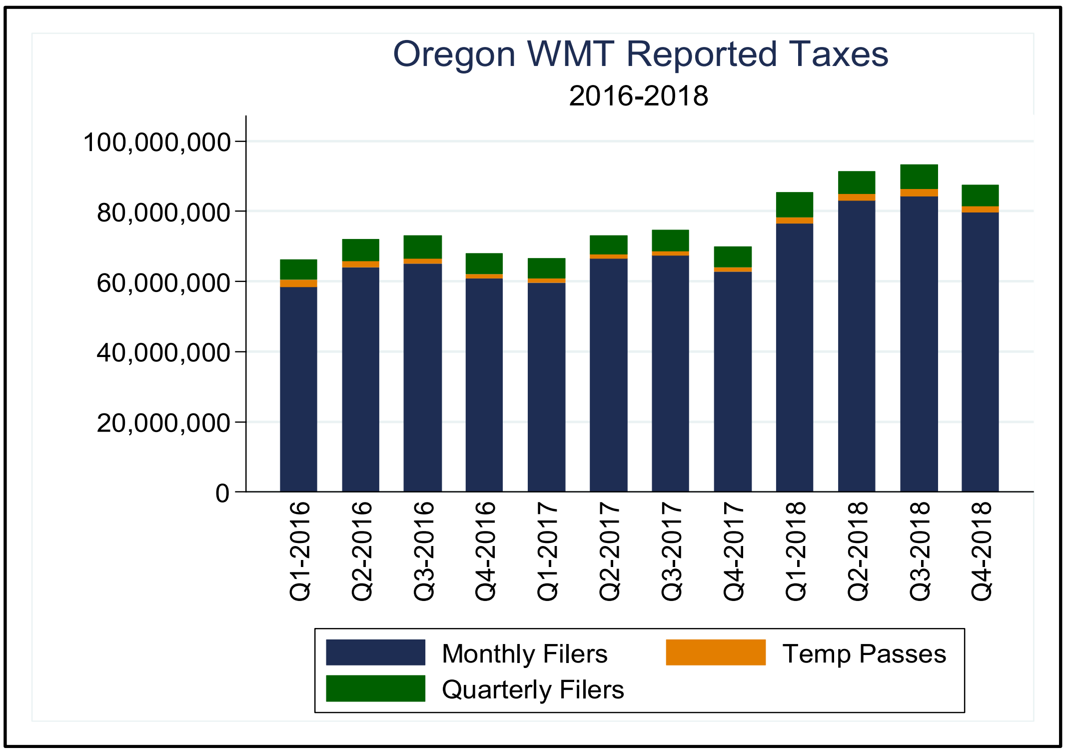


Figure 2.2: WMT tax revenues by quarter, 2016-2018

The WMT revenue totals are somewhat different than the WMT totals provided by CCD. ODOT reports show revenues of $318.7 million in 2017 and $397.3 million in 2018. There are several reasons why the revenue numbers reported in Figure 2.2 do not match official ODOT totals. First, the totals in Figure 2.2 do not include all sources of total reported revenues. Figure 2.3 shows the ODOT WMT totals reported by ODOT from 1962 through 2018 (provided by CCD). In addition to WMT mileage receipts, Figure 2.3 includes all cash receipts, registration fees for non-apportioned (i.e. intrastate) trucks, the $9 fee for temporary passes, flat fees for haulers of commodities exempted from WMT mileage-based rates, amended returns, audit receipts, reinstatement and suspension fees, trip permits, plate replacement, penalties, interest, and non-sufficient funds fees.

The graph includes two plots – one of actual revenues and another that adjusts revenues based on inflation. Inflation statistics were derived using the Consumer Price Index (CPI) calculator and data provided by the Bureau of Labor Statistics (2019). In 1962, the WMT generated $16.8 million in revenue – or $139.3 million in 2018 dollars. Revenue increases have been fairly steady, with organic increases and decreases largely related to economic growth and recession. In other instances, the revenue levels would change abruptly, largely due to changes in the WMT rates assessed to motor carriers. Recent changes to WMT rates occurred in 2000, 2004, 2010, and 2018. Rates also changed in 2020, although this occurred after the study period. WMT rate increases typically occur as the result of Oregon's Highway Cost Allocation Study, which determines cost responsibility and cost allocation parameters that informs legislative action (see Chapter 1 for more information).

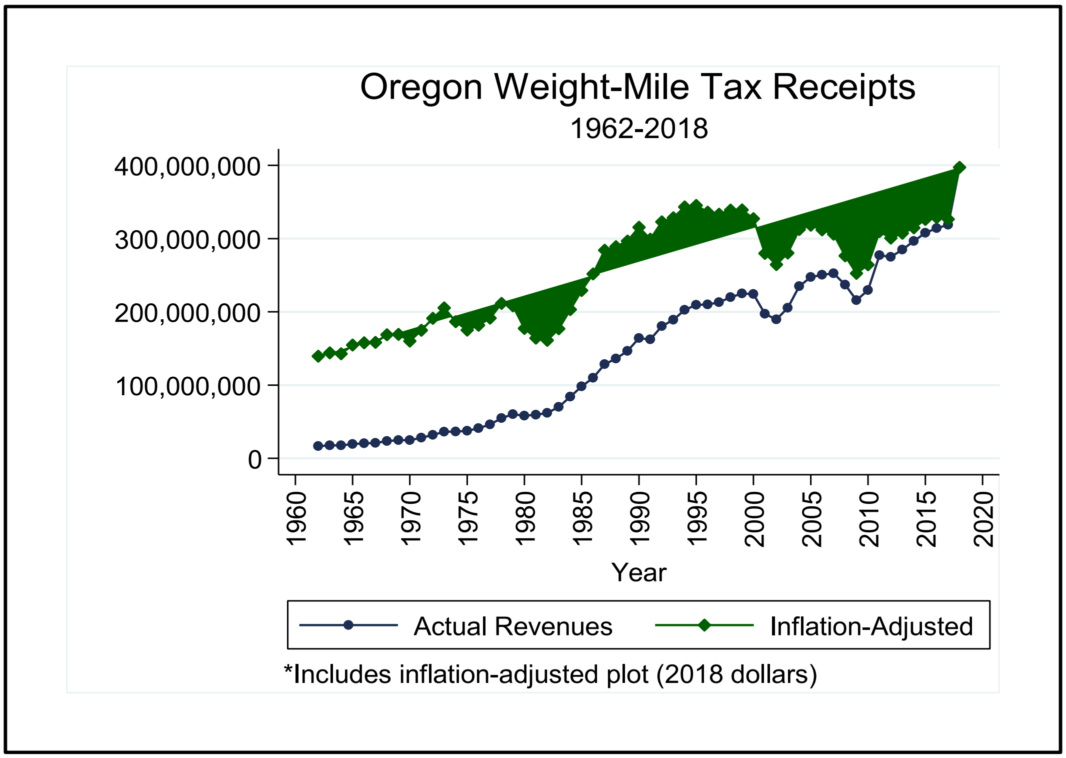


Figure 2.3: Oregon WMT receipts, reported and inflation adjusted, 1962-2018

2.2 TEMPORARY PASSES AND TRIP PERMITS

Oregon DOT also provided data on temporary passes and trip permits. Temporary passes are credentials that are generally purchased by motor carriers that do not have an established WMT tax account, or have a vehicle that has not been permanently enrolled under their tax account. As previously noted, these carriers do report their mileage, the heaviest declared weight for the reporting period, and axle weights when declared weights are heavier than 80,000 pounds. Carriers can declare multiple declared weights on a temporary pass and pay for mileage at those declared weights to reflect the nature of their vehicle configurations. While the temporary WMT data reports the credential validation date, the more detailed temporary passes and trip permits data include a pass/permit effective date and pass/permit expiration date. Except in rare cases, passes/permits are good for 10 days including the effective date. The data also includes trip permits, which are unrelated to WMT taxes but instead applies to operating authority for out-of-state carriers who do not have IRP (or apportioned) license plates but want to do business in Oregon on a short-term basis.

Table 2.4 reports the number of temporary WMT passes and TRIP permits for non-apportioned commercial vehicles in Oregon. Currently Oregon issues far more WMT passes than TRIP permits. Registration is required in every state to operate legally, and most motor carriers have IRP registration. Before the passage of the Full Reciprocity Plan and its subsequent implementation in 2015, carriers had to declare which jurisdictions they intended to operate in during the coming year. After Full Reciprocity was passed, carriers were allowed to operate in all IRP jurisdictions without having to make a declaration. Consequently, the percentage of carriers in need of trip permits diminished from 35,741 in 2015 to 29,206 in 2018. WMT passes followed a similar trajectory, dropping from 171,224 in 2015 to 106,733 in 2018. Note that the comparisons for WMT passes in years 2016 to 2018 in Table 2.3 and Table 2.4 reveals a slight though inconsequential discrepancy because the data was pulled from two difference sources.

Table 2.4: WMT Passes and Trip Permits Issued by ODOT, 2015-2018

Year	WMT Passes	Trip Permits	Total
2015	171,224	35,741	206,965
2016	120,419	31,326	151,745
2017	93,555	30,170	123,725
2018	106,733	29,206	135,939
Total	491,931	126,443	618,374

2.3 ODOT COMMERCIAL VEHICLE SCREENING DATA

Administrators in ODOT's CCD provided the KTC research team with commercial vehicle screening data from weigh stations, virtual weigh stations, and fueling stations around the state. The data is obtained by inspectors at weigh stations, license plate readers (LPRs) or at fueling stations as required by state law. When a vehicle enters the bypass lane at a weigh station, the inspector will key the license plate. The keyed plate is run against several databases, including the WMT database, FMCSA's SAFER database, and others to ascertain whether the carrier has outstanding taxes, a history of safety issues, is operating at or below its registered and tax declared weights, and has an active OW/OD permit. Similarly, the fueling data is generated at the fueling station when the vehicle license plate or temporary pass number is entered at the time of fueling. All of the data is manually entered with the exception of the weigh-in-motion (WIM), LPR screening, and preclearance programs such as Greenlight and Drivewyze, which are all automated.

Figure 2.4 reports the quarterly count of screening records for weighing on WIM or fixed scales at Oregon weigh stations, LPR screening data from locations where such equipment is installed, and fuel receipts from 2015 through 2018. During the time period analyzed, Oregon compiled roughly 22.8 million records of commercial vehicle screenings and fuel reports. Most of the records – 16.2 million over a four-year stretch, or 71 percent of all screening records – are the weigh station, virtual weigh station, and portable truck screenings via manually keyed observations. Although total weigh station observations were down somewhat in 2018, the trend there has been steady. Nearly 4.5 million records come from the fueling records collected at fueling stations around the state, and those record counts increased starting in 2016. The increase in 2015 is the result of a 2015 change to Oregon law that required fuel sellers with 100 or more transactions a month to report fuel purchases electronically. CCD began receiving the data in 2016, which caused an uptick in the availability of commercial vehicle fueling records. Prior to changes in state law, only select sellers were providing this data.

Approximately 2.1 million LPR records were accumulated during the same time period at five LPR sites, with notable increases in 2017 and 2018. The five LPR sites in Oregon are Junction City Northbound, Junction City Southbound, Modoc Point, Woodburn Northbound and Woodburn Port-of-Entry. Most of the increase in 2017 and 2018 is the result of the LPR system rollout at the Woodburn Northbound site and increased usage of both Junction City sites. These records will be used to estimate WMT liabilities for specific companies and compared to actual returns to ascertain WMT evasion rates.

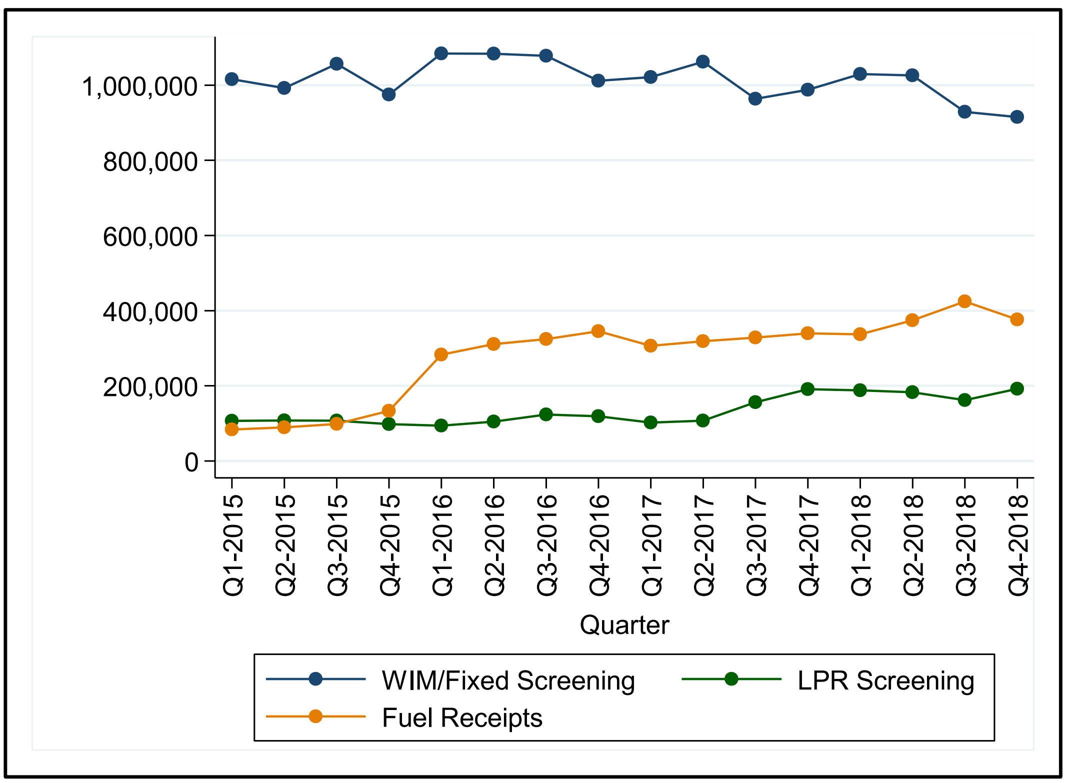


Figure 2.4: ODOT commercial vehicle screening and fueling records, 2015-2018

As Table 2.5 demonstrates, there are different types of weigh stations or information systems gathering observations. Between 2015 and 2018, nearly 77 percent of all the commercial screening records came from the weigh stations included in Oregon's Green Light preclearance program. ODOT includes 21 stations as part of the program. These stations are positioned along I-5, I-82, I-84, U.S. Highway 97, Oregon Highway 730, and U.S. Highway 30. Records from the Green Light stations include both preclearance observations from program participants based on transponder signals and manual reads from the WIM scale. About 2.1 million records also came from 71 fixed locations around the state, most of them on non-Interstate highway state routes with less traffic. A very small portion of records comes from portable routes made possible by short-term enforcement details making use of portable scales. Last, the five LPR sites account for about 2.1 million records, which is very similar to the fixed site totals for the four-year period. However, in the last two years of the cycle, LPR record counts significantly exceeded the fixed counts. LPR systems automate data collection processes, which results in increased screening efficiency. The downside is they tend to be less accurate (and therefore less reliable for enforcement purposes) for enforcement. License plate readers may incorrectly decode a license plate for a variety of technical reasons, such as lighting defects, local weather, dirty license plates, truck speed, etc. There are also going to be some duplicate records at the Woodburn Northbound and Woodburn Port-of-Entry, as these weigh stations have both LPR systems, Green Light records, and manually keyed observations. Our methodology will include steps to identify those duplicate records and eliminate them.

Table 2.5: Number of Screening Records by Year and System Type

Scale Type	Sites	2015	2016	2017	2018	Total
Green Light	21	3,500,788	3,729,133	3,518,120	3,350,604	14,098,645
Fixed	71	533,994	524,288	513,814	544,687	2,116,783
Portable	68	4,920	3,937	2,715	3,661	15,233
LPR	5	418,442	441,528	556,684	724,424	2,141,078
Total	165	4,458,144	4,698,886	4,591,333	4,623,376	18,371,739

2.4 INSPECTION DATA

ODOT provided KTC a dataset containing all commercial vehicle inspections conducted in Oregon in 2017 and 2018. Each inspection is recorded with a base plate, state, inspection date, inspection location, highway, milepost, and load origin and load destination information. A total of 125,530 inspections were recorded - 66,092 in 2017 and 59,438 2018, respectively. The inspection data can be used to determine the median number of miles a vehicle logs while on a trip through Oregon because it includes the load origin and destination. Obviously, such a comparison invites a few caveats. The operational patterns of inspected vehicles may in some unknown ways deviate from uninspected vehicles. Therefore, we have to make certain assumptions about the uninspected vehicles. Additionally, the origin and destination data make no indication of the interim stops a vehicle might make along the way to its final destination. Furthermore, in the vast majority of cases it will be unknown whether the vehicle is coming back through Oregon via a return trip because it is highly unlikely the truck will be inspected again in such a short span of time. Nevertheless, having a metric for the average number of miles traveled depending on the location where a vehicle was observed will be useful for the evasion analysis.

In order to estimate the distance a vehicle traveled within Oregon for the delivery indicated in the shipping paper or log, it is necessary to have accurate load origin and destination information in the inspection report. 10,684 inspection records were deleted due to inaccurate descriptions in the load origin and destination fields. Common mistakes include missing city information, missing state information, or both. In addition, 2,326 inspections were dropped from the dataset because their load origin and destination fall in the same city. So, the further analysis begins with the dataset of 112,520 inspections. 33,230 inspections were roadside inspections, and 78,267 inspections were conducted at 97 inspection locations. 1,023 inspections were not categorized since it was not clear where the inspection occurred. Of the 78,267 inspections we started this analysis with, we estimated the distance a vehicle traveled within Oregon state boundary for 75,508 cases. We dropped 2,759 records, because either load origin or destination could not be matched to the cities recorded in the U.S. Cities Database (https://simplemaps.com/data/us-cities). Therefore, the analyzed data file contains 75,508 observations with total miles traveled within Oregon.

Table 2.6 shows the distribution of inspection locations throughout the state for the subset of data where it was possible to determine route length. The largest number of inspections occurred at the Woodburn Port-of-Entry Scale, with 9,920 inspections. The Woodburn inspections constituted more than 13 percent of all route-verified inspections performed during this time. Next is the Umatilla Port-of-Entry station in the northeastern region of the state, with 11.8 percent of all sampled inspections. Rounding out the top five inspection locations are three other point-of-entry stations – Farewell Bend, Cascade Locks, and Klamath Falls, with 7.9, 6.9, and 5.4 percent of sample inspections, respectively. Collectively, these five point-of-entry stations account for 45 percent of the inspections in the sample. Overall, 60,367 of the sampled inspections are conducted at weigh stations with a Green Light preclearance system, which is nearly 80 percent of the sample. Note that this number would be lower if the 33,230 roadside inspections were included.

Table 2.6: Oregon Commercial Vehicle Inspections by Location, 2017-2018

Inspection Location	Freq.	%
Adair NB (N of Corvallis)	10	0.01
Alston (4 mi W of Rainier)	59	0.08
Arlington Portable	41	0.05
Ashland NB (2 mi N of Ashland)	37	0.05
Ashland POE (3.5 mi N of Ashland)	3,981	5.27
Ashland SB (3.5 mi N of Ashland)	1,935	2.56
Athena Portable	83	0.11
Baker (1 mi S of Baker)	5	0.01
Bandon (2 mi S of Bandon)	41	0.05
Bend (2 mi S of Bend)	1,446	1.92
Blodgett EB (2 mi E of Blodgett)	52	0.07
Blodgett WB (2 mi E of Blodgett)	10	0.01
Booth Ranch NB (3 mi N of Myrtle Cr)	1,295	1.72
Booth Ranch SB (2 mi N of Myrtle Cr)	4,589	6.08
Brightwood EB (12 mi E of Sandy)	168	0.22
Brightwood WB (12 mi E of Sandy)	227	0.3
Brockway (2 mi W of Winston)	44	0.06
Brookings (S of City Limits)	12	0.02
Brush Creek Portable (OR38&Brush)	22	0.03
Burns (1 mi E of Burns)	2	0
Burns Junction (Junction OR78/US95)	375	0.5
Cascade Locks POE	5,172	6.85
Cheshire (1 mi W of Cheshire)	8	0.01
Coaledo (5 mi N of Coquille)	25	0.03
Cold Springs (Junction US730/OR37)	396	0.52
Dayton (N Dayton Junction)	623	0.83
Deer Island (1 mi W of Columbia)	12	0.02
Dry Canyon Portable	2	0
Eagle Point NB	16	0.02
Eagle Point SB	35	0.05
Elgin (4.7 mi N Elgin)	14	0.02
Emigrant Hill (18 mi E of Pendleton)	1,462	1.94
Eola (4 mi W of Salem)	1,276	1.69
Farewell Bend POE	5,989	7.93
Fort Hill (E of Valley Junction)	543	0.72
Foster (1 mi E Sweet Home)	47	0.06

Foster Scale	2	0
Gates (1 mi W of Gates)	255	0.34
Glendale Valley Rd (Glendale)	13	0.02
Glide (1 mi W of Glide)	11	0.01
Grants Pass Portable	9	0.01
Hauser (6 mi N of Coos Bay Bridge)	105	0.14
Hermiston Hwy Portable	37	0.05
Horse Ridge (11 mi Bend)	20	0.03
Hubbard NB (1 mi N of Hubbard)	582	0.77
Hubbard SB (1 mi N of Hubbard)	1,255	1.66
John Day (1 mi W of John Day)	14	0.02
John Day Pull Out (5 mi E of John)	9	0.01
Juniper Butte NB	1,160	1.54
Juniper Butte SB	2,445	3.24
Klamath Falls POE	4,045	5.36
Klamath Falls SB (1 mi N of Town)	1,437	1.9
La Grande (2 mi W of La Grande)	2,841	3.76
Lake Creek (20 mi E of Medford)	63	0.08
Lakeview	10	0.01
Long Tom Portable (3.2 mi E of No)	7	0.01
Lowell (4 mi E of Lowell Junction)	1,140	1.51
Minam (22 mi E of Elgin)	88	0.12
Moro SB Portable	44	0.06
Myrtle Point (E of City Limit)	45	0.06
North Plains (2 mi W of North Plains)	130	0.17
Noti (1.2 mi E of Noti)	531	0.7
Nyssa	8	0.01
Olds Ferry (20 mi NW of Ontario)	1,407	1.86
Philomath (W of Town)	210	0.28
Pilot Rock (W of Pilot Rock)	2	0
Pleasant Valley (8 mi S of Tilla)	96	0.13
Prineville (1 mi E of Prineville)	37	0.05
Rainbow Rock (2 mi N of Brookings)	14	0.02
Rock Creek (2 mi E of Clackamas)	445	0.59
Rocky Point (3.5 mi E of Scappoose)	1,090	1.44
Sams Valley Portable (2 mi E of Gol)	37	0.05
Scio Scale WB (2 mi E of Scio)	9	0.01
Seaside (7 mi N of Seaside)	71	0.09

Selma (7 mi N of Cave Junction)	25	0.03
Siletz (6 mi S of Siletz)	13	0.02
Sisters (Junction US20/OR126)	94	0.12
Sports Park (2 mi E of White City)	20	0.03
Tillamook (2 mi E of Tillamook)	41	0.05
Umatilla City Portable	27	0.04
Umatilla POE	8,871	11.75
Vale (1.5 mi E of Vale)	137	0.18
Waldport (1/2 mi S of Waldport)	5	0.01
Walterville (10 mi E of Springfield)	500	0.66
Wilderville (8 mi S of Grants Pass)	21	0.03
Woodburn NB (2 mi N of Woodburn)	2,701	3.58
Woodburn POE	9,931	13.15
Wyeth WB (10 mi E of Cascade Locks)	3,344	4.43
Total	75,508	100.00

Once the sample was finalized, KTC researchers developed a method for calculating route distances using QGIS 3.4. For each inspection with a verifiable origin and destination, the first step was to calculate shortest paths between load origins and inspection locations. Next, they were added to the shortest paths between load destinations and inspection locations. Finally, the entire paths from load origins to destinations were clipped with the state boundary of Oregon to estimate the distance (in miles) driven within Oregon. Despite the effort to estimate accurate mileage, this method has a few limitations. The load origin and destination is recorded at the city level, not the exact address. Figure 2.5 shows a geographic centroid of Portland, OR. If a load is delivered from Portland, OR, it could be anywhere within the city boundary. However, the geographic centroid of Portland, OR is used as a representative point of Portland, OR in the analysis. If the accurate origin of the load was point A on the map below, the error would be 10.6 miles. For the points B, C, and D, the errors would be 10.2, 12.1, and 12.1 miles, respectively. The size of the estimation error could be larger or smaller depending on the size of a city.

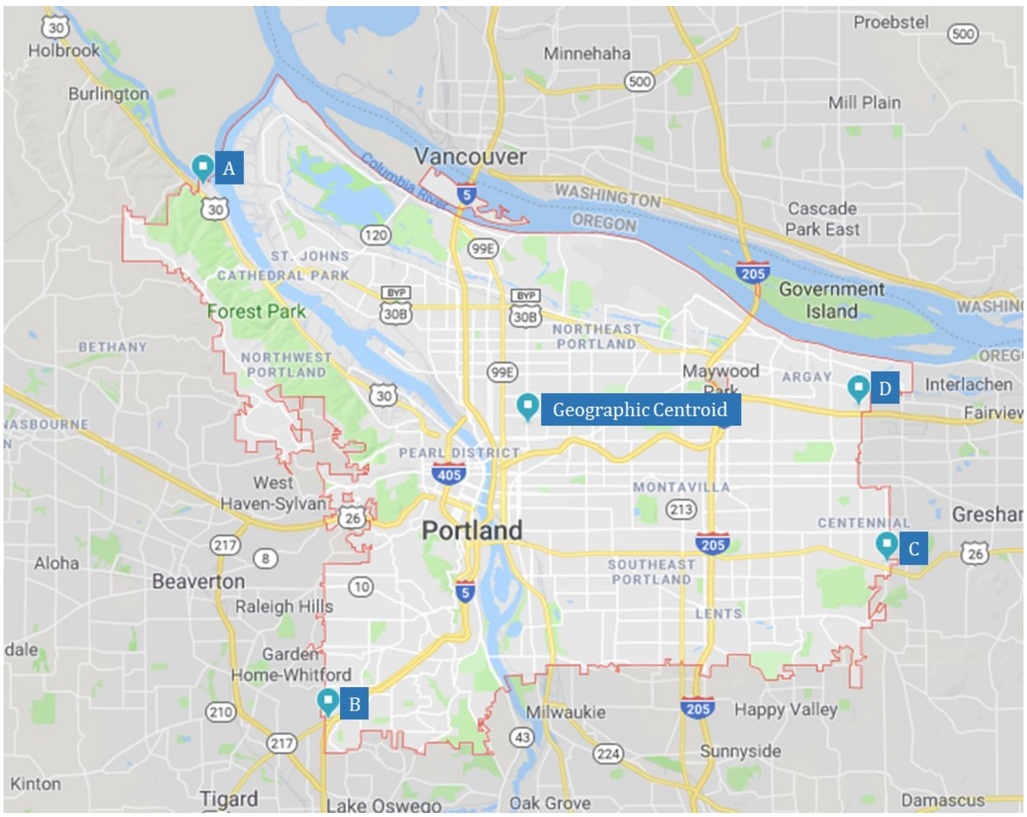


Figure 2.5: Geographic centroid of the Portland area

Origin and destination information is limited in precision and therefore assumptions must be made. To estimate trip lengths for each inspection in the sample, QGIS chose the shortest path. However, a driver may not have used the shortest path in mileage. Drivers often choose to use the quickest path based on time instead of distance. For example, Figure 2.6 shows possible routes for a vehicle heading south to San Luis, AZ and inspected at Juniper Butte SB while en route. There are two routes available for the driver to choose from. The total distances and travel times do not differ that much, but the distances driven within Oregon differ substantially. Our analysis provides an estimate using path A, but the driver might have chosen path B due to its shorter travel time. If this were the case, our result underestimates travel distance within Oregon by 121 miles (From Juniper Butte SB to point A is 183 miles and to Point B is 304 miles). Our model may be therefore somewhat conservative in instances where multiple routes are possible.

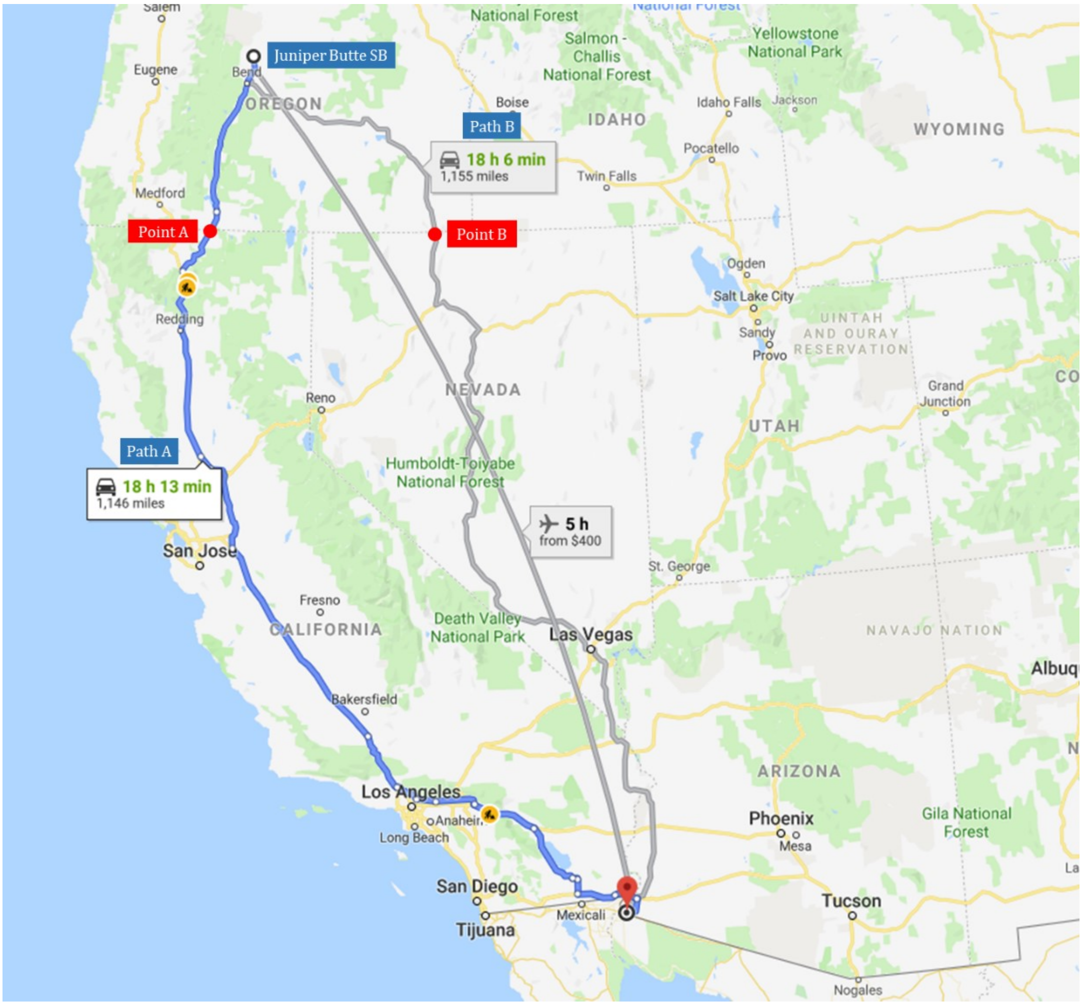


Figure 2.6: Comparison of estimates based on mileage and travel time

Also, there are many cases where it is hard to explain why a vehicle is inspected at a certain location. Figure 2.7 shows a vehicle delivering goods from Spokane, WA to Portland, OR, was inspected at Lake Creek, which is 268 miles away from Portland, OR. If the shortest route was chosen between load origin and destination, the vehicle would not have been inspected at the recorded location. It is possible the vehicle made a circuitous route with several stops along the way. Another possibility is an error on the bill of lading or an incorrect entry on the inspection report. Despite such limitations, taking an average of the estimated Oregon trip miles for vehicles inspected at specific locations will be a good proxy for truck mileage that can be applied to the larger volume of trucks identified in the screening data based on screening location. For screening locations where no inspections occur, we will generate an alternative assessment based on the direction and proximity to the nearest station where inspections occur.

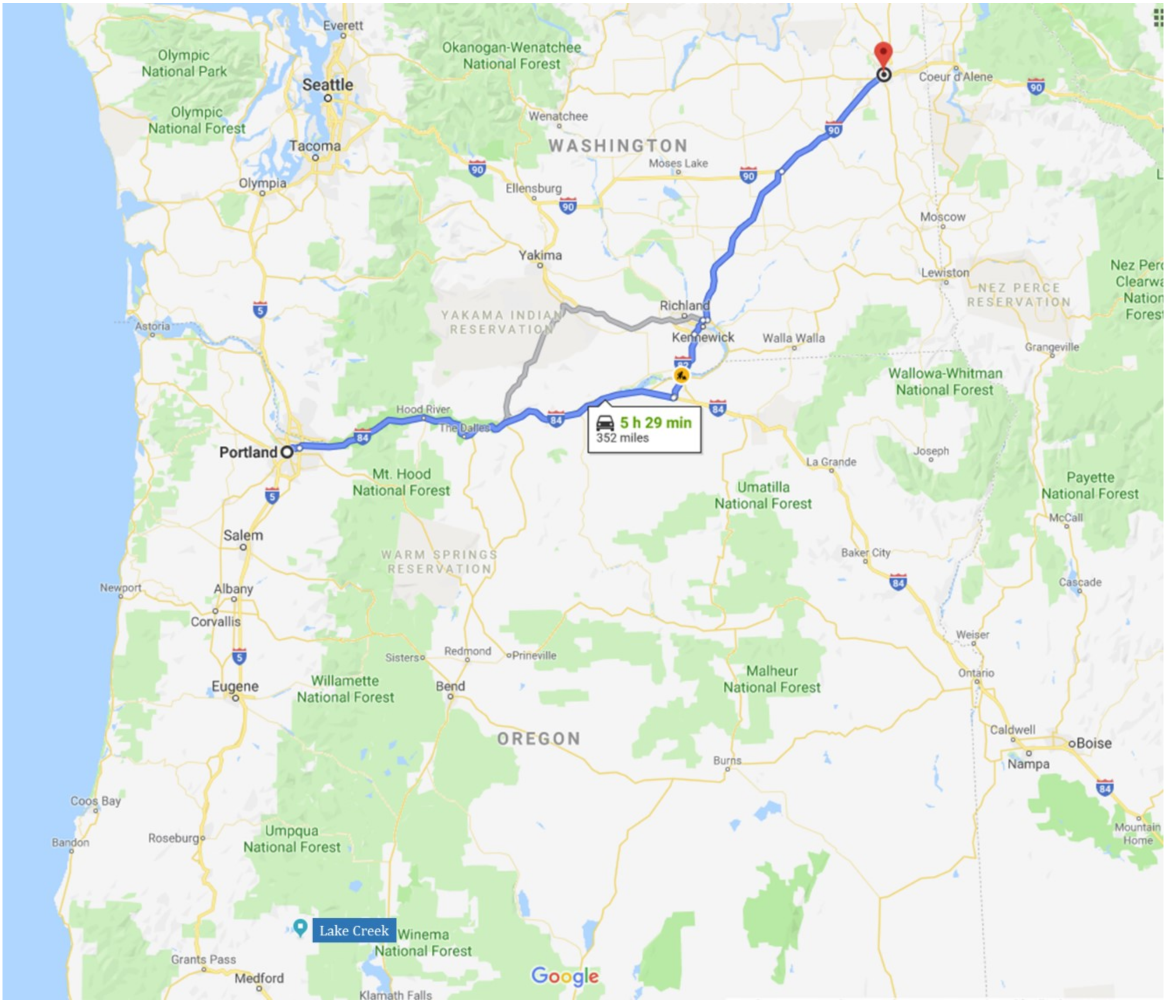


Figure 2.7: Shortest route for a vehicle incompatible with inspection location

2.5 ENFORCEMENT DATA

There are two classes of violations of interest – those directly related to violations of WMT requirements and other violations that could occur as a result of a carrier or driver who refuses to comply with commercial vehicle enforcement requirements. Direct violations of WMT requirements are located in ORS 825. If a carrier violates ORS 825.100, it lacks the license, certificate, or permit to operate legally in the state, and the ODOT CCD suspends the account. The citation will include the ORS 825.100 violation if the carrier continues operating on a suspended tax account. ORS 825.450 requires that all motor carriers have a receipt stating the combined axle weight of all WMT-eligible vehicles. Without the receipt, a carrier does not have the proper credentials to operate in Oregon. A carrier may declare multiple weights to account for variations in configuration and laden weight so that it can split declared mileage for each vehicle in to different tax brackets rather than paying one rate for all mileage. However, if the carrier exceeds all of the declared weights on the receipt it is in violation of ORS 825.450(2). Carriers are not required to have a tax account where they file monthly or quarterly returns unless they frequently operate within Oregon. However, an infrequent operator or new entrant is required to obtain a temporary pass that authorizes the carrier to operate during a 10-day window. These carriers are required to pay a $9 fee and report their estimated trip mileage. If the mileage exceeds the carrier's estimate, the law requires that they call and report the additional miles. ORS 825.470. Carriers may also credit unused miles.

Carriers or drivers who fail to comply with commercial vehicle size and weight enforcement requirements are cited under ORS 818.400. The statute spells out specific types of failures within its subsection. For example, ORS 818.400(1)(a) requires a vehicle to enter an ODOT-managed truck inspection facility when its sign is set to "OPEN." Running the scale is considered a refusal to stop and be weighed. There was a change during the study period in terms of how violations were coded, and therefore 818.400(1)(a)(b)(d) violations are folded into a single ORS 818.400; violations of 818.400(1)(c) are categorized separately. The 818.400(1)(c) violation is more specific – it pertains to a failure to move into the right lane for purposes of a weight or size check when instructed to do so by a road sign. In many cases a carrier might refuse to comply with various subsections of ORS 818.400 because there are outstanding WMT taxes owed, but there could also be other motivations for violating the statute. These violations can be for any sort of refusal to comply with commercial vehicle enforcement. These violations may occur because a truck is overloaded, or because the driver is over their hours-of-service limit. Another common reason for non-compliance is because drivers and/or carriers know they have not paid WMT taxes (and fees if applicable). To avoid citation for any kind of compliance issue, including WMT, drivers may run a scale traffic control sign, ignore the instructions of an officer, or illegally bypass a weigh station by not taking the scale ramp as required.

WMT and commercial vehicle enforcement penalties are described in Table 2.7. ORS 825.950 provides fines, civil penalties and process for these violations. Violations that fall under ORS 818.400(a), 818,400(b), and 818.400(d) may be issued as a Class A traffic violation or a criminal misdemeanor depending on the case facts. Unless they plan to contest the charges, most carriers and drivers pay the presumptive fine because most counties will allow prepayment of the fine and not require a court appearance. The presumptive fine for Class A traffic violations changed during the analysis period. It was $435 in 2016 and 2017 but increased to $440 on January 1, 2018.[3] If the violation is issued as a criminal misdemeanor, there is a civil penalty of up to $100 and a court appearance is required. Criminal court filing costs and case fees would also be applicable. The long-term consequences are more serious for the driver if the violation is issued as a misdemeanor because the violation will be added to their criminal record if convicted. Violations of ORS 818.400(c), is grouped separately because of the slightly different nature of the charge. Violations of ORS 818.400(1)(c) are treated by the courts as a misdemeanor crime with a civil penalty of up to $100. Criminal court filing costs and case fees would also be applicable, and a court appearance is required.

Previously WMT-related violations found in ORS 825 are all Class A traffic violations, although commercial vehicle enforcement officers have the discretion to issue a misdemeanor violation for individuals who violate ORS 825.450. The civil penalty for violation of ORS 825.450 can be up to $1,000. The court process for WMT-related, ORS 825 violations is the same as those

[3] During part of the study period the presumptive fine was $435.In addition, some counties add a local surcharge of $5, which means the fine for those counties used to be $440.

described for ORS 818 violations. In most cases, traffic violations can be pre-paid in lieu of a court appearance. Criminal referrals in the case of 825.400 violations issued as criminal misdemeanors will also include court costs. Additional details are provided in ORS 825.950 and OAR 740.300-040.

Table 2.7: WMT and Commercial Vehicle Enforcement Violations and Descriptions

Violation	Description	Usual total Fine/Court Cost Amount
818.400	Failure to comply/failure to stop and weigh	$440 – Traffic Violation - May also be issued as a misdemeanor crime requiring appearance in court where the fine is determined by the judge.
818.400 (1) (c)	Failure to move into proper lane	Issued as a misdemeanor crime requiring appearance in court where the fine is determined by the judge
825.100	Motor Carrier Account Suspended	$440 – Traffic Violation
825.450	No/Invalid ODOT Weight Receipt	As of 9/26/19- NA / Changed to Not Enrolled/Issued ODOT vehicle weight identifier $440 – Traffic Violation
825.450 (2)	Exceeding Tax Declared Weight	$440 – Traffic Violation
825.470	No/Invalid ODOT Pass	$440 – Traffic Violation

Table 2.8 reports the number of violations detected for each of the six specific charges previously described from 2015-2018. The table reports both warnings and citations for each of the six violation types. The overall number of violations of WMT requirements and commercial vehicle enforcement instructions increased in each year for which data were provided. The vast majority of these violations are WMT-related. The most frequent violations are for those who do not have a valid ODOT weight receipt or those who do not have an ODOT temporary pass. About 75.5 percent (38,847 total violations) of all citations and warnings reported were for these two violations. Carriers regularly operating in the state should have a vehicle-specific weight receipt with a declaration of that vehicle's declared weight class or classes. Sometimes, carriers will come through a port-of-entry without knowledge that a state-specific credential is required for the WMT, and as a result have no ODOT weight receipt with them. Enforcement officers will generally give carriers a warning for a first-time violation and require carrier to obtain a temporary pass from the CCD service center, which requires carrier to estimate Oregon mileage during the 10-day window during which the vehicle can legally operate.[4] Carriers obtaining a temporary pass may also add miles (as previously noted) or credit unused miles in the event Carriers operating on a suspended tax license had 7,249 violations, or 14.1 percent. Trucks exceeding their declared weight comprised 2,500 violations during the four-year period. The ORS 818 violations are less common, but most of them pertain to the general failure to stop at a weigh station or comply with commercial vehicle enforcement instructions, which accounts for 2,738 warnings and citations. The 818.400(1)(c) violations are fairly infrequent – just 97 in the

[4] Carriers with a temporary pass may also add miles to their tax report, credit unused miles.

three years were reported. We also note that CCD data only reports 818.400 violations that include illegal bypasses and failure to stop for a red light. Other related violations were removed, and data specific to violations of 818.400(1)(c) were unavailable for 2015.

Table 2.8: WMT-Related Citations and Warnings Issued, 2015-2018

Violation	Description	2015	2016	2017	2018	Total
818.400	Failure to comply/failure to stop and weigh	465	599	906	768	2,738
818.400 (1) (c)	Failure to move into proper lane	--	26	41	30	97
825.100	Motor Carrier Account Suspended	1,302	1,743	1,982	2,222	7,249
825.450	No/Invalid ODOT Weight Receipt	5,597	5,900	6,024	5,954	23,475
825.450 (2)	Exceeding Tax Declared Weight	600	666	596	638	2,500
825.470	No/Invalid ODOT Pass	4,040	3,985	3,619	3,728	15,372
Total		12,004	12,919	13,168	13,340	51,431

KTC researchers also compared the percentage of citations and warnings for each of the six violations types. The results are reported in Table 2.9.[5] Yearly totals are not reported, as the overall citation rate for the six charges was pretty stable during the four years for which data were provided.

Several general takeaways emerge from the data. First, violations of WMT requirements under ORS 825 are more likely to result in a citation than violations of ORS 818. In particular, violations where the carrier was operating on a suspended account resulted in a citation 87.7 percent of the time, which is not surprising given the seriousness of the charge relative to some of the others. The other violations of ORS 825 have a much higher citation rate than the ORS 818 violations, but not as high as those for operating with a suspended WMT account. Violations of 818 infrequently result in a citation issuance, particularly 818.400(1)(c). The ORS 818 violations may result in lower citation rates for several reasons. Violations of 818.400(1)(c) are infrequent. Officers may be less comfortable issuing a citation for a more infrequent violation. It is also possible a driver might have made an honest mistake in failing to get into the right lane.

[5] Note first of all that the number of total violations matches the totals reported in Table 2.8 for all ORS 825 WMT violations. There are some discrepancies between the number of ORS 818 violations reported and the citations and warnings data, which were collected at a different point in time. The only meaningful difference is the citations and warning data includes all violations of 818.400 instead of just screening out the violations specifically pertaining to running a scale installment or ignoring a red light given by commercial vehicle enforcement officers. The impact on the overall percentages is not significant.

The 818 violations are also misdemeanors and so will go on a driver's criminal history record, whereas the ORS 825 violations are not. It is also true that enforcement of the direct WMT violations will generate more revenue than the 818 violations. It is also possible that a person who tries to ignore the directions of commercial vehicle enforcement got charged with a more serious violation that does not show up in this data.

Table 2.9: Citation and Warning Rate for WMT Violations, 2015-2018

Violation	Violation Description	Citation %	Warning %
818.400	Failure to stop and weigh	24.0%	76.0%
818.400 (1) (c)	Failure to move into proper lane	3.2%	96.8%
825.100	Motor Carrier Account Suspended	87.7%	12.3%
825.450	No/Invalid ODOT Weight Receipt	48.5%	51.5%
825.450 (2)	Exceeding Tax Declared Weight	33.4%	66.6%
825.470	No/Invalid ODOT Pass	55.4%	44.6%
Total		53.7%	46.3%

KTC researchers will use the citation and warning data for purposes of supplementing the inspection data mileage estimates derived by using the origin and destination data contained in the citation data. The data includes citations and warnings for several different kinds of violations committed by individuals operating a commercial vehicle – not just the select violations reviewed previously. The data, which runs from 2016 to 2018, includes 159,799 citations and warnings. The data will be filtered to focus on weigh stations or enforcement locations that maintain commercial screening records and used as part of the evasion methodology laid out in 2.10.1.

2.6 AUDITS

Another enforcement mechanism employed by ODOT is to audit motor carriers for a variety of credentialing programs, including carriers required to pay the WMT. ODOT's CCD provides a preliminary audit for all WMT carriers every three years. During the preliminary audit process, auditors run database searches to determine at a high level whether a motor carriers with an active WMT tax license failed to file a monthly or quarterly report, a carrier filed a late report, a carrier was screened during a reporting period where the return indicated no miles of operation, a carrier without a WMT license or temporary WMT pass was screened by an LPR system or virtual weigh station without being stopped by ODOT officers or other law enforcement personnel, or the mileage reports are low relative to the estimated mileage a carrier amassed based on available screening data. Preliminary audits may occasionally utilize fueling receipts, IRP filings or IFTA tax returns. Based on the results of the preliminary analysis and other relevant criteria, the CCD makes selections for full audits.

Full audits of motor carriers require a much more detailed review of operations. These audits typically require motor carriers to submit detailed documentation, including fueling receipts, driver logs, or other documentation pertaining to mileage. Auditors may also review the

Highway Use Tax, IFTA, and IRP filings to ensure the carrier is compliant with state laws. Carriers do have the ability to apply for waivers or reductions under certain circumstances, and may appeal an audit assessment if they do not agree with its findings. During WMT audits, the auditor will determine whether the carrier owes additional taxes or potentially overpaid taxes based on company liabilities. These audits cover longer periods of time, ranging from several months to 3 years depending on the carrier. In addition, the auditors will also look for any outstanding registration debits or credits, as well as late payment charges (LPC), penalty and interest.

The auditor looks for non-payment of intrastate fees, or an out-of-state non-apportioned carrier who operated in Oregon without paying for the $43 trip permit fee required if there is no Oregon registration or IRP (apportioned) plate. Under ORS 825.490 and ORS 490.494, auditors are also to assess LPC, penalty and interest depending on the amount of additional taxes owed. The LPC charge is equal to 10 percent of the WMT taxes owed in all cases. It is assessed separately from the penalty charge. The penalty depends on the size of the fee adjustment. Table 2.10 shows the penalty amounts based on the fee adjustment sizes. If the fee adjustment is less than 5 percent greater than the WMT tax reported by the carrier, there is no penalty. For example, if the carrier reported $50,000 in WMT taxes for the audit period and the audit showed the carrier's total liability to be less than $52,500, there is no penalty, although the carrier will still owe a 10 percent LPC on the difference between $50,000 and the total assessment. If a carrier owes 5 to 15 percent more in WMT than initially reported, the penalty is 5 percent. If the fee adjustments show a carrier owes at least 15 percent more than was originally reported, the penalty is 20 percent. If the carrier did not file a tax return, the penalty is 25 percent of the overall WMT assessment. Penalties are calculated separately for each reporting period; for the sake of simplicity the above example does not take this provision into account. For interest, auditors determine the beginning date for interest and registration fees, and calculate interest on both the unpaid taxes and fees. Interest accrues at the rate of 1 percent per month. Interest accrues until taxes and fees are paid.

Table 2.10: WMT Audit Penalty Assessment Criteria

Adjustment	Penalty
Fee adjustments equal less than 5 percent of tax reported	0%
Fee adjustments equal 5-15 percent of tax reported	5%
Fee adjustments equal more than 15 percent of tax reported	20%
No report filed	25%

Table 2.11 displays summary statistics of WMT audits conducted each month from 2015 to 2018. Each year's audit activity is summarized by two columns. The first indicates the number of audits performed in a particular month, and the second net fees (debits minus credits) from WMT audits. These fees include net assessments of unpaid WMT taxes and fees, unpaid intrastate registration fees or temporary passes, LPC, penalties, and interest. Some audits result in net credits instead of net debits. For that reason, the August 2015 data shows negative net fees, as a large trucking company ended up receiving a sizeable refund. Between 2015 and 2018, CCD auditors conducted roughly 746 audits per year and assessed net fees of $6.3 million annually.

These numbers break down to about 62 audits per month and $527,301 net collections per month. Net fees do not include out-of-state travel costs, which were $20,300 to $22,967 in 2015 and 2016 but increased to $48,157 and $50,737 in 2017 and 2018, respectively. About 78 percent of the total audit fees collected during the four reporting years come from the additional WMT tax assessments, with a small amount of WMT assessments also including RUAF. The other 22 percent comes from registration fees, LPC, penalties and interest.

Table 2.11: Monthly WMT Audit Totals, 2015-2018

	2015		2016		2017		2018	
Month	***Audits***	***Net Fees***	***Audits***	***Net Fees***	***Audits***	***Net Fees***	***Audits***	***Net Fees***
January	70	$1,649,032.42	57	$694,241	67	$488,492	46	$434,578
February	37	$291,966.86	77	$474,717	54	$423,722	51	$381,328
March	53	$988,229.08	70	$362,640	82	$682,828	73	$558,848
April	69	$394,336.62	62	$280,037	64	$454,254	55	$245,121
May	52	$380,758.53	61	368,523	54	$461,703	63	$615,614
June	62	$654,397.09	62	$451,023	75	$628,731	50	$430,868
July	63	$387,340.96	45	$324,528	77	$1,198,529	57	$203,587
August	41	-$46,905.05	54	$283,777	88	$825,105	66	$759,275
September	51	$177,944.11	62	$345,486	46	$301,172	50	$377,687
October	57	$371,088.39	75	$581,551	74	$997,903	71	$615,119
November	59	$538,785.34	65	$502,156	64	$513,561	91	$1,024,869
December	66	$459,895.18	70	$815,677	66	$555,351	57	$423,590
Total	678	$6,246,870	760	$5,484,356	811	$7,531,352	730	$6,070,483

2.7 IRP DATA

One way to estimate WMT tax evasion is to compare WMT returns to the mileage carriers report to IRP, Inc. for their interstate, apportioned vehicles. The IRP agreement requires that carriers report either the actual mileage every IRP vehicle logs in each jurisdiction, or otherwise use mileage estimates in the event a vehicle is a new registrant. The mileage estimates for carriers not reporting actual miles are based on the base jurisdiction of the motor carrier, the number of vehicles, and the proportion of miles the average vehicle or carrier logs in each travel jurisdiction based on a mileage estimation chart. Registrations are renewed annually, and mileage reports are based on operational activities during the previous reporting period. Those reporting periods depend upon the jurisdiction and month in which the registration is renewed. For example, IRP registrations where Oregon is the base jurisdiction are always renewed January 1 of each year. Table 2.12 adapted from the current IRP Agreement, reports the reporting period requirements for mileage reporting based on the registration month. Essentially, reporting is based on the fiscal year beginning in July and running through June. Vehicles or fleets registered during January and September 2019 would have a mileage reporting period between July 1, 2017 and June 30, 2018. Vehicles or fleets registered between October and December 2019 would have a mileage reporting period between July 1, 2018 and June 30, 2019. These reports can be lined up with

WMT tax reports from the same time period at the carrier level to ascertain whether a carrier is reporting more IRP fleet mileage in Oregon than the WMT tax.

Table 2.12: Required IRP Reporting Periods based on Registration Month

If the first month of Registration Year is:	The Reporting Period is:
January, 2019	July 1, 2017-June 30, 2018
February, 2019	July 1, 2017-June 30, 2018
March, 2019	July 1, 2017-June 30, 2018
April, 2019	July 1, 2017-June 30, 2018
May, 2019	July 1, 2017-June 30, 2018
June, 2019	July 1, 2017-June 30, 2018
July, 2019	July 1, 2017-June 30, 2018
August, 2019	July 1, 2017-June 30, 2018
September, 2019	July 1, 2017-June 30, 2018
October, 2019	July 1, 2018-June 30, 2019
November, 2019	July 1, 2018-June 30, 2019
December, 2019	July 1, 2018-June 30, 2019

Like the WMT, the eligibility and requirements of IRP are subject to complex criteria. There are some differences in the specific vehicles required to report both WMT mileage and IRP mileage, which will cause discrepancies in certain cases. IRP and WMT requirements kick in for vehicles with at least two axles and a gross vehicle weight or registered gross vehicle weight in excess of 26,000 pounds. For most carriers, the profile of vehicles required to pay IRP and WMT fees, and therefore report miles, will be very similar if not identical. However, there are some specific aspects that could cause differences in mileage reporting. WMT taxes are assessed on both interstate vehicles from all jurisdictions and intrastate vehicles registered in Oregon. While interstate vehicles in all jurisdictions must track and report miles for IRP registration apportionment, intrastate vehicles registered in Oregon would generally not be registered with or be required to submit mileage reports to IRP. Depending on the nature of lease agreements, there might be differences as well. For example, although the IRP agreement expresses a minimum weight of 26,001 pounds, commercial vehicles at a lower weight picking up and dropping off a load in another state may also be subject to IRP registration requirements but not WMT taxes. However, the vast majority of eligible vehicles would be treated similarly under both programs for purposes of mileage assessment.

Most IRP information comes from the IRP Clearinghouse, which is operated and maintained by IRP, Inc. and used to facilitate transmittals between jurisdictions. Oregon is not currently an IRP Clearinghouse participant, so ODOT provided data on Oregon-based vehicles separately. All other jurisdictions' data came from the IRP Clearinghouse. The IRP Clearinghouse contains records of the total mileage reported for each fleet and jurisdiction where there was travel during a specific reporting period. Each jurisdiction has different registration start and end dates, but the reporting period for fleet mileage is based on the first month of registration. Most jurisdictions

(39) do staggered registration where the registration period can start during any month of the year, including neighboring states California and Washington, as well as nearby British Columbia. Nine other jurisdictions stagger registration by the most proximate quarter. The remaining 11 jurisdictions begin all registrations in a particular month. Oregon's belongs to the latter group. Its registration periods begin in January and run through December, although there is a grace period for registration displays that lasts until March 15.

Figure 2.8 shows the total IRP mileage reported by apportioned (or interstate) commercial vehicles registered in Oregon between 2017 and 2018, reported in thousands of miles. These numbers do not include mileage logged by intrastate vehicles or apportioned vehicles registered in other states.

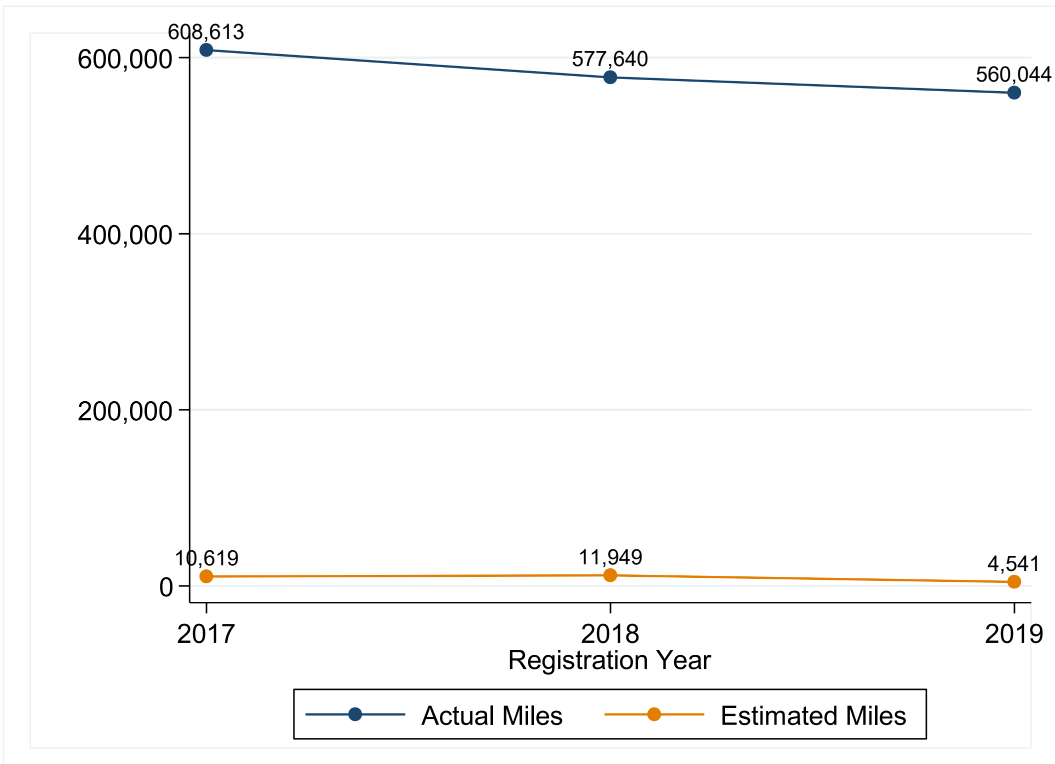


Figure 2.8: Reported IRP miles for carriers with Oregon as base jurisdiction, 2017-2019

Figure 2.8 categorizes IRP mileage into actual miles and estimated miles. The actual miles are based on actual operations in the previous year, whereas estimated miles are for vehicles or fleets with no previous apportioned mileage in Oregon. Unsurprisingly, the vast majority of fleets registered in Oregon reported actual miles instead of mileage estimates. While carriers may add additional vehicles at the time of registration renewal, the mileage reports are based on the activities of those vehicles during the past year. Mileage logs in the forthcoming year are then used to apportion registration fees at the time of the next renewal, and so goes the cycle. The estimates are necessary at the time a carrier first registers, or at the very least, registers activity in a particular jurisdiction for the first time, to apportion mileage registration. The combined number will yield the total actual and estimated miles reported in Oregon for the years previously noted. In 2017, Oregon-based IRP carriers reported more than 619 million miles logged in the state, which declined to 590 million in 2018 and again to approximately 565 million in 2019.

Figure 2.9 reports IRP miles for Oregon and all other IRP jurisdictions in 2018 with the exception of New Brunswick (not visualized and not an IRP Clearinghouse participant) and Illinois (whose data was unavailable for technical reasons). The mileage totals includes both actual and estimated mileage. The total travel mileage figure for Oregon based on reporting in all IRP jurisdictions is 1.89 billion for the 2018 registration year. Nearly 96 percent of all reported miles for IRP travel in Oregon for the 2018 registration year were based on operations during the previous year, while the remaining 4 percent were mileage estimates for carriers without previous activity to report.

The base jurisdictions whose carriers reported the most miles are Oregon (590 million), Indiana (462 million), California (217 million), and Washington (149 million). That Oregon's own carriers log the most mileage is an expected finding, as well as high mileage reports from neighboring states California and Washington. The Indiana figure might be somewhat surprising for those unaware of industry trends. Indiana registers a quite large number of fleets relative to its size due in large part to its industry friendly laws, policies, and services. Federal laws and IRP regulations about where carriers can register are somewhat flexible provided that a carrier meet certain requirements, such as having a facility or terminal in the base jurisdiction. A large proportion of these vehicles are not actually domiciled in the state of registration. The next tier of jurisdictions based on mileage reporting totals are those between 10 million and 100 million miles. Fourteen jurisdictions fall into this category, including nearby province British Columbia, Idaho, Utah, Arizona, Nebraska, Oklahoma, Texas, Minnesota, Iowa, Missouri, Wisconsin, Ohio, North Carolina and Florida. This tier, combined with the top four jurisdictions for IRP mileage, constitutes 95 percent of all IRP miles reported in Oregon for the 2018 registration year.

One advantage of the IRP agreement for each jurisdiction is that every other jurisdiction could potentially audit a carrier based in or traveling on its roads. There are minimal auditing requirements for all IRP participants. Section 1025a specifies that "[e]ach Member Jurisdiction shall conduct a number of Audits equivalent to an average of three percent per year of the number of Fleets whose registration it renews annually under the Plan." Nevertheless, audits of out-of-jurisdiction companies have become less common in recent years, as budgetary pressures have squeezed the personnel and travel budgets of state auditors.

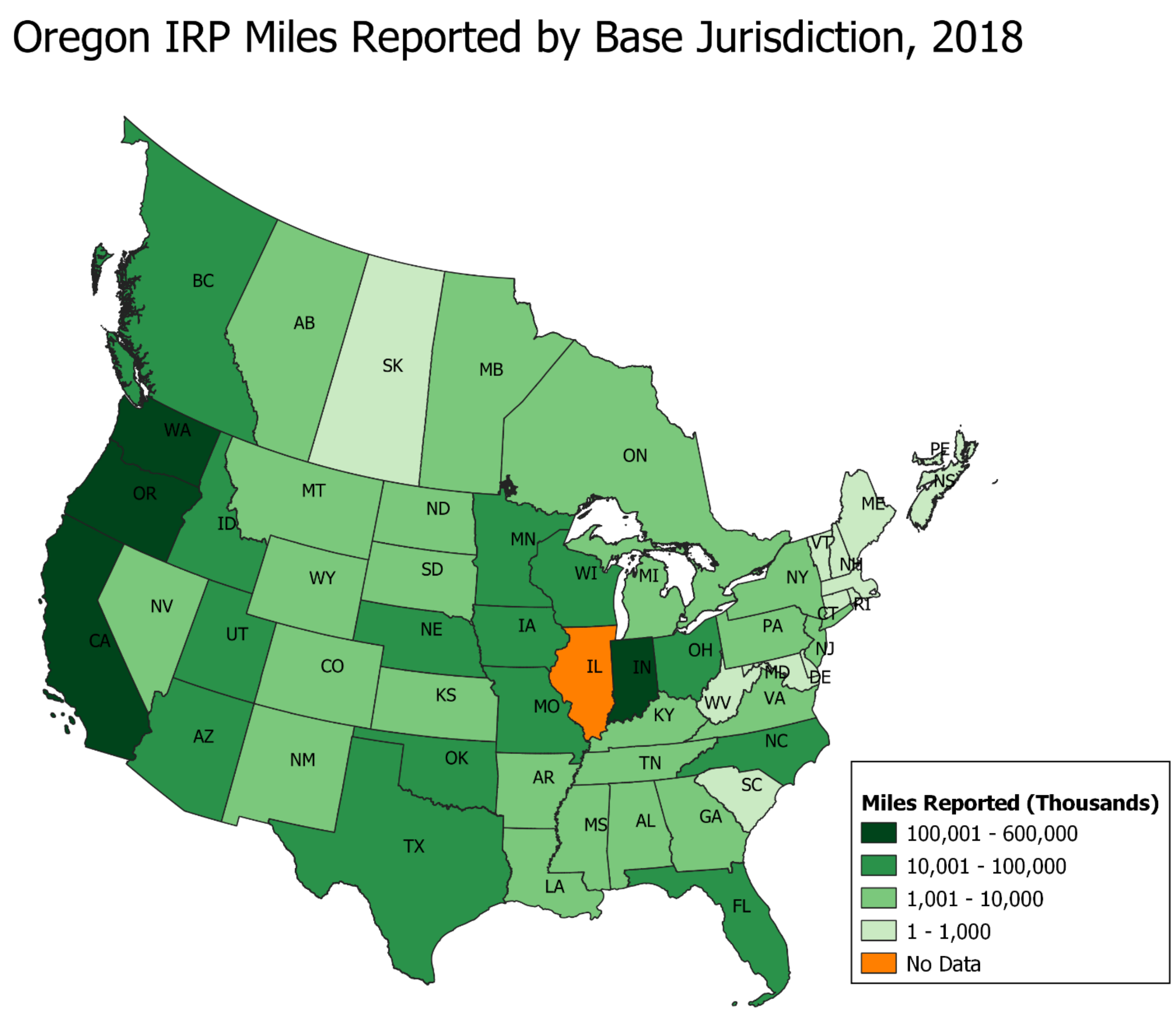


Figure 2.9: Oregon IRP travel mileage (registration year 2018)

2.8 IFTA DATA

IFTA presents a unique situation for motor carriers operating in Oregon, as the state does not assess a fuel tax for commercial vehicles. Although Oregon does not assess a fuel tax on vehicles over 26,000 pounds, Oregon participates in the agreement, which allows carriers to file with ODOT if Oregon is their base jurisdiction. Under the IFTA Articles of Agreement, carriers operating interstate vehicles having two axles and a gross vehicle weight or registered gross weight over 26,000 pounds have a qualified motor vehicle and must participate (IFTA Agreement, R245.100). Tax obligations are weighed against credits for fuel purchases in each jurisdiction where the motor carrier has already paid some tax at the pump. Because there is not fuel tax, IFTA carriers in Oregon do not remit fuel taxes directly to the state. However, carriers with interstate fleets registered in Oregon will pay IFTA taxes to other jurisdictions in which they traveled using Oregon as a pass-through for those payments. All IFTA taxes are paid to Oregon, and then apportioned and transmitted to other jurisdictions on behalf of the carrier. The carriers must also report fleet mileage logged in Oregon, even though no fuel tax is owed. Mileage reporting in Oregon is necessary despite the absence of a tax because fuel taxes are apportioned based on the percentage of fleet mileage logged in each jurisdiction, and exclusion of Oregon mileage would distort the apportionment calculations.

One significant difference between IFTA and IRP is that IRP registration is paid in advance based on estimates or past operations, while IFTA taxes are based on operations in the previous quarter. The reported mileage still covers the same time period. Another wrinkle with IFTA is that total miles and taxable miles are not the same. Taxable miles takes specific mileage and vehicle exemptions into account, and such exemptions differ in each jurisdiction. Figure 2.10 shows the total reported IFTA miles and taxable IFTA miles from 2015 to 2019 for all fleets when Oregon is the travel jurisdiction. Due to the large number of miles, we report them in units of one million. The data show a steady upward trend in total mileage reported each year, beginning at 1.6 billion total miles in 2015 and extending to almost 1.76 billion miles in 2018. The taxable miles take a similar trajectory and are on average about 91 million miles less than the total reported miles. In each year, about 94 to 95 percent of total miles are also taxable miles. Exemptions are largely the purview of individual jurisdictions. Oregon does not assess a tax, so differences between the two does not have a practical effect in terms of liabilities. However, there are instances where the two numbers differ. Those numbers could diverge in certain circumstances. For example, if a tow truck or mobile home towing truck went back and forth, above and below the minimum weight requirement, there could be differences in mileage. In some instances, there are reporting issues with IFTA returns because Oregon has many weight-mile tax exceptions (e.g. flat fees in lieu of WMT) and the carrier confuses WMT exemptions with IFTA exemptions. In Oregon, officials are most concerned with total miles. In 97 percent of the quarterly IFTA filings for 2018, where Oregon is listed as a travel jurisdiction, the total miles and taxable miles are the same.

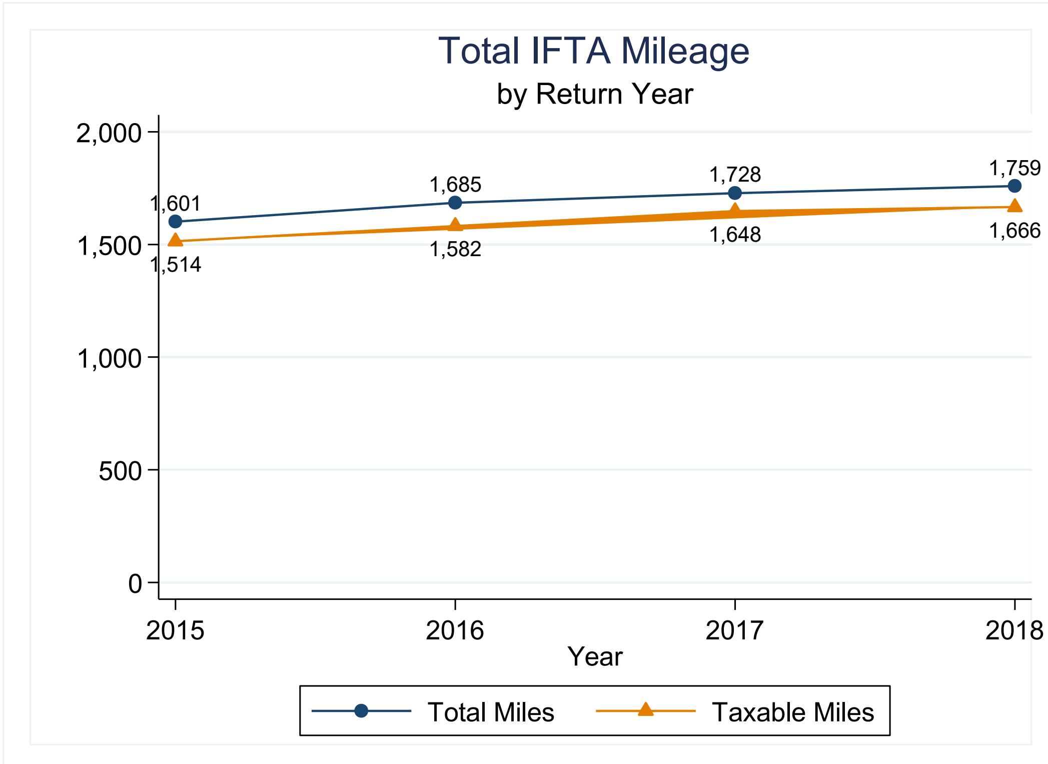


Figure 2.10: IFTA mileage for carriers traveling in Oregon, 2015-2019

Figure 2.11 displays the reported taxable IFTA mileage for all fleets during the 2018 transaction year based on each carrier's base jurisdiction. The map is similar to that of the IRP mileage map, though there are some differences. As indicated previously, there is no Illinois data for IRP but data is available for IFTA. The jurisdictional composition of the IRP and IFTA datasets is different, and those reasons are largely due to small differences in jurisdiction memberships and jurisdiction reporting capabilities. The registration year for IRP and IFTA are also somewhat different and will need to be validated with WMT return data on a jurisdiction-by-jurisdiction basis for IRP, whereas the IFTA reporting periods are more straightforward. It is important to remember that mileage comparisons in the WMT evasion analysis will be made at the carrier level rather than the jurisdiction level, so the comparison will be more straightforward.

There are notable similarities in terms of the geographic patterns. The four base jurisdictions with carriers reporting the most taxable IFTA miles traveled – between 100 and 600 million - are Oregon, California, Washington, and Indiana. These four jurisdictions also had the most reported IRP mileage, albeit in a slightly different order. Collectively, if British Columbia is included, the five IFTA jurisdictions reporting the most Oregon travel miles account for about 71 percent of all mileage reported in 2018. The West Coast freight corridor is a major driver of economic activity for the trucking industry in Oregon. Indiana remains a misnomer because its administrators register large numbers of fleets that are not actually domiciled in the state.

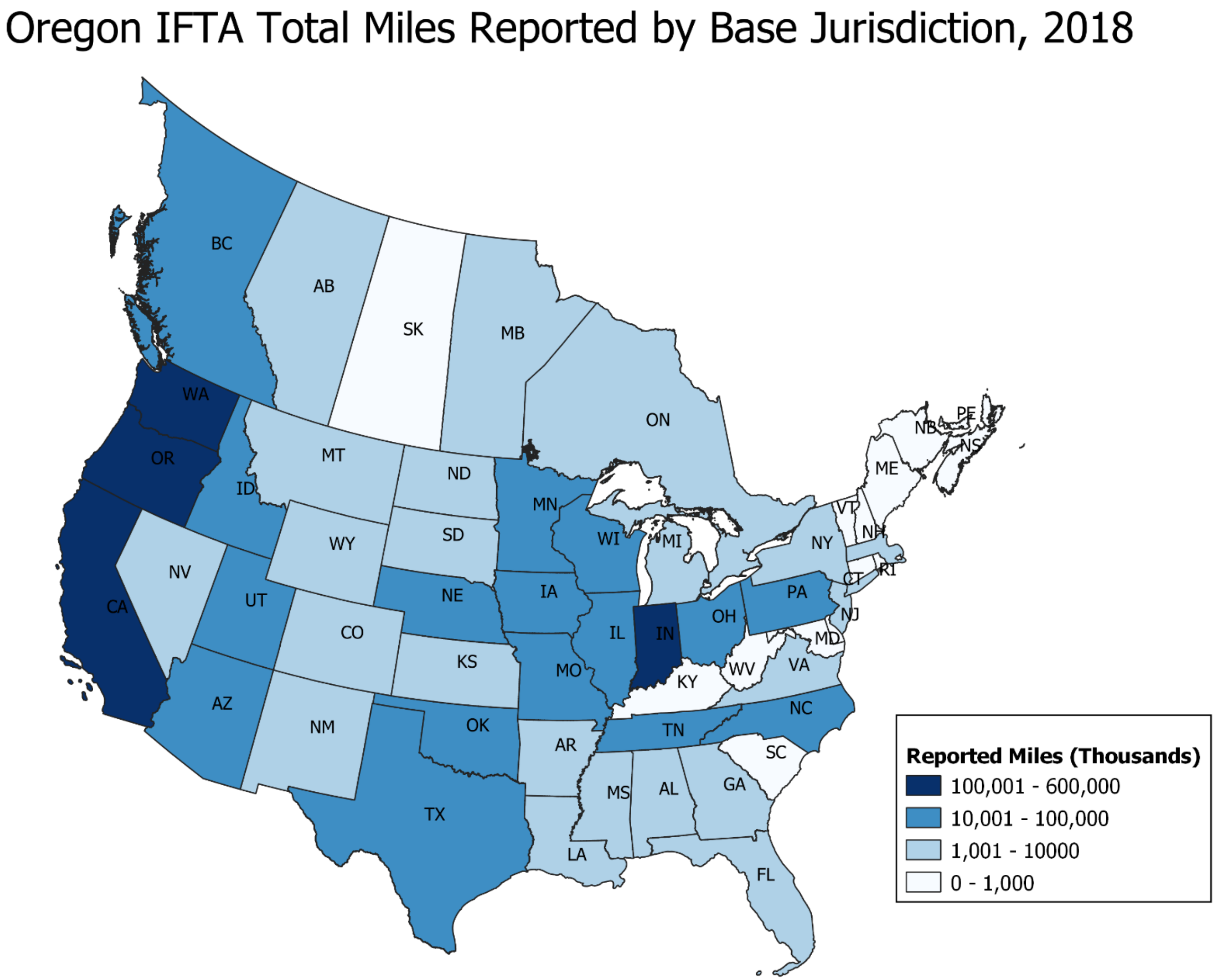


Figure 2.11: Oregon IFTA travel mileage (reporting year 2018)

The second tier (10 to 100 million) includes several other neighboring jurisdictions in the western United States, Texas and parts of the Midwest. Oklahoma, like Indiana, tends to be an outlier. The 20 jurisdictions reporting the most mileage constitute 94.1 percent of Oregon's total IFTA mileage, which in 2018 was 1.76 billion. There are definitely local and regional contours to the data.

2.9 VMT DATA

ODOT's Transportation Data Section, which is part of the Transportation Systems Monitoring Unit, collects data on vehicle miles travelled (VMT) on both state and federal highways on behalf of ODOT and to meet FHWA reporting requirements. The state highway system includes roughly 8,000 miles of state and federal roads. The section publishes transportation volume tables on an annual basis, providing updates on traffic volumes on state and federal highways.[6] The reports provide Annual Average Daily Traffic (AADT) volumes at various mile markers throughout the state based on the availability of automatic traffic recorders (ATRs). ATRs are permanent, in-pavement devices that record traffic volumes year-round. As of 2017, there were 180 active ATRs around the state according to ODOT's *Transportation Volume Tables* (Transportation Systems Monitoring Unit, 2018a). The permanent ATRs around the state tend to be on high-traffic roads, including major interstates, federal highways, and state routes. These ATRs generally record the number of vehicles in a particular lane and direction of a major highway. A map of ATR locations is available on the ODOT website (Transportation Systems Monitoring Unit, 2018b). The ATR data is supplemented with vehicle classification data, which is collected via manual counts, tube counts, or from permanent Automatic Vehicle Classifiers (AVCs). The classification uses the FHWA vehicle classification system specifications, which was developed during the 1980s. The AVCs classify vehicles based on the speed, weight, vehicle length and axle spacing. However, most of the vehicle classification data is based on samples from the tube counts or manual counts. Tube counts are derived from portable road tube counters that count vehicles in similar fashion to AVCs, although they utilize pneumatic tubes instead of piezoelectric inductive loops to detect a vehicle. Manual counts typically involve a 24-hour video capture and manual counting and classification by the Transportation Systems Monitoring Unit.

Figure 2.12 displays the vehicle classification schema developed by FHWA.[7] The scheme includes a class number, a definition of a vehicle in said class, the types of vehicles that can be included in said class, and the number of axles. Class 1 vehicles are motorcycles, Class 2 covers most varieties of passenger cars, and Class 3 applies to pickups, vans, and pickups and vans with trailers. Buses are in Class 4. Class 5 units includes larger pickups with dual rear tires, campers, and straight box. The remaining class groups (6-13) are varying configurations of commercial vehicles. Generally speaking, however, only vehicle classes 7-13 would be subject to the WMT

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[6] Archived traffic counts and volumes data, ramp interchange diagrams, permanent ATR recorder data, permanent ATR recorder maps, traffic flow maps, state highway vehicle classification data, VMT, and available data from other jurisdictions, including counties, cities, universities, and other states. The data is accessible at: https://www.oregon.gov/ODOT/Data/Pages/Traffic-Counting.aspx#TVT-Complete

[7] It should be noted that there are other versions of commercial vehicle classifications used by state and federal transportation agencies.

requirements, as all light and medium duty vehicles in Classes 1-6 have a gross registered weight rating of 26,000 pounds or less (John, Schuh, & Smith, 2009). It should be noted that for some of the higher classes of vehicles, classification could vary depending on how many axles were dropped and in operation. Those variable classification schemes depend on whether the truck was loaded or unloaded.

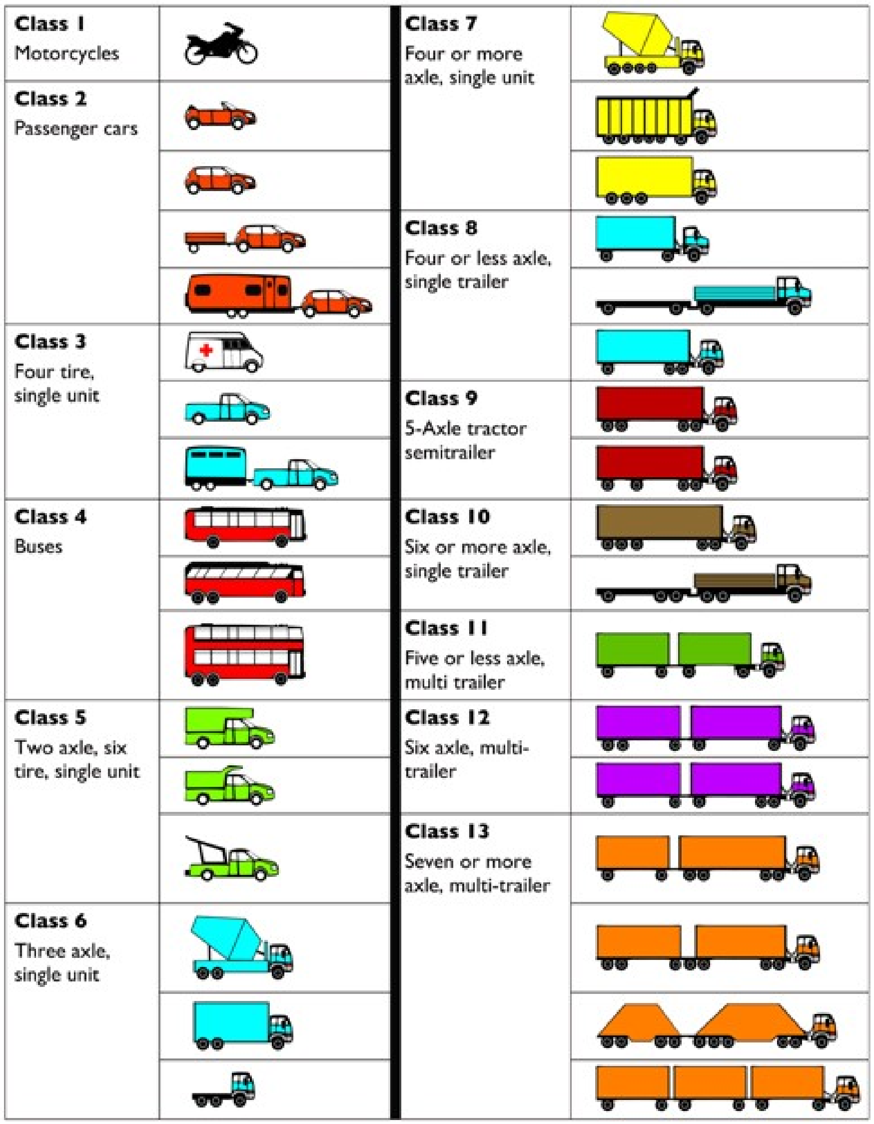

Figure 2.12: FHWA vehicle category classification

Data collection takes place in a staggered fashion such that not every milepost location on every route is counted every year. There are 493 highways with segments of various lengths that are counted every three years. For example, traffic counts for all of the highway segments in the 2018 *Transportation Volume Tables* are based on staggered counts conducted in 2016, 2017, and 2018. Table 2.13 displays the statewide daily vehicle miles traveled (DVMT) by vehicle class and road type. Estimated DVMT is displayed by roadway type and vehicle class as shown in

Table 2.13. There are seven roadway types broken out by rural and urban mileage per HPMS requirements. Those include Interstate and non-interstate highways on the Federal Highway System (abbreviated as Interstate), other principal arteries (O.P.A.), other freeways and expressways (O.F.E.), minor arterials, major collectors, minor collectors, and local routes. The figure totals the mileage by both route type and vehicle mileage. The total overall DVMT for Oregon is just under 101 million miles per day, which extrapolates to 36.8 billion VMT annually. Of that, Class 2 passenger cars constitute the majority of vehicle miles traveled in Oregon – about 65 percent. Class 3 (mostly pickups and vans) is the next-largest category with 19.2 percent of estimated miles traveled. Medium duty trucks in the Class 5 category constitute more than 7 percent of total DVMR. Heavy trucks in Classes 7 to 12 constitute about 4.5 percent of DVMT – just over 7 million miles a day. Extrapolated for an entire year, the VMT for heavy trucks in that class comes to 2.57 billion miles.

Having examined the methodology and interviewing ODOT officials about the data, there are significant methodological concerns about the reliability of DVMT as it pertains to vehicle classification data. There are several reasons for the concern. The first is that the collecting of such data is very cost-intensive. Either states must embed expensive AVCs in the pavement, pay workers to move and setup tube counting equipment, or conduct manual counts. Most of Oregon's AVCs merely count vehicles – there is year-round data on traffic flows but not for the distribution of that traffic across the 13 FHWA classes. Just 13 of the 180 AVCs around the state provide vehicle data by class. The other AVC data must be supplemented by manual counts, which are conducted over a 24- to 48-hour period of time. There are 4,857 sites where data on Oregon's state highway system is collected, and the vast majority of that data is based on samples with short time frames of 24- to 48-hours. Additional data on non-state roadways comes from other local and state sources. Samples are not collected on every road segment annually. Roughly half of the data points in the 2018 *Transportation Volume Tables* were collected in 2017 or even 2016. Numbers collected in previous years are adjusted to reflect area growth trends, whether local traffic in a specific area increased or not. In addition, AADT numbers presented for newly opened or reopened highways, the numbers are adjusted to reflect year-long operations. These collection methods all have limitations. Limited collection to year-round traffic counts, even less collection of vehicle classification data, and the described adjustments to routes created in previous years all introduce potential measurement error and generally more likely to upwardly bias the DVMT estimates than downwardly bias them. These limitations are by no means comprehensive, but they demonstrate error potential.

Table 2.13: Oregon Statewide DVMT by Roadway Type

		DVMT by FHWA Vehicle Class (Thousands)													Total
R/U	***Classification***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	
Rural	Interstate	37	5,909	2,070	29	324	78	7	91	1,955	336	40	58	213	11,148
	O.P.A.	129	7,511	2,423	183	778	96	15	198	197	116	7	7	74	11,735
	Minor Arterial	60	2,883	1,108	26	723	23	2	234	38	12	1	2	4	5,116
	Major Collector	74	2,597	1,217	33	717	72	4	168	86	57	1	2	33	5,061
	Minor Collector	12	723	385	12	211	7	1	21	3	3	2	-	1	1,379
	Local	25	2,438	1,549	54	997	135	80	142	44	49	-	-	17	5,531
Urban	Interstate	43	11,003	2,596	46	418	92	11	89	1,180	185	30	40	87	15,818
	O. F. E.	29	2,670	1,066	28	122	27	7	27	9	10	15	2	4	4,016
	O.P.A.	130	10,876	3,194	302	577	67	11	177	81	29	36	3	17	15,499
	Minor Arterial	116	8,401	2,357	192	609	64	8	142	98	33	17	2	18	12,056
	Major Collector	56	5,186	1,503	94	447	32	5	63	31	6	2	1	4	7,432
	Minor Collector	5	537	155	3	49	1	0	6	-	-	0	-	-	757
	Local	41	3,523	1,039	125	388	48	4	53	95	76	1	1	14	5,407
All	All	759	64,256	20,663	1,127	6,360	743	154	1,411	3,816	912	151	117	486	100,955

According to ODOT officials, non-AVC samples are collected on weekdays, meaning that for most segments comparable data from weekends is unavailable. This approach also upwardly biases the DVMT numbers at non-AVC data collection sites because weekday traffic is generally higher than weekends or holidays when no data is collected. It also makes it impossible to account for adjustments in the composition of vehicular traffic as it pertains to FHWA vehicle classification on those days without collecting a significant amount of additional data for purposes of making adjustments. ODOT officials indicated that they make adjustments for weekends and seasonal variation for the overall volume data, but they do not make adjustments to the composition of vehicle class data. Each class share of the VMT is held constant for weekdays, weekends and holidays. This approach is potentially problematic because the traffic share of commercial trucks tends to fall on weekends and holidays, and as past studies have indicated, at a greater rate than non-commercial traffic (Cambridge Systematics, Inc. and SYDEC, Inc., 1996).

Another point made in the Cambridge Systematics, Inc. and SYDEC, Inc. study is that the state's available AVC equipment with classification functionality frequently overcounted large trucks. One specific example is cars or trucks with trailers, as their similar axle spacing might cause an AVC device to erroneously classify those vehicles as a heavy truck. Another is two vehicles following close together being classified as a single vehicle, which could mean two passenger vehicles in tight formation getting classified as a heavy truck. Manually collected classification data is notably limited to 24-hour and 48-hour windows where short-term changes in traffic conditions could result in significant measurement error. As noted in Chapter 1, the Cambridge Systematics, Inc. and SYDEC, Inc. study researchers conducted some field tests to assess VMT methodological issues with collection vehicle volume and classification data for heavy trucks and ended up downwardly adjusting the annual, statewide VMT for trucks by 26.3 percent as a result. If applying that metric to Oregon's 2018 DVMT data, the statewide heavy truck VMT for 2018 is reduced from 2.57 billion to 1.9 billion. While there is confidence in the overall VMT mileage data, the classification data has been less reliable because of the difficulty of collecting reliable data due to fiscal, technological, and labor constraints.

There are further potential sources of error that should also be addressed. An FHWA report about VMT data collection best practices provides some key insights into the challenges states face pertaining to volume and classification data quality. Technology limitations – particularly non-AVC collection of data, is challenging in high-traffic areas because of safety considerations for the collection crew, and because traffic congestion often precludes reliable classification counts. Equipment failures, construction work, traffic incidents, institutional issues, and data processing and quality control are also factors (Fepke et al., 2004). Most of the states interviewed indicated that volume data was the primary focus, whereas speed and classification data were secondary. States have been working at the time of the study and ever since to address some of these issues with VMT data collection. ODOT officials indicated they plan to implement infrastructure upgrades over the next couple of year that should bolster the accuracy of vehicle volume and classification data. Recent FHWA guidelines for HPMS vehicle classification programs may be instructive as to how ODOT proceeds (FHWA Traffic Monitoring Guide, 2014; Office of Highway Policy Information, 2016).

Given the overall methodological challenges associated with the data, correcting the biases would require several data collection initiatives. First, one would need to gather VMT classification data from numerous route types during weekends on a year-round basis to correct for the differentiation in weekend vehicular traffic. It would require calibration tests of AVCs to correct for vehicle misclassification. Investigators would also have to make a broad number of assumptions about exemptions from the tax, and how said exemptions might translate into mileage exempt from the WMT tax. It would also need to parse reconciliation with current VMT adjustments undertaken by current practices. Collecting all of this data and improving the methodological approach for VMT calculations will require a prolonged effort large in scale, and is therefore beyond the scope of this study. We do recommend that ODOT's Transportation Systems Monitoring Unit should incorporate methodological improvements to the VMT classification data collection process, as the data is critical to FHWA and Oregon's Highway Cost Allocation study.

New VMT data collection methods are currently in development. In particular, research literature on the use of ubiquitous traffic volume estimation is nascent and growing. The growing availability of GPS data from services like Google and Waze, along with commercial vehicle probe data from services like TomTom will allow for much cheaper and more accurate VMT data collection (Garikapati, 2019; Hou et al., 2017; and Chen and Zhang, 2020). To take advantage of such data, it is crucial for states to enter partnering and data sharing agreements with private companies to obtain the data and compare or supplement with more traditional VMT estimation techniques. Like traditional VMT, the new methods still have some methodological limitations, but the lower cost of data collection make the approach more feasible for state DOTs.

2.10 METHODS FOR MEASURING WEIGHT-MILE TAX EVASION

2.10.1 ODOT Commercial Truck Screening Data and WMT Returns

Consistent with the methodology used by Forlines et al. (2019), this approach to estimating WMT evasion uses ODOT commercial trucking observations data collected from fixed weigh stations around the state to identify potential evasion by comparing vehicle screening data to WMT tax returns. The detail of both the returns and the screening data allow comparisons to be conducted at both the company and vehicle level. First, the files will be cleaned up to prevent any issues with data quality. Such processes include cleaning up variables with blank spaces, which might prevent matching; eliminating duplicate screenings at scales where there are LPR readers and manually entered; identifying multiple scale crossings by the same vehicle so as not to overestimate trips through Oregon; and other corrections as needed. Next, the observations data will be grouped by return period to match the return reporting period. To match the tax returns and screening data at the company level, researchers will use the Oregon WMT account number, which is included in both the observations data and tax returns data. If there is no match on account number, the USDOT number or carrier name can be used as an alternative match. To match the tax returns and screening data at the vehicle level, researchers can use vehicle VIN or plate string and state.

The analysis will categorize carriers as in compliance with WMT requirements, or otherwise categorize motor carriers in one of three mutually exclusive evasion categories. The first category would be “No WMT Return.” Carriers would be included in this category if observed at a weigh station but subsequently not filing a return for the corresponding reporting period. This would apply to carriers with active authority or temporary passes. The second category would be for those carriers who file “0 miles” on their WMT returns but were observed at a weigh station during the reporting period. Carriers are required to file a return every reporting period whether they file monthly or quarterly. This ensures their tax account stays active and that they can easily file in the future if for some reason they temporarily cease operations in Oregon. On the other hand, the process creates a scenario where some carriers may attempt to evade the WMT in hopes that ODOT administrators and auditors fail to notice they are still actively operating in the state. The other category is “Underreported miles,” which would apply to carriers whose company-level mileage estimation is significantly higher than their reported WMT miles.

To derive the estimated mileage evasion for each category, the research team will implement a methodology similar to that used by Forlines et al. (2019). First, the reported mileage will be calculated by adding the mileage reported in all carrier WMT tax filings for each quarter (monthly filings and temporary pass filings will be assigned to corresponding quarters but not flat fee filings). Next, we use the inspection data described in Section 2.4 and the citation and warning data from Section 2.5 to estimate the average trip miles for each inspected truck by using GIS software to calculate the number of miles necessary to pick up and deliver a load without making any additional stops. The estimation method generates a somewhat conservative measurement of mileage, but it will be adjusted in the next step. If there are locations where trucks are screened but where no inspections occur, an alternative estimate will be used based on the most direct path a thru truck would take and/or the average trip lengths at nearby stations. Obviously, each station will have far more observations or vehicle screenings than inspections or citations/warnings, so we extrapolate the average trip mileage for inspected vehicles to all screened vehicles to generate an observed mileage estimate at each weigh station. This approach implicitly assumes that the trip lengths of inspected and cited vehicles are representative of all screened carriers, which we think is a reasonable assumption. So, the average trip length is multiplied by the total number of observations to generate an observed miles total for each weigh station, and those are summed to get a total number of observed miles. This sample includes all reported inspections and applicable citations and warnings, and includes both interstate and intrastate vehicles.

The total reported mileage for the quarter is then divided by the observed mileage to generate an estimated mileage ratio. This ratio corrects for unobserved mileage for which there is no screening mechanism. In particular there is very little screening on urban and local roads, and the adjustment attempts to capture those miles. The reported mileage will nearly always be higher than the observed mileage, but the smaller the estimated mileage ratio, the more reliable the estimate. These estimates will be calculated for each quarter of 2016 through 2018. To derive a company’s estimated tax liability, the individual mileage estimate for each station will be multiplied by the number of screening observations at that station for each company, and then multiplied by estimated mileage ratio to derive adjusted mileage. The adjusted mileage is then used to estimate WMT mileage liability for the company. To identify carriers in the “Underreported miles” category, the research team will subtract reported mileage from the adjusted mileage to determine the degree to which a carrier underreported WMTT mileage. The WMT mileage evasion rate will be calculated for the "Underreported miles" category based on the difference between the adjusted mileage and the reported mileage. Based on the distribution of the data, the research team will likely establish a threshold. For example, a carrier may need to have underreported mileage by at least 3 or 5 percent to be included in the category. For carriers in the "No WMT return" or "0 miles" evasion categories, the entire adjusted mileage estimate would be used to estimate overall evasion except for mileage associated with valid WMT passes. The company-level evasion rate for each carrier in the "No WMT return" or "0 miles" category is 100 percent by default, but the overall mileage discrepancy is more important, as it will be used to estimate overall WMT evasion.

Monetary WMT tax evasion will be estimated by using the applicable tax rate for each vehicle screening based on the truck's declared weight. In the event there is no observation for a company that includes a vehicle weight, the rate bracket of the modal vehicle weight observed during each quarter will be applied to the tax estimate.

The total miles evaded for all three evasion categories will be calculated for each quarter and for the overall analysis period. The overall mileage evasion will be measured as a percentage of the total miles evaded based on a comparison of WMT reporting during each quarter and the total mileage evasion estimates. The analysis will include a point estimate as well as confidence intervals to generate a high- and low-end estimates for the overall evasion. Supplementary analysis will accompany the base mileage evasion numbers to provide more context and look for additional evasion that might not show up via straightforward comparisons of observations and WMT return data. For the monetary evasion, we will calculate base evasion rates but also apply late fees, penalties, and interest. Those monetary amounts will be broken out separately so that Audits will be compared with the estimations to determine what percentage of the evasion was detected by the CCD auditors.

2.10.2 WMT Returns and IRP Registration Filings

The second primary approach to estimating WMT evasion is to compare WMT tax returns with IRP registration filings. KTC researchers have obtained the 2018 IRP returns where carriers declare their mileage and can compare with the WMT returns during the same period, as noted in Section 2.7. The mechanism for matching the WMT data and IRP return data is the USDOT number. Unfortunately, IRP does not require states (the requirement is not applicable to Canadian provinces) to send up the USDOT field. Inspection of the data indicates that about 30 percent of the carriers reporting mileage in Oregon do not have a corresponding USDOT number. To address the missing data issue, the research team plans to match the IRP account number using T-files from the FMCSA's SAFER database. The tables include IRP account data, IRP fleet data, and IRP vehicle data, but do not include mileage data. Therefore, the IRP account numbers will need to be matched with the IRP Clearinghouse data, which will provide the USDOT number necessary to match WMT returns with the remaining unmatched IRP mileage reports. The data will be checked to assure reliability, as associations between USDOT numbers and IRP account numbers may change over time, particular for owner-operators and registrants.

The analysis will be comparing the mileage reports at the carrier level rather than the vehicle level, and the mileage reports will be compared to ascertain whether the carrier reported more WMT mileage than IRP mileage. There are several reasons why the data might not line up for a particular company. The first is that eligibility requirements are not the same for IRP and WMT. Although both are required of vehicles over 26,000 pounds, there are differences that might influence reporting. A carrier might have several intrastate vehicles required to pay WMT but not subject to IRP registration requirements. Some carriers will split their IRP vehicles into separate fleets for accounting purposes, and those fleets must be combined so that a complete mileage picture can be assembled. In some limited instances, an intrastate vehicle under 26,000 pounds may require an IRP credential if it picks up a load and (through use of temporary permits in each state in which it operates) drop it off in another state, but not be required to pay the WMT. To ensure these differences do not impact the accuracy of the comparison between IRP and WMT returns, the research team will compare the vehicle numbers from WMT filings and IRP SAFER data to determine whether the vehicle universe is similar for both filings and to make adjustments if necessary.

Last, and perhaps most importantly, it should also be noted that discrepancies between IRP filings and WMT returns could be because a carrier is attempting to evade one or another. In this instance we posit that WMT mileage underreporting or non-filing is apt to be more likely than IRP underreporting or non-filing because of the structures of those programs. Underreporting pretty straightforwardly saves a carrier on taxes, but the complex structure of IRP makes evasion strategies more complicated. Underreporting or incorrectly diverting Oregon mileage to other IRP jurisdictions could increase the percentage of miles logged in other jurisdictions and thereby increase fees owed to other jurisdictions. For example, California and Washington state both have higher IRP registration fees than Oregon as well as other truck fees assessed to carriers that are not assessed in Oregon. A carrier attempting to underreport Oregon miles could inadvertently increase their IRP fees. This is not to assert a carrier could not commit IRP evasion, merely that it is more complicated by virtue of its structure.

The estimated overall mileages will be compared where comparisons can be made, and the research will report on the differences and estimated evasion of both IRP and WMT where a carrier reports significantly different totals for one than the other, notwithstanding legal reasons why differences may manifest themselves. The comparison is less straightforward than the WMT returns and commercial screening data described in Subsection 2.10.1, as the same universe of vehicles is not always required to pay the fees. The analysis will also compare the overall mileage picture, which will require identifying and dropping intrastate vehicles registered in Oregon liable for WMT out of the sample to provide a fair comparison. Any identified evasion would need to be parsed out if a company had already been flagged as evading WMT in Subsection 2.10.1, or if a subsequent audit of the company resulted in an assessment of additional taxes, fees, penalties and interest. Consistent with Subsection 2.10.1, WMT mileage evasion and revenue evasion will be estimated.

2.10.3 Comparison of WMT Returns and IFTA Returns

The third methodology estimation method is to compare WMT mileage to IFTA mileage. As previously noted, this is best done by comparing quarterly IFTA returns with the WMT filings for the same reporting period. IFTA Clearinghouse data has two primary forms – demographic data and transmittal data. The streamlined IFTA demographic data is account-level data that provides the legal name, business name, USDOT number, IFTA number, IFTA account status, jurisdiction (state or province), and the IFTA status and expiration dates. The IFTA transmittal data includes many of the same fields as the demographics data as well as return type, total miles, taxable miles, average miles per gallon, taxable gallons, and taxable gallons paid, and net gallons paid, among others. The exception is that transmittal data does not include a USDOT number, so it will need to be matched to the demographic data, and from there matched to WMT returns. As stated in Subsection 2.8, the total miles will be compared against the WMT miles at the company level. As with IRP, IFTA mileage is only accrued by interstate vehicles, although there are a couple of exceptions. For IRP, there are some intrastate farm vehicles, as well as some vehicles under 26,000 pounds that have apportioned plates. The comparison will exclude intrastate vehicles, which are easily identified in most cases the WMT data because the intrastate plates begin with the character "YC," whereas interstate, apportioned vehicles plates begin with "YA." However, this would only apply to Oregon-based vehicles – not out-of-state vehicles or vehicles leased to a fleet that is not plated in Oregon. But we believe this approach will eliminate the vast majority of intrastate vehicles.

Unlike the IRP data, which for mileage reporting was only available for 2018, the IFTA returns are provided for each quarter, so the WMT returns will be matched to the appropriate quarter. As such, monthly returns will be bundled into matching quarters and the temporary passes will be assigned based on the pass validation date. As with the IRP data, some of the IFTA data has no USDOT data. To match the roughly 40 percent of the IFTA carriers with no USDOT number in the demographic data, the research team will obtain SAFER data from the T25 files for IFTA data that will enable the research team to identify the missing USDOT numbers. As with the IRP data, these matches will be checked for accuracy, as IRP/IFTA account associations to USDOT numbers can change over time.

As with IRP data, there are reasons why there might be discrepancies in IFTA mileage and WMT mileage, albeit fewer than for IRP. Although Oregon does not assess a fuel tax for heavy trucks, the IFTA agreement still requires carriers to report their miles. There is some difference between total miles and taxable miles on the Oregon returns, which is interesting because according to the IFTA exemptions database Oregon does not allow vehicle exemptions, fuel exemptions, or distance exemptions. An analysis of IFTA returns filed between January and October 2019 revealed there were 3,299 returns where the taxable and total miles differed, whereas taxable and total miles matched on 101,650 returns. The research team will further investigate the reasons for such discrepancies, and whether some exclusions should be included. One possible reason could be due to a carrier's farm operations.

The mileage reported by carriers to IFTA should closely match WMT returns for the same reporting period in most instances. The high-level comparison of WMT and IFTA returns in this chapter indicates the total overall mileage reported is close. Most commercial vehicles are equipped with intrastate plates and the fleet composition for IFTA and WMT will be similar for most (though not all) fleets. Given that Oregon does not assess a fuel tax, there is far less incentive to underreport IFTA mileage than WMT mileage. Other than basic IFTA compliance costs (e.g. tracking mileage, filing returns, etc.) reporting actual IFTA mileage in Oregon will not impact that carrier's tax liability. Any carrier reporting more IFTA mileage than WMT miles is quite likely to be evading WMT tax liability.

The research team will compare evasion based on taxable IFTA miles and taxable WMT mileage unless further investigation reveals the total mileage to the more appropriate metric. Comparisons will be at the company level and take differences for corresponding fleet sizes into account if possible. WMT and IFTA fleet sizes should be similar if not identical in most cases. After taking potential differences in fleet size into account, the research team will calculate the percentage difference between the reported WMT and IFTA tax mileage in each quarter of 2016, 2017 and 2018. To calculate the unpaid tax amount, the research team will equally apportion all underreported mileage to all carrier vehicles with a WMT return for the reporting period. KTC researchers will tabulate mileage differentials and additional taxes owed for all carriers to calculate a statewide, quarterly mileage and tax evasion total for each quarter. As with the other evasion detection methods, researchers will match carriers with outstanding taxes and fees with audits data where possible to determine whether a subsequent audit uncovered the evasion.

2.10.4 Comparison of WMT Mileage Evasion Methods

After conducting the first three phases of the analysis, the research team will compare evasion of WMT based on the evasion identified by the comparisons of WMT returns with commercial vehicle observation screening data, IRP mileage reports, and IFTA tax returns. The first step will be to compare the three groups of carriers found to be non-compliant. The analysis would take a high-level look at evasion found for each estimation method. In addition, the analysis will look at carriers whose screening records, IRP reporting and IFTA filing point toward WMT evasion. The research will look for overlaps occurring during the same reporting period for each of the evasion estimation techniques. In this stage, the reporting period will need to be an annual period, as we are unable to subdivide the IRP data into smaller units of time due to the limitations of that dataset. The analysis will include confidence intervals or ranges of estimated evasion for each method used. The goal is to determine the consistency of the estimates, assess similarities and differences, and determine which method(s) of evasion estimation are best suited for future use. The comparison will also include both mileage evasion and WMT revenue losses due to that evasion.

The next step will be to capture enforcement of WMT evasion. To do that, audits will be matched to the carriers whose evasion is detected the first three phases. If the audit period does not entirely align with the evasion estimation period, the percentage of audit time overlap with the WMT evasion estimate will be applied to the audit total. For example, if a 3-year audit finds $200,000 of WMT evasion for a carrier, but the overlap period with the study data is only a year, then the enforcement capture is calculated as one-third of $200,000, or $66,667. In practice, unpaid WMT Evasion is rarely evenly spread across all reporting periods, but the data does not report the monthly or quarterly distribution of the unpaid WMT. The audit capture portion of WMT will look solely at revenue and not mileage, as the audit data does not include before and after WMT mileage reported. When looking at the recovered revenue, we will separate the WMT tax amount recovered from the late payment fee, penalty and interest so that the analysis measures WMT evasion as the additional taxes paid resulting from an audit, notwithstanding late fees, penalty and interest.

After the research team makes all of the necessary adjustments, it will calculate a total WMT evasion estimate that measures WMT tax for all three methodologies and provides a range of potential evasion based on the distribution of comparisons with screening data, IRP data and IFTA data. One adjustment the research team will make when estimating the full impact of enforcement against WMT evasion is to include CCD data that captures amended tax return revenue in addition to the original tax returns. CCD receives a significant number of returns and amendments after it runs preliminary reports and assessments to determine which carriers have not been filing taxes as usual. Unfortunately, this activity – which does not rise to the level of a fully documented audit – is not fully documented. While CCD records the additional revenues resulting from this process, the additional reported mileage is not available. KTC researchers will work with CCD to determine a method to approximate the distance. Accounting for these amended collections will improve the accuracy of evasion estimates and WMT evasion enforcement by ODOT.

3.0 ANALYSIS OF OREGON WEIGHT-MILE TAX EVASION

In this chapter we use three methods to estimate WMT evasion rates: 1) comparison of commercial truck screening data to WMT tax returns, 2) comparison of IRP registration filings to WMT tax returns, and 3) comparison of IFTA filings to WMT tax returns. In Section 3.1, ODOT commercial trucking observation data from fixed weigh stations and portable WIM scales are used to identify potential evasion by comparing vehicle screening data to WMT tax returns. In Section 3.2, we compare WMT tax returns with 2018 IRP registration filings to estimate WMT evasion. Section 3.3 compares WMT mileage to IFTA tax return mileage to estimate the WMT evasion. Finally, in Section 3.4, WMT evasion estimates from the three approaches are compared in terms of mileage evasion and revenue evasion.

3.1 ESTIMATION OF TAX EVASION RATES USING ODOT COMMERCIAL TRUCK SCREENING DATA AND WMT RETURNS

3.1.1 Data Preparation

We used inspection, citation, and warning data to estimate the average trip length of each truck observed passing through an Oregon weigh station or commercial vehicle screening location from 2016 through 2018 regardless of whether it was stopped. Trip lengths were estimated using QGIS and ArcGIS software. Inspection, citation, and warning data include load origin and destination information, whereas screening data collected at weigh stations or screening locations lack this information because origin and destination can only be obtained by stopping a truck and inspecting its bill of lading. The origin and destination fields record both the city and state. Lacking information on precise locations, we used GIS software to estimate trip mileage for each record using the geographic centroid of each city (see Section 2.4). Analysis also used Oregon's geographic borders for trips beginning or terminating in another state so that only mileage logged in Oregon was counted.

When we estimated the trip mileage (see Section 2.4), we assumed that a vehicle took the shortest route from the origin to the weigh station where it was inspected, and that it proceeded to the destination along the shortest route in miles. We estimated a trip mileage in Oregon for each inspection, citation, and warning record. For each weigh station, an average trip mileage was calculated based on the facility's associated records. Average trip mileage was calculated so we could estimate the trip length for all observed vehicles. Vehicles were combined by a WMT account number to generate a carrier-level estimate. Among several methods to estimate the trip mileage with the origin and destination information, we chose the shortest route in miles approach for two reasons: 1) it reduced the probability of overestimation and 2) it was more straightforward compared to alternatives (e.g., shortest-time-traveled approach).

We had access to inspection data from 2017 and 2018 and citation/warning data from 2016 to 2018. Datasets were combined and duplicates removed, which left just one record per vehicle stopped. Removing duplicates prevented over counting mileage associated with a single trip. For example, if an inspection resulted in a citation or warning, the inspection record remained, and the citation or warning record was removed from the dataset. If multiple citations were issued from an inspection, only one citation record remained while the others were deleted. Scrubbing duplicates also prevented inspections that resulted in multiple citations and warnings from either raising or lowering the average trip mileage. Table 3.1 shows the distribution of the number of inspections, citations, and warnings by year in the dataset used to estimate average trip mileage for a vehicle screened at a weigh station (a weigh station-specific trip mileage for every vehicle passing through a weigh station). All told, 157,912 records were used to generate estimates.

Table 3.1: Inspections, Citations, and Warnings in the Analysis

Year	Inspection	Citation	Warning	Total
2016	No data	13,480	15,098	28,578
2017	38,159	14,840	15,711	68,710
2018	31,374	14,126	15,124	60,624

Table 3.2 includes a selection of weigh stations and indicates how many inspection, citation, and warning records we used to estimate average trip mileage per screened vehicle specific to each weigh station. Weigh stations where the total number of inspections, citations, and warnings exceeded one percent of the aggregated total are included in the table below. The full list of weigh stations and associated information can be found in **Error! Reference source not found.**. S ix port-of-entry stations (POEs) with the highest number of inspections conducted are listed on the top of Table 3.2. At Umatilla POE, a total of 19,454 inspections, citations, and warnings were issued, which is 12.32 percent of the total inspections, citations, and warnings issued from 2016 to 2018. Over 50 percent (52.31 percent) of the records used for estimating average trip mileage were collected at the six POEs.

Table 3.2: Inspections, Citations, and Warnings by Commercial Vehicle Screening Site

Scale	Scale Name	Inspection	Citation	Warning	Total	Percentage
3006	Umatilla POE	8,401	6,880	4,173	19,454	12.32%
2409	Woodburn POE	9,298	4,013	3,686	16,997	10.76%
2306	Farewell Bend POE	5,497	2,723	6,946	15,166	9.60%
1404	Cascade Locks POE	4,823	3,656	3,195	11,674	7.39%
1507	Ashland POE	3,270	3,511	4,123	10,904	6.91%
1807	Klamath Falls POE	3,890	1,096	3,430	8,416	5.33%
1007	Booth Ranch SB	4,089	1,681	2,185	7,955	5.04%
1402	Wyeth	3,185	1,553	1,527	6,265	3.97%
2408	Woodburn NB	2,505	1,476	1,355	5,336	3.38%
3103	La Grande	2,703	1,006	1,067	4,776	3.02%
3005	Emigrant Hill	1,367	1,795	1,006	4,168	2.64%
1604	Juniper Butte SB	2,086	643	1,355	4,084	2.59%
1506	Ashland SB	1,572	1,120	1,262	3,954	2.50%
1008	Booth Ranch NB	965	1,174	1,562	3,701	2.34%
1805	Klamath Falls S	1,335	747	1,278	3,360	2.13%
2305	Olds Ferry	1,278	1,038	563	2,879	1.82%
3004	Cold Springs	323	1,824	714	2,861	1.81%
2601	Rocky Point	1,043	717	455	2,215	1.40%
0906	Bend	1,357	292	548	2,197	1.39%
1603	Juniper Butte NB	1,035	313	568	1,916	1.21%
2402	Hubbard SB	1,211	277	204	1,692	1.07%

Based on the load origination and destination information recorded with each inspection, citation, and warning, we determined if the trip was an interstate trip or intrastate trip. If the trip origin and destination cities were both located in Oregon, we assumed it was an intrastate trip. We concede that it is possible for an interstate trip to begin and end in Oregon, but without a way to verify intervening stops our GIS analysis suggested that the vast majority of those trips were intrastate. Trips originating or terminating in another state were assumed to be interstate. For example, of the 19,454 records associated with Umatilla POE, 19,343 records (99.43 percent) were collected from interstate trips and the remaining 111 records (0.57 percent) were from intrastate trips. The most common interstate trip was between Washington and Oregon (21.28 percent). Trips from Washington to California by way of Oregon accounted for 6.48 percent of all interstate records at Umatilla POE. The average trip mileage for interstate trips at this POE was 206.97 miles and that of intrastate trips was 129.70 miles (Table 3.3).

Table 3.3: Average Interstate Trip Miles and Intrastate Trip Mile by Commercial Vehicle Screening Site

Scale	Scale Name	Interstate Trip Mileage	Intrastate Trip Mileage
3006	Umatilla POE	206.97	129.70
2409	Woodburn POE	302.32	123.86
2306	Farewell Bend POE	211.50	210.79
1404	Cascade Locks POE	371.42	156.88
1507	Ashland POE	304.67	59.01
1807	Klamath Falls POE	302.29	188.20
1007	Booth Ranch SB	302.11	133.10
1402	Wyeth	373.20	161.11
2408	Woodburn NB	302.29	97.59
3103	La Grande	206.43	158.68
3005	Emigrant Hill	212.63	134.31
1604	Juniper Butte SB	291.00	144.57
1506	Ashland SB	302.11	98.08
1008	Booth Ranch NB	304.11	106.73
1805	Klamath Falls SB	289.00	174.92
2305	Olds Ferry	206.42	130.20
3004	Cold Springs	53.90	67.83
2601	Rocky Point	53.30	40.40
0906	Bend	327.11	115.09
1603	Juniper Butte NB	304.38	125.71
2402	Hubbard SB	280.84	56.60

Commercial vehicle screening data were collected at 163 weigh stations or portable scales over the study period, but inspection, citation, and warning records of interstate trips were available for only 97 screening locations. Among the screening locations with inspection, citation, and warning records, some weigh stations had a relatively small volume of accumulated records. The volume of records impacts our confidence in the mileage estimates because estimates derived from a larger number of records are less susceptible to error. Consistent with the Central Limit Theorem, we distinguished between screening locations where the average interstate trip mileage was derived from less than 30 records from locations at which mileage was obtained from more than 30 records. Screening locations where more than 30 records were used to estimate average interstate trip mileages are marked with a green circle in the maps that appear in this chapter. Screening sites with fewer than 30 records are not included in the following maps because of the high probability of average interstate trip mileage being over- or underestimated by outliers. See **Error! Reference source not found.** for average interstate trip mileage estimates for screening s ites with fewer than 30 records.

Table 3.4 classifies the estimation method for weigh stations based on the number of inspection, citation, and warning records available. We adopted a uniform approach to estimate trip mileage, irrespective of the number of records. Table 3.4 lists the number of stations in each category. Estimated trip lengths for weigh stations in the *Predicted using GWR* category were calculated using geographically weighted regression (GWR).

Table 3.4: Interstate Trip Mileage Estimation Methods for Truck Screening Locations by Records Available for Estimation

	Interstate Trip Miles	
	Screening Locations	***Total Inspections, Citations, and Warnings***
Less than 30 Records	34	426
Equal to or more than 30 Records	63	127,477
Predicted using GWR	66	0
Total	163	127,903

Estimated trip lengths for weigh stations with data were calculated using the inspection, citation, and warning data for all stations where data were available. However, we are most confident in our results for stations where 30 or more records were available. Unfortunately, at several screening locations (many of them virtual locations or systems using portable scales) screening data were available, but not supplementary inspection, citation, and warning data. For these locations, trip mileage was inferred using GWR in ArcGIS. Screening locations with more than 30 data entries for inspections, citations, and warnings were included in GWR, but stations with fewer than 30 records were excluded to prevent outliers from disproportionately impacting our results.

Unlike ordinary least squares (OLS) regression, which produces one set of coefficients for every point in the dataset, GWR is a local regression model that allows coefficients to vary. With GWR a separate predictive equation for every screening site in Oregon was generated that incorporated dependent and explanatory variables from screening sites in close proximity. Before moving onto GWR, we investigated explanatory variables that affect the average interstate and intrastate trip mileage of a screening site using OLS regression in STATA. Three explanatory variables have a statistically significant relationship with average trip miles: distance to the nearest state border with Washington, Idaho, and California; hierarchy of the road; and the annual average daily traffic for trucks (APPENDIX C).

The distance to the nearest state border (i.e., with Washington, Idaho, or California) correlates positively with average interstate trip miles. The eight screening sites along US 101provide a nice example of this trend. Average interstate trip mileage increases as the distance from the state border to a weigh station increases. The distance between the Seaside weigh station and the Washington/Oregon border is 10.23 miles, while the distance between that border and the Waldport weigh station is 107.68 miles. Average interstate trip miles for Waldport are much greater than at Seaside. The same pattern is observed as a screening site also is located away from the California/Oregon border. A major portion of trips screened at these sites originates at nearby cities and ends in Washington or California. Since the average number of interstate miles traveled for these weigh stations is heavily influenced by those trips, average interstate miles approaches the distance from the nearby city to the state border. Figure 3.1 captures the positive relationship between the distance from a weigh station to the nearest state border and average interstate trip miles.

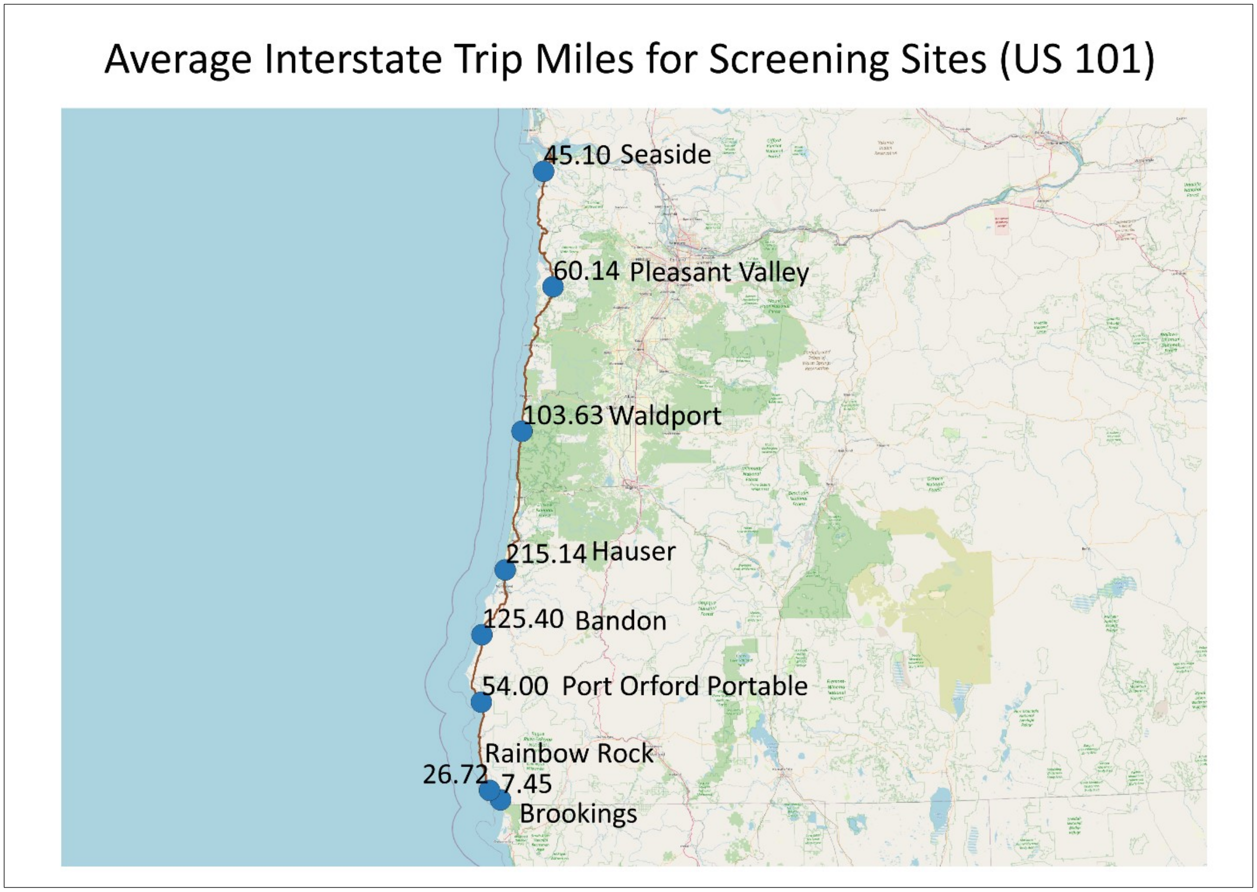

Figure 3.1: Average interstate trip miles for screening sites (US 101)

OLS regression indicated a statistically significant relationship between the average trip miles and the hierarchy of the road on which a screening site is located. The U.S. Department of Transportation Federal Highway Administration classifies roadways into four major categories: principal arterial, minor arterial, collector, and local. The *principal arterial* classification contains three subcategories (interstate, other freeways and expressways, and other), while *collector* has two subcategories (major collector and minor collector). The subcategories under *principal arterial* and *collector* have both urban and rural forms. Among the 137 fixed screening sites, 63 are located on *rural other principal arterials*, and 27 are located on *urban other principal arterials*. Urban roadways are positively related to average interstate trip miles, while rural roadways are positively related to average trip miles.

Table 3.5: Commercial Vehicle Screening Site by Road Hierarchy

Classification	Frequency	Percent
Rural Other Principal Arterial	63	45.99%
Urban Other Principal Arterial	21	15.33%
Rural Minor Arterial	19	13.87%
Rural Interstate	13	9.49%
Rural Major Collector	6	4.38%
Urban Minor Arterial	6	4.38%
Urban Collector	5	3.65%
Urban Interstate	2	1.46%
Rural Minor Collector	1	0.73%
Urban Minor Collector	1	0.73%
Total	137	100.00%

The last explanatory variable that is statistically related to average trip miles is truck annual average daily traffic (AADT). This statistic is calculated by obtaining the annual volume of truck traffic for a roadway and dividing that number by 365. It is positively related to the average trip miles. Truck AADT tends to be higher on major interstate highways, which are frequently used for longer interstate trips. On the other hand, truck AADT is relatively low on rural roadways used for local and intrastate trips.

While OLS found that distance to the nearest state border, road hierarchy, and truck AADT as explanatory variables significantly related to average trip miles, our analysis suggested that GWR could produce a better estimate than OLS regression since screening sites are distributed throughout the state. According to Tobler's First Law of Geography, geographically proximate things are more related to each other than distant things (Tobler, 1970). So, it is reasonable to assume that screening stations close to one another exhibit average trip mile values which are more similar than they are to more distant screening stations. GWR incorporates this principle into analysis. Average trip miles predicted using GWR in ArcGIS are indicated with a yellow circle in Figure 3.3 and Figure 3.4.

3.1.1.1 Estimation of average trip mileages in Oregon for interstate trips

Figure 3.2, Figure 3.3, and Figure 3.4 visualize the relative lengths and spatial patterns of average trip mileages in Oregon for interstate trips for each screening location as well as the methods we used to estimate trip length. Weigh stations whose estimated trip lengths were calculated using inspection, citation, and warning data, and where more than 30 records are available are denoted with green circles. Circle size is proportional to average estimated trip length. To improve legibility these maps do not include weigh stations for which estimated trip lengths were calculated using fewer than 30 records of inspections, citations and warnings. Average trip mileages for interstate trips for those inspection locations can be found in APPENDIX B. Yellow circles indicate screening locations where estimated trip lengths were calculated using GWR.

Figure 3.2 depicts average interstate trip mileages for weigh stations which had more than 30 interstate trip records available. Regardless of the number of inspections, citations, and warning records, estimated interstate trip miles for each screening site were calculated by averaging the interstate trip miles documented in all records at a screening site. Circle size reflects the average number of miles a vehicle traveled in Oregon when it was screened at the weigh station while making an interstate trip. The bigger the circle, the longer the travel distance in Oregon. The four weigh stations with the biggest average interstate trip mileages are Sisters, Walterville, Wyeth, and Cascade Locks POE.

The weigh stations in the longest travel distance category (304.00 to 388.65 miles) are located along I-5 and US 97. All six weigh stations along I-5 (Ashland POE and SB, Booth Ranch SB and NB, and Woodburn POE and NB) had very similar average interstate trip mileages. Among these, the lowest mileage was recorded at Ashland SB (302.11 miles) and the highest mileage at Ashland POE (304.67 miles). Given that the distance from the Washington-Oregon border to the Oregon-California border along I-5 is 313 miles, it appears that a large portion of commercial vehicles screened at weigh stations along I-5 traveled from one border to another. This is supported by ODOT's 2016–2018 commercial truck screening data. For example, 43.31 percent of vehicles making interstate trips at Booth Ranch NB had a load origin in California and a destination in Washington.

Similar patterns exist for weigh stations along US 97. There are four weigh stations on US 97, Klamath Falls SB and NB, Bend, and Moro SB. The highest average mileage was recorded at Bend (327.11 miles), followed by Klamath Falls POE (302.29 miles), and Moro SB (320.62). The lowest mileage recorded on US 97 was 289.00 miles at Klamath Falls SB.

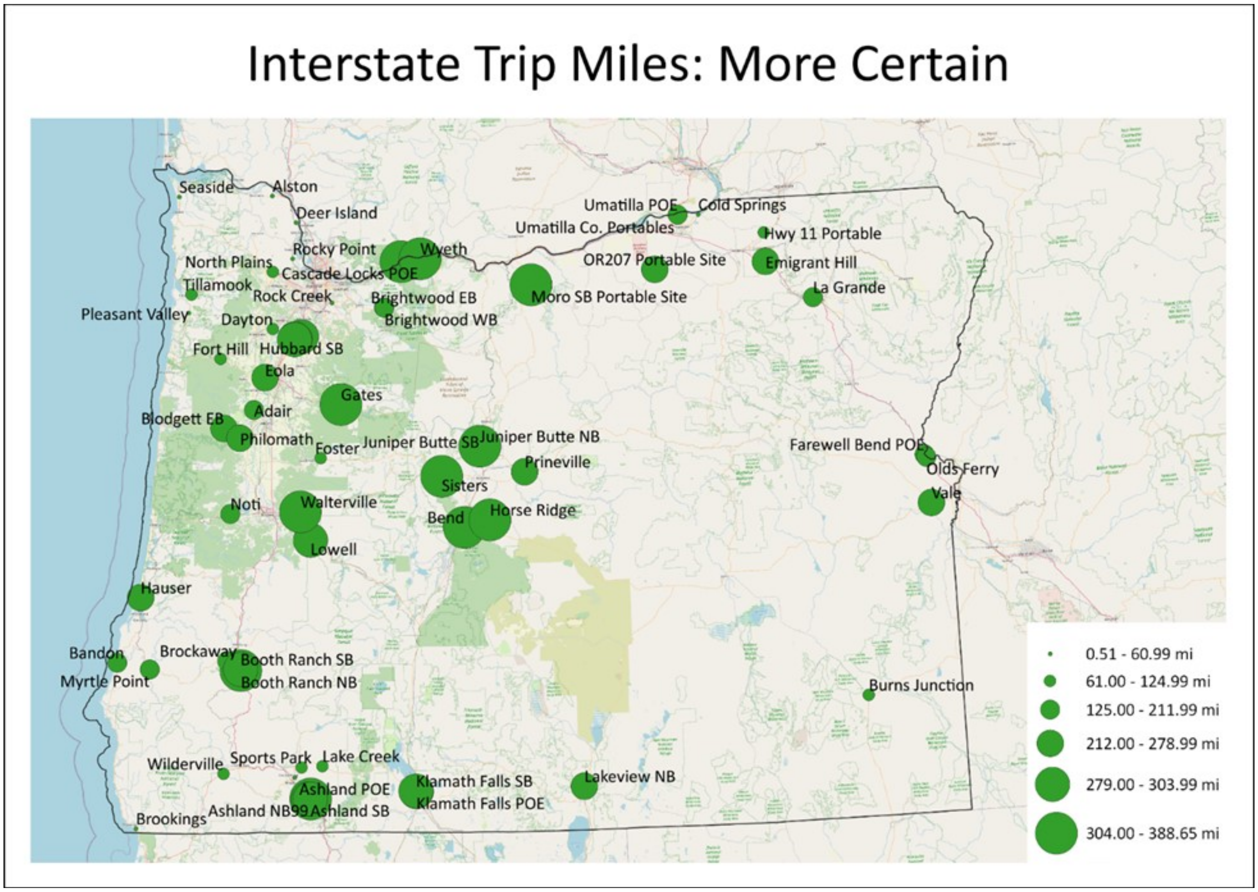

Figure 3.2: Average interstate trip miles estimated with more than 30 observations

Figure 3.3 captures interstate trip miles predicted with GWR as well as estimated average interstate trip miles for stations with more than 30 observations. Both types of stations are on the same map as this lets us compare predicted average interstate trip mileages (yellow circles) to stations for which we have greater certainty (green circles). The map below focuses on I-5 to see if predictions are both intuitive and statistically valid. As noted, weigh stations or portable scales along I-5 had very similar average trip miles, ranging from 302.11 miles to 304.67 miles. Four weigh stations or portable scales near I-5 lacked inspection, citation, or warning data; all four had average trip miles less than the weigh stations on I-5. Average interstate trip mileage for the Dead Indian Memorial scale was predicted to be 212.99 miles. For the Table Rock Road scale, it was 114.60 miles. Regression indicated that average trip miles have a statistically significant relationship with road hierarchy and truck AADT. Unlike I-5, which is an *urban interstate*, the Dead Indian Memorial scale is on an *urban minor arterial*, and the Table Rock Road scale is on a major collector. Also, truck AADT for all the weigh stations on I-5 exceeded 5,000 but the truck AADT for the Dead Indian Memorial scale was 240.

The prediction for the O’Brien portable site seems reasonable considering that other screening location on US 199 had average interstate trip mileages close to the predicted mileage. The estimated average interstate trip mileage was 69.91 miles for the

Wilderville weigh station. Since both screening locations are on US 199, which is a *rural other principal arterial*, and the truck AADTs were similar, the predicted value for the O'Brien portable site was similar to Wilderville.

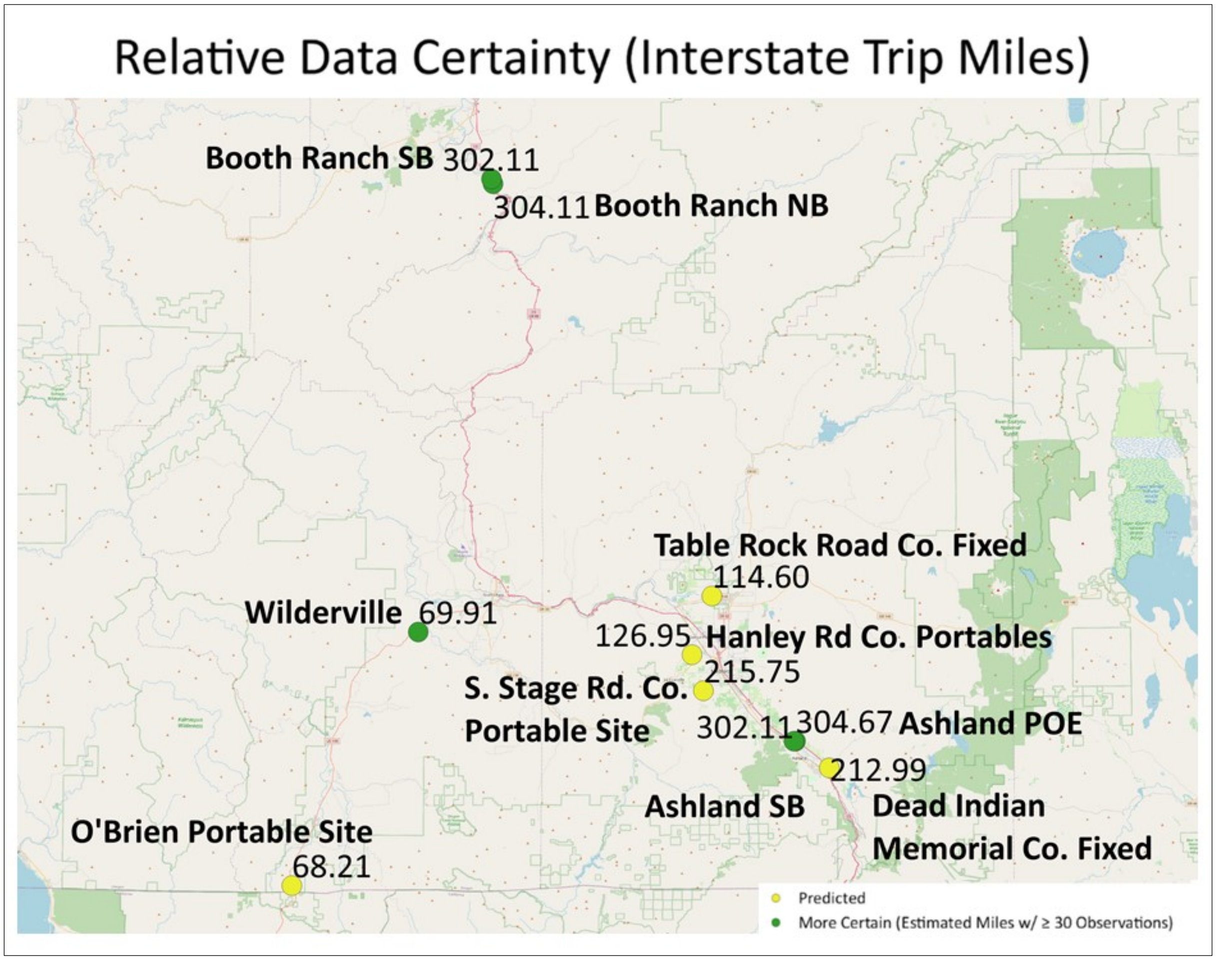

Figure 3.3: Average interstate trip miles predicted with geographically weighted regression (I-5)

Figure 3.4 shows the average interstate trip miles for weigh stations and portable sites on or near I-84. As with the previous map, average interstate trip miles for locations marked with green were estimated using more than 30 observations in the ODOT commercial truck screening data, and locations marked with yellow indicate that the average interstate trip miles were predicted using GWR. Average interstate trip miles for weigh stations on I-84 ranged from 206.42 miles to 212.63. Considering that the distance from the Washington-Oregon border through Umatilla to the Oregon-Idaho border through Ontario is 209 miles, we could see that the most vehicles screened here enter into Oregon through Umatilla and exit through Ontario.

The ODOT commercial truck screening data show that the most frequently appearing load destination state at the Olds Ferry weigh station was Idaho (22.26 percent), and the next-most-frequent destination state was Texas (12.85 percent). A similar pattern is shown at the Emigrant Hill weigh station. 17.50 percent of the load destinations were for Idaho (from Washington), and 16.45 percent of these trucks went to Texas. Weigh stations or portable sites with no inspection, citation, and warning data were predicted to have lower average interstate trip mileages because of the road hierarchy and truck AADT. Average interstate trip miles for the Nyssa screening site were estimated using 50 inspection, citation, and warning records. Among the 50 records, 39 (78 percent) showed that either the origin or the destination was Nyssa, Oregon. The distance from the city centroid of Nyssa, Oregon, to the Oregon/Idaho border along US 26, where the Nyssa screening site is located, is 0.6 miles. The low average interstate trip miles (0.51 miles) for the Nyssa screening site was heavily influenced by trips either originating from Nyssa, Oregon, and going to other states or ending in Nyssa, Oregon, arriving from other states.

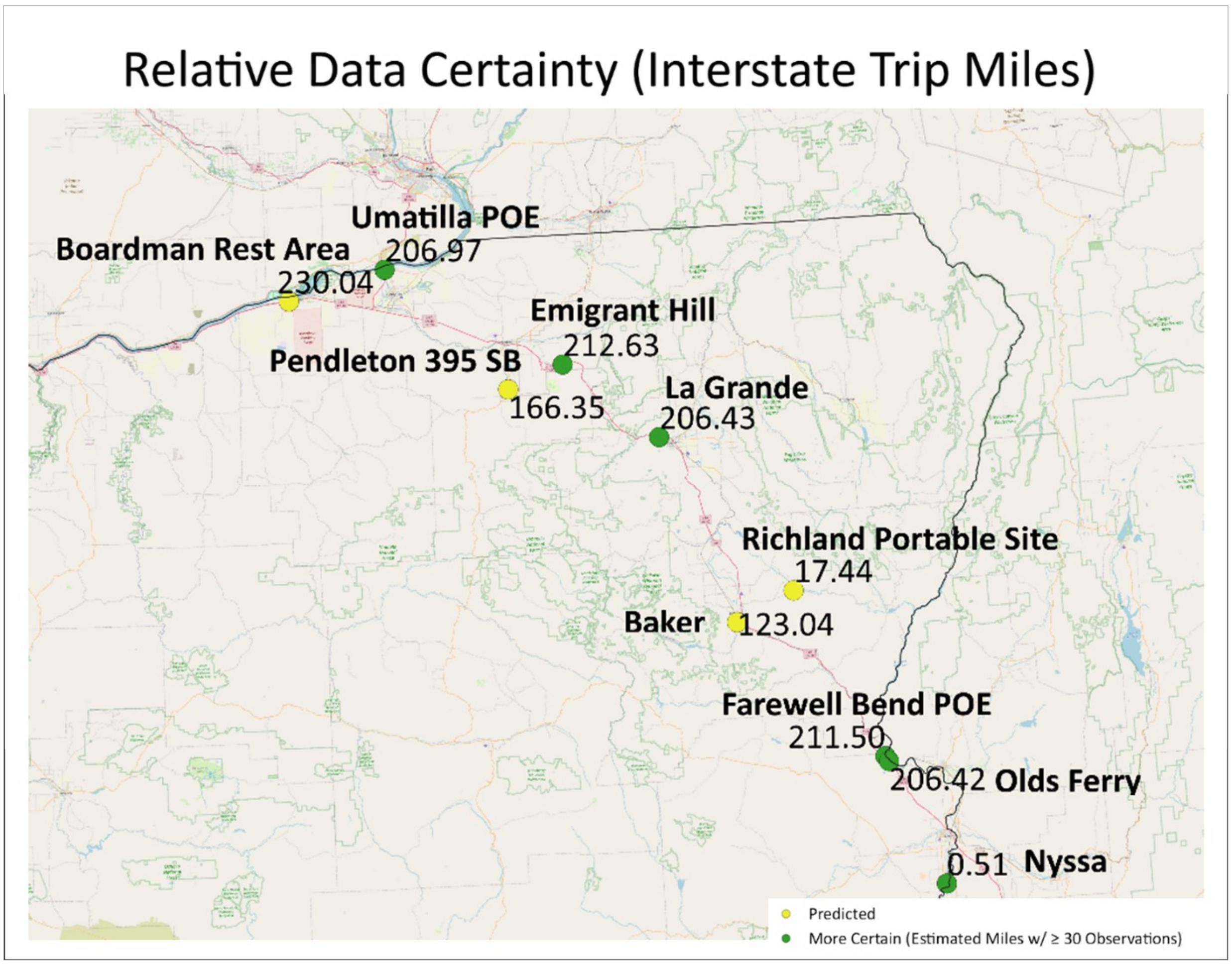

Figure 3.4: Average interstate trip miles predicted with geographically weighted regression (I-84)

3.1.1.2 Estimation of average trip mileages in Oregon for intrastate trips

For intrastate trips, we estimated average trip miles in Oregon using the techniques applied in Section 3.1.1.1 for interstate trips. There were 65 commercial truck screening locations with more than 30 inspection, citation, and warning records that resulted from intrastate trips. Also, there were 31 commercial truck screening locations with less than 30 of those records. Regardless of the number of records, we used the same approach to estimate trip miles. For each vehicle, average trip miles in Oregon recorded in screening records at screening location were treated as taxable miles for the vehicles passing through that site. GWR was used to calculate average trip miles for screening locations without any inspection, citation, and warning record in the "Predicted using GWR" category. Of the 30,009 inspection, citation, and warning records from inspections of vehicles traveling within Oregon, 29,629 (98.73 percent) records were used to make average trip mileage estimations for screening sites with no inspection, citation, and warning records.

Table 3.6: Intrastate Trip Mileage Estimation Methods for Truck Screening Locations by Records Available for Estimation

	Intrastate Trip Miles	
	Screening Location	***Inspections, Citations, and Warnings***
Less than 30 Records	31	380
Equal to or more than 30 Records	65	29,629
Predicted using GWR	67	0
Total	163	30,009

Figure 3.5 shows average intrastate trip miles for screening locations with more than 30 inspection, citation, and warning records. The highest estimate was made at Farewell Bend POE (210.79 miles) and the lowest at Ashland NB99 (19.38 miles). To estimate the average intrastate trip mileage for Farewell Bend POE, 148 inspection, citation, and warning records were used. The most frequent trips were between Ontario and Huntington, (28.74 miles). The next two frequent trips were between Ontario and Portland, (372.19 miles), and between Ontario and Boardman, (222.29 miles). The average intrastate trip miles estimate for Ashland NB99 was made with 30 records. The records include eight trips between Ashland and Medford (8.48 miles). The next two frequent trips were between Ashland and White City (21.92 miles), and between Ashland and Talent City (5.62 miles).

Average intrastate trip miles for Woodburn POE (123.86 miles) were estimated with the most inspection, citation, and warning records (5,317 records). The five most common routes included Portland as either the origin or destination. The most frequent route was between Portland and Salem (53.18 miles). This was followed by routes between Portland and Eugene (112.79 miles), Portland and Albany (70.37 miles), Portland and Medford (276.98), and Portland and Toledo (141.25 miles).

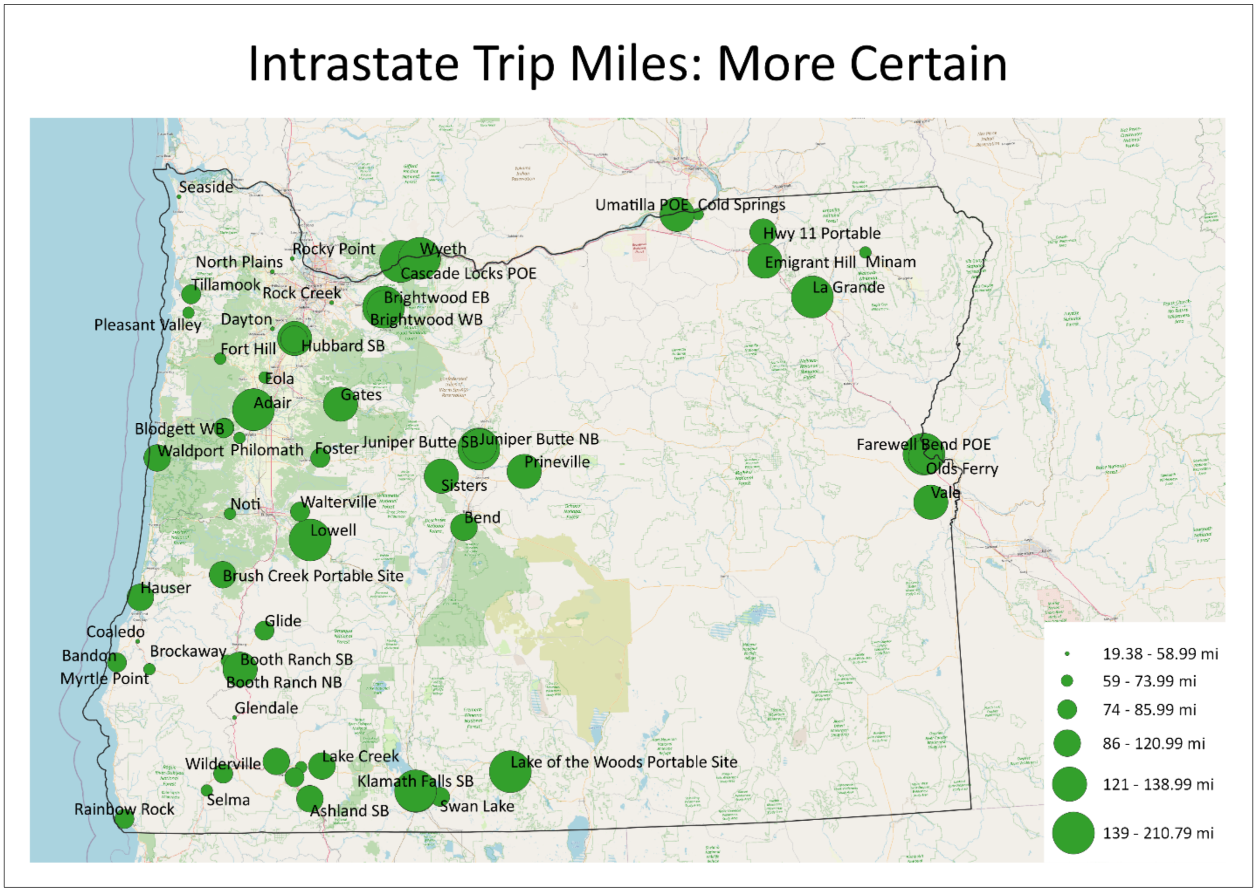

Figure 3.5: Average intrastate trip miles estimated with more than 30 observations

Figure 3.6 includes intrastate trip miles predicted with GWR as well as average intrastate trip miles estimated using more than 30 observations. They are placed on the same map together so we can compare predicted average intrastate trip mileages to the ones with higher certainty (green circles). The map's focus is on I-5 to see if predictions are both intuitive and statistically valid. A large portion of the inspection, citation, and warning records for Booth Ranch SB showed that screened trucks traveled from Portland to Medford (273.16 miles), Eugene to Medford (166.67 miles), Sutherlin to Riddle (33.30 miles), Roseburg to Riddle (21.59 miles), and Roseburg to Glendale (44.59 miles). The aforementioned trip records heavily affected the average intrastate trip miles at Booth Ranch SB weigh station (133.10 miles).

The five most common load origins of intrastate trips at Booth Ranch NB were Riddle, Medford, Glendale, Myrtle Creek, and White City. The five most common load destinations were Dillard, Roseburg, Portland, Eugene, and North Bend. Average intrastate trip mileage (106.73 miles) of trips screened at Booth Ranch NB was heavily determined by frequent trips, including Myrtle Creek to Dillard (12.36 miles), Glendale to Dillard (39.03 miles), Medford to Portland (273.13 miles), Myrtle Creek to Roseburg (17.94 miles), and Riddle to Roseburg (21.60 miles).

Unlike inspection, citation, and warning records collected at Booth Ranch SB and NB, the records gathered at Ashland POE and Ashland SB reflect shorter trips either from or to Ashland. The load origin for 74.40 percent of the total 207 records was Ashland. The most common destinations were Medford, White City, and Ashland. This reflects the fact that vehicles screened at Ashland POE generally made more local trips than vehicles screened at Booth Ranch SB and NB, resulting in a low average intrastate trip length of 59.12 miles. When using GWR to predict average intrastate trip miles for screening locations without any records, the screening locations close to one another with known average intrastate trip miles are more statistically influential than distant screening locations. Lower average intrastate trip miles of Ashland POE and Ashland SB affects estimated average intrastate trip miles of Table Rock Road, Hanley Road, S. Stage Road, and Dead Indian Memorial Co. screening sites.

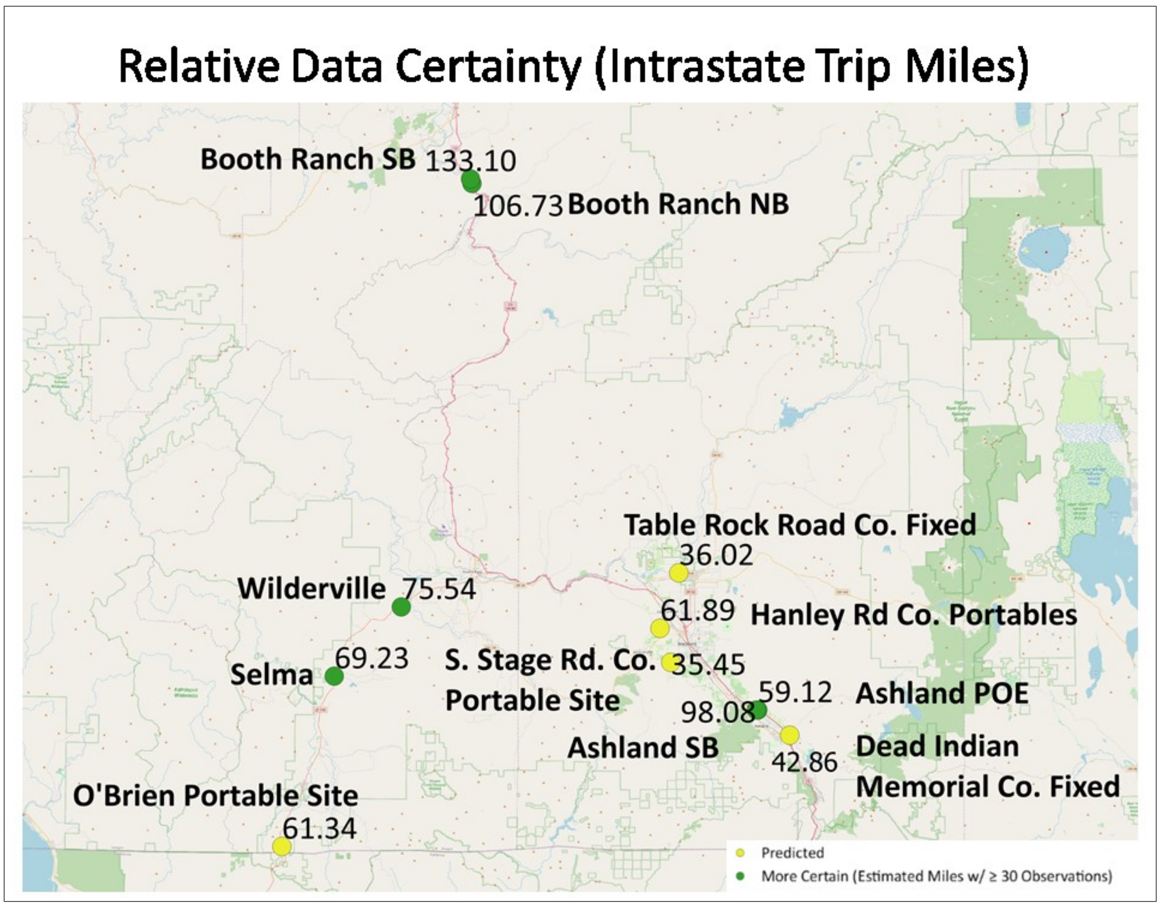

Figure 3.6: Average intrastate trip miles predicted with geographically weighted regression (I-5)

3.1.1.3 Estimation of weighted sum mileage for each screening location

Average mileages for interstate trips and intrastate trips were estimated to calculate taxable miles for each trip screened and recorded at weigh stations. However, screening data lack load origin and destination information, so we cannot determine either interstate or intrastate mileage. As a result, we needed to estimate an average trip mileage that weights the average interstate and intrastate trip mileage to mitigate estimation error. We calculated this mileage as a weighted sum based on the average mileage and the ratio of interstate trip records to intrastate trip records. We then used this as an average trip mileage for all screening records at each station. For each weigh station, we multiplied the average interstate trip mileage by the proportion of interstate trips and the averaged intrastate trip mileage by the proportion of intrastate trips. Next, they were summed. The summed value always lay between the average interstate and intrastate trip mileages by design. For Umatilla POE, 206.97 (the average interstate trip mileage) was multiplied by 0.9943 (the proportion of interstate trips) and 129.70 (the average intrastate trip mileage) was multiplied by 0.0057 (the proportion of intrastate trips). Then, the two numbers were added to produce a weighted sum mileage, which was 206.53 miles in this case (Table 3.7). The final value was very close to the average interstate trip mileage because almost all of the trips recorded at this POE were interstate trips.

Ashland POE records show that 97.34 percent of the inspections, citations, and warnings were from interstate trips and 2.66 percent from intrastate trips. Among the interstate trips, 45.23 percent were between Oregon and California, and 33.23 percent were between California and Washington by way of Oregon. Among the small number of intrastate trips recorded at Ashland POE, 31.43 percent operated between Ashland and Central Point, and 20.00 percent operated between Ashland and Medford. Average interstate trip mileage of the vehicles recorded at Ashland POE was 304.67 and the intrastate trip mileage was 59.01. After the ratio of interstate trips and intrastate trips was considered, the number of trip miles used in the analysis was 300.00 for trips recorded at Ashland POE.

Other weigh stations had a more balanced distribution of interstate trips and intrastate trips. At Hubbard SB, 43.26 percent were interstate trips and 56.74 percent were intrastate trips. Owing to this distribution, the interstate to intrastate weighted sum mileage was 153.61, close to the mean of the interstate trip mileage (280.84) and intrastate trip mileage (56.60). **Error! Reference source not found.** includes full i nformation on average interstate trip mileages, intrastate trip mileages, and weighted sum mileages for each commercial vehicle screening site.

Table 3.7: Average Interstate Trip Miles, Intrastate Trip Miles, and Weighted Sum Mileage by Commercial Vehicle Screening Site

Scale	Scale Name	Interstate Trip Mileage	Intrastate Trip Mileage	Weighted Sum Mileage
3006	Umatilla POE	206.97	129.70	206.53
2409	Woodburn POE	302.32	123.86	246.49
2306	Farewell Bend POE	211.50	210.79	211.49
1404	Cascade Locks POE	371.42	156.88	337.23
1507	Ashland POE	304.67	59.01	300.00
1807	Klamath Falls POE	302.29	188.20	292.53
1007	Booth Ranch SB	302.11	133.10	252.14
1402	Wyeth	373.20	161.11	347.88
2408	Woodburn NB	302.29	97.59	247.93
3103	La Grande	206.43	158.68	203.14
3005	Emigrant Hill	212.63	134.31	207.37
1604	Juniper Butte SB	291.00	144.57	259.73
1506	Ashland SB	302.11	98.08	296.69
1008	Booth Ranch NB	304.11	106.73	266.20
1805	Klamath Falls SB	289.00	174.92	276.27
2305	Olds Ferry	206.42	130.20	201.39
3004	Cold Springs	53.90	67.83	54.50
2601	Rocky Point	53.30	40.40	45.48
0906	Bend	327.11	115.09	270.37
1603	Juniper Butte NB	304.38	125.71	248.80
2402	Hubbard SB	280.84	56.60	153.61

We estimated average interstate trip miles for sites with inspection, citation, and warning records by calculating the average miles traveled in Oregon. For screening sites without records, we predicted the average interstate trip miles using the following information: interstate trip miles, road hierarchy, and the truck AADT. Information from screening sites with fewer than 30 records was not used in the GWR given the high probability of error due to outliers. The same method was used to calculate average intrastate trip miles for each screening site. Then, the weighted sum mileage for each screening site was calculated with average interstate trip miles, intrastate trip miles, and the ratio of the interstate to intrastate trip records.

Overall, we are more confident in the average trip lengths predicted with a larger number of records than those predicted with fewer than 30 records or via GWR. Most truck screening records came from weigh stations with a critical mass of inspections, citations, and warnings, and so the vast majority of observed truck trips were from those weigh stations. Furthermore, the spatial distribution of both stations with more than 30 inspection, citation, and warning records and portable sites whose estimated trip length was predicted using GWR reveals that estimated trip lengths for stations predicted using GWR were highly similar to their counterparts when the weigh stations are located on the same interstate or highway. As a result, we are confident that these estimates are reasonable proxies for the average trip length of screened (as opposed to inspected) trucks for which we have no origin and destination information. These values are critical for the overall mileage estimate we calculated for observed carriers, which were compared to their WMT returns.

3.1.2 Estimation of tax evasion rates

We combined estimated trip mileages for each screening site with screening data to generate mileage estimates for each carrier observed at Oregon truck screening sites between 2016 and 2018. Estimates were then compared with monthly and quarterly WMT returns to estimate tax evasion rates.

From 2016 to 2018, Oregon's commercial truck screening sites collected approximately 14 million screening records. The number of records collected each quarter remained steady across the study period (Table 3.8).

Table 3.8: Screenings by Quarter

		Screening
2016	Q1	1,205,494
	Q2	1,212,111
	Q3	1,228,086
	Q4	1,152,827
2017	Q1	1,145,837
	Q2	1,193,502
	Q3	1,143,320
	Q4	1,203,496
2018	Q1	1,241,293
	Q2	1,231,044
	Q3	1,115,225
	Q4	1,128,918
Total		**14,201,153**

Table 3.9 lists the 20 sites with the most screening records during Q1 of 2016. These sites handled 94.66 percent of all screenings. At the top of this list, Woodburn POE, Ashland POE, and Farewell Bend POE accounted for 36 percent of all screenings. All of the weighted sum mileages reported in Section 3.1.1.3 for these 20 locations were estimated with more than 30 inspections, citations, and warning records. For example, the weighted sum mileage for Woodburn POE was estimated using 16,997 inspection, citation, and warning records. We used 10,904 records for Ashland POE and 15,166 records for Farewell Bend POE. Compared to

weighted sum mileages estimated with fewer than 30 inspection, citation, and warning records, estimates developed based on more than 30 records are likely more accurate. Since 94.66 percent of the total screening data were linked to the weighted sum mileage estimated with a higher degree of confidence, mileage estimates for each carrier observed at Oregon truck screening is highly accurate. If a motor carrier with several vehicles logged 10 screening records at Ashland POE and 20 screening records at Umatilla POE in a quarter, its taxable miles would be 7130.60.

Table 3.9: Screenings by Commercial Vehicle Screening Site in 2016 Q1

Scale	Scale Name	Screening	Weighted Sum Mileage
2409	Woodburn POE	237,817	247.93
1507	Ashland POE	114,442	300.00
2306	Farewell Bend POE	87,976	211.49
2408	Woodburn NB	87,976	246.49
1404	Cascade Locks POE	85,715	337.23
3006	Umatilla POE	80,081	206.53
1007	Booth Ranch SB	71,865	252.14
1008	Booth Ranch NB	70,246	266.20
1506	Ashland SB	63,136	296.69
1402	Wyeth	52,383	347.88
2305	Olds Ferry	42,382	201.39
1807	Klamath Falls POE	31,424	292.53
3103	La Grande	30,390	203.14
1805	Klamath Falls SB	20,632	276.27
3004	Cold Springs	16,924	54.50
1604	Juniper Butte SB	14,799	248.80
3005	Emigrant Hill	12,630	207.37
2601	Rocky Point	8,407	45.48
1603	Juniper Butte NB	6,256	259.73
2402	Hubbard SB	5,581	153.61
Total		**1,141,062**	

To avoid overestimating taxable mileage, we eliminated duplicate screenings, which left one screening record for each trip. LPR systems are used to screen vehicles at weigh stations where they have been installed. Thus, the same vehicle information could be entered manually by officers or by a WIM scale. If a vehicle had a LPR record that matched with a manually entered record or WIM record within a 15-minute period, we removed the LPR record. If a vehicle was screened more than once at a screening location with a WIM scale in a 15-minute period, only one record remains in the screening dataset. If a vehicle was weighed by a WIM scale and static scale at a screening location, the system contained duplicate records. In this case, removing either WIM or static scale records was necessary to avoid overestimation. We also looked into the cases where a vehicle was screened more than once on a single trip. For example, a vehicle delivering shipments from Washington to Idaho traveling along I-84 could be screened at Umatilla POE, La Grande weigh station, and Farewell Bend POE. Also, a vehicle traveling from Washington to California along I-5 could be screened at Woodburn POE, Booth Ranch SB, and Ashland SB on a single trip. In both cases, if the second and the third screenings were recorded within a reasonable timeframe considering the distance between screening sites, we preserved only the first screening in the dataset. The duplicate removal process eliminated about 15 percent of the screening data, leaving 12,065,980 screening records for subsequent analysis.

During our study period, 69,967 motor carriers (unique USDOT number) filed a monthly or quarterly WMT return or purchased a temporary pass. Monthly returns were matched to the corresponding tax reporting quarter. Total mileage reported over the three-month period (i.e., quarter) was compared to the estimated mileage for the same time period in the same manner as the quarterly returns. Table 3.10 lists the number of motor carriers that either filed a WMT or obtained a temporary pass every quarter is recorded in Table 3.10. The number shows a slightly increasing trend over the study period.

Table 3.10: Motor Carriers Filing a WMT or Purchasing a Temporary Pass

		Motor Carriers
2016	Q1	30,047
	Q2	31,942
	Q3	32,109
	Q4	31,232
2017	Q1	31,274
	Q2	32,343
	Q3	33,117
	Q4	32,083
2018	Q1	32,256
	Q2	33,931
	Q3	34,862
	Q4	33,644

Cleaned screening data were matched with WMT tax returns and temporary pass data by USDOT number and quarter. In Table 3.11, the first column lists the number of carriers for which we matched screening data and WMT returns. Depending on the quarter, approximately 67 to 71 percent of the tax records were matched to vehicles screened and recorded at weigh stations. We calculated estimated mileages for these carriers and compared them to reported mileage. Between 29 and 33 percent of motor carriers filing the tax did not have matching screening results. Therefore, we could not complete evasion estimates for all carriers because no screening data were available to generate estimated WMT mileage. Some carriers had screening data recorded but had no WMT return or temporary pass on file. For example, in Q1 of 2016, 493 motor carriers operated vehicles while not filing a WMT return or purchasing a temporary pass. The number of motor carriers operating vehicles without filing a WMT return has generally increased over time (Table 3.11). Since March 2016, ODOT's CCD has been implementing a strategy to address the tax evasion committed by motor carriers in this category. The CCD is identifying motor carriers in this group and suspending their accounts until they submit an amended report. After submitting this report, they are returned to good standing.

Table 3.11: Motor Carriers with and without Matching Screening Data

		Motor Carriers with Screening Results	Motor Carriers without Screening Results	Motor Carriers in Screening Results but No Tax Return
2016	Q1	21,095	8,952	493
	Q2	22,730	9,212	573
	Q3	22,492	9,617	643
	Q4	21,588	9,644	621
2017	Q1	21,757	9,517	654
	Q2	22,824	9,519	700
	Q3	22,992	10,125	707
	Q4	22,193	9,890	728
2018	Q1	22,398	9,858	721
	Q2	23,729	10,202	729
	Q3	23,506	11,356	711
	Q4	22,524	11,120	704

In the following analysis, in each quarter we excluded WMT returns filed by the motor carriers without screening results. Without excluding them from analysis, they would automatically be considered as having no tax liability, because taxable miles are calculated based on screening records. No screening records mean no taxable miles for the carriers regardless of the reported miles in WMT returns. However, these carriers may not go through screening locations because they specialize in a short-distance local delivery or they have knowledge of the local area that lets them avoid screening. Therefore, a different approach was needed to estimate the tax evasion rate of this group. The number of motor carriers in this group is sizeable, but the miles reported in WMT returns by them was disproportionately small. During Q1 of 2016, total miles reported by all motor carriers in WMT returns were 428,794,557, but carriers in this group accounted for just 4.00 percent of total miles (Table 3.12).

Table 3.12: Share of Mileages by Motor Carriers with and without Matching Screening Data

		Miles Filed by Motor Carriers with Screening Results	Miles Filed by Motor Carriers without Screening Results	Total Miles
2016	Q1	411,662,178 (96.00%)	17,132,379 (4.00%)	428,794,557
	Q2	447,349,557 (95.94%)	18,938,714 (4.06%)	466,288,271
	Q3	453,593,584 (95.62%)	20,759,511 (4.38%)	474,353,095
	Q4	422,028,555 (95.89%)	18,109,681 (4.11%)	440,138,236
2017	Q1	412,818,774 (95.80%)	18,083,803 (4.20%)	430,902,577
	Q2	453,202,164 (95.71%)	20,312,095 (4.29%)	473,514,259
	Q3	462,643,768 (95.63%)	21,123,443 (4.37%)	483,767,211
	Q4	433,883,968 (95.88%)	18,631,280 (4.12%)	452,515,248
2018	Q1	434,183,803 (96.17%)	17,297,440 (3.83%)	451,481,243
	Q2	459,344,119 (95.61%)	21,073,579 (4.39%)	480,417,698
	Q3	462,571,069 (95.38%)	22,395,620 (4.62%)	484,966,689
	Q4	433,535,967 (95.70%)	19,502,788 (4.30%)	453,038,755

After matching screening data to the WMT records and temporary pass data, we classified motor carriers into one of four mutually exclusive categories: 1) no tax return, 2) underreported mileage, 3) reported *0* WMT miles, but vehicles detected, and 4) in compliance. *No Tax Return* includes motor carriers with no tax record but which had vehicles operating in Oregon and screened at weigh stations. The *Underreported* category includes motor carriers with aggregated estimated mileage greater than reported miles. The *Reported 0 WMT Miles* category includes motor carriers reporting no WMT miles on a return but which had vehicles screened at a weigh station or portable scale during the reporting period.

To estimate taxable miles, we first associated the weighted sum mileage with each screening record. Weighted sum mileages are specific to each weigh station. Next, we aggregated the associated miles across vehicles and motor carriers for each quarter. Then a ratio of the total reported miles to the aggregated estimated mileage was calculated for each quarter (Table 3.13). The ratio was used to correct for limitations posed by the number of weigh stations in Oregon and their operating hours. Due to the limited location and the operating hours of weigh stations, it is important to derive the expected reported miles for each mile observed at a weigh station. The ratio of reported miles to the observed miles for Q1 of 2016 was 1.43, meaning that for every mile observed at a weigh station, the expected reported miles in tax was 1.43 miles. The last step to estimate taxable miles was to multiply the weighted sum mileage associated with each screening record by the ratio for the quarter. The calculated ratio excluded miles reported by motor carriers without screening results. It did not affect the evasion rate estimates in the following sections because calculated mileage evasion and revenue evasions were divided by the total WMT miles reported and tax paid by the motor carriers with screening records.

Table 3.13: The Ratio of WMT Reported Miles to the Observed Miles

		WMT Reported Miles (in thousands)	Observed Miles (in thousands)	Ratio
2016	Q1	411,662.18	300,627.22	1.37
	Q2	447,349.56	302,226.69	1.48
	Q3	453,593.58	306,924.31	1.48
	Q4	422,028.56	286,041.97	1.48
2017	Q1	412,818.77	286,099.38	1.44
	Q2	453,202.16	296,556.66	1.53
	Q3	462,643.78	279,271.56	1.66
	Q4	433,883.97	296,509.50	1.46
2018	Q1	434,183.80	305,321.53	1.42
	Q2	459,344.12	304,699.56	1.51
	Q3	462,571.07	276,015.72	1.68
	Q4	433,535.97	279,760.72	1.55

3.1.2.1 WMT mileage evasion

The difference between the mileage reported in WMT returns and estimated taxable miles adjusted with the ratios in Table 3.13 is the mileage underreported by a motor carrier in a quarter. WMT mileage evasions were estimated separately for each category. Screening records without corresponding tax records fall into the *No Tax Return* category. In Q1 of 2016, 493 motor carriers failed to either file a WMT return or purchase a temporary pass, yet vehicles belonging to these carriers were screened 7,442 times at weigh stations and portable scales. For this quarter, the estimated mileage evasion for carriers not filing a return was 2,007,809 miles, a relatively small number compared to the estimated mileage evasion in the *Underreported* category.

When aggregated taxable miles for a motor carrier in a quarter were greater than the reported miles for the quarter, the motor carrier was included in the *Underreported* category. 6,996 motor carriers fell into this group. Estimated mileage evasion was 37,692,299 miles. Compared to the total mileage evasion for a quarter, mileage evasion by motor carriers in this category constituted over 90 percent of all evasion throughout the study period.

Motor carriers with zero mileage reported in WMT returns, but which had vehicles with the carrier's USDOT number screened at a weigh station, were categorized in the *Reported "0" WMT Miles* category. For Q1 of 2016, 175 motor carriers were in this category, and the estimated mileage evasion associated with the group was 2,007,809 miles. It is a small amount of WMT mileage evasion compared to mileage evasion from the *Underreported* category. Estimated mileage evasion for each category and quarter is presented in Table 3.14, Table 3.15, and Table 3.16.

In 2016, a total of 1,734,633,874 miles were reported in WMT returns, and the estimated mileage evasion for the same year was 184,854,065 miles. Aggregated mileage evasion was 10.66 percent of all reported mileage. The absolute amount of mileage evasion has increased since 2016. But its relative size compared to the aggregated WMT mileages reported increased between 2016 and 2017 but then stabilized in 2018.

Table 3.14: Estimated WMT Mileage Evasion by Category (2016)

	2016			
Tax Evasion Category	***Q1***	***Q2***	***Q3***	***Q4***
No Tax Return				
Observations	7,442	13,089	7,707	8,119
Motor Carriers	493	573	643	621
Mileage	2,007,809	4,304,971	2,290,229	2,386,047
Percent of Total Mileage Evasion	5.01%	8.90%	4.43%	5.33%
Underreported Mileage				
Observations	425,548	452,349	469,457	433,303
Motor Carriers	6,996	7,650	8,005	7,585
Mileage	37,692,299	43,871,761	49,166,712	41,916,381
Percent of Total Mileage Evasion	94.09%	90.70%	95.18%	93.64%
Reported "0" WMT Miles				
Observations	1,094	554	557	1,317
Motor Carriers	175	142	169	156
Mileage	361,432	195,563	199,874	460,986
Percent of Total Mileage Evasion	0.90%	0.40%	0.39%	1.03%
Total				
Observations	434,084	465,992	477,721	442,739
Motor Carriers	7,664	8,365	8,817	8,362
Total Mileage Evasion	40,061,541	48,372,294	51,656,815	44,763,415
Percent of Total Mileage Evasion	100.00%	100.00%	100.00%	100.00%
Percent of Mileage Reported	*9.73%*	*10.81%*	*11.39%*	*10.61%*
Annual Total Mileage Evasion	***184,854,065***			
Percent of Mileage Reported	***10.66%***			

Table 3.15: Estimated WMT Mileage Evasion by Category (2017)

	2017			
Tax Evasion Category	***Q1***	***Q2***	***Q3***	***Q4***
No Tax Return				
Observations	8,810	13,858	9,128	13,115
Motor Carriers	654	700	707	728
Mileage	2,659,880	4,717,133	3,023,650	3,998,000
Percent of Total Mileage Evasion	5.65%	8.82%	5.12%	8.61%
Underreported Mileage				
Observations	428,765	449,810	476,980	423,042
Motor Carriers	7,424	7,648	8,742	7,725
Mileage	44,245,656	48,591,821	55,856,966	42,216,245
Percent of Total Mileage Evasion	93.97%	90.89%	94.60%	90.95%
Reported "0" WMT Miles				
Observations	520	434	413	655
Motor Carriers	154	159	159	199
Mileage	180,154	153,902	162,905	204,964
Percent of Total Mileage Evasion	0.38%	0.29%	0.28%	0.44%
Total				
Observations	438,095	464,102	486,521	436,812
Motor Carriers	8,232	8,507	9,608	8,652
Total Mileage Evasion	47,085,689	53,462,856	59,043,521	46,419,209
Percent of Total Mileage Evasion	100.00%	100.00%	100.00%	100.00%
Percent of Mileage Reported	*11.41%*	*11.80%*	*12.76%*	*10.70%*
Annual Total Mileage Evasion	***206,011,275***			
Percent of Mileage Reported	***11.69%***			

Table 3.16: Estimated WMT Mileage Evasion by Category (2018)

	2018			
Tax Evasion Category	***Q1***	***Q2***	***Q3***	***Q4***
No Tax Return				
Observations	11,185	11,943	10,356	8,553
Motor Carriers	721	727	711	704
Mileage	3,098,945	3,523,184	3,404,687	2,491,717
Percent of Total Mileage Evasion	7.18%	7.61%	5.58%	4.92%
Underreported Mileage				
Observations	429,774	472,924	473,367	423,100
Motor Carriers	7,770	8,001	8,480	7,874
Mileage	39,810,114	42,535,163	57,379,591	47,982,033
Percent of Total Mileage Evasion	92.23%	91.90%	94.12%	94.70%
Reported "0" WMT Miles				
Observations	823	633	468	551
Motor Carriers	194	138	164	168
Mileage	254,649	226,604	182,843	192,553
Percent of Total Mileage Evasion	0.59%	0.49%	0.30%	0.38%
Total				
Observations	441,782	485,500	484,191	432,204
Motor Carriers	8,685	8,866	9,355	8,746
Total Mileage Evasion	43,163,709	46,284,951	60,967,121	50,666,303
Percent of Total Mileage Evasion	100.00%	100.00%	100.00%	100.00%
Percent of Mileage Reported	*9.94%*	10.08%	13.18%	11.69%
Annual Total Mileage Evasion	***201,082,084***			
Percent of Mileage Reported	***11.24%***			

3.1.2.2 WMT revenue evasion

Potential revenues from tax liabilities were estimated by multiplying underreported miles by weight distance tax rates (Table 2.1 and Table 2.2). They were estimated separately for each category as well. Screening records that do not have corresponding tax records fall into the No Tax Return category. In Q1 of 2016, 493 motor carriers failed to either file a WMT return or purchase a temporary pass, but their vehicles were screened 7,442 times at weigh stations and portable scales. For this quarter in this category, the estimated tax liability for carriers not filing a return was $322,132.11, but it constitutes only 5.23 percent to 6.86 percent of the total potential revenues of the quarter.

When a motor carrier's aggregated taxable miles in a quarter exceeded miles reported for the quarter it was included in the Underreported category. A total of 6,996 motor carriers fell into this group, with estimated tax liabilities ranging from $4,324,507.20 to $5,785,966.94. The tax liability in this category is presented as a range because motor carriers can declare multiple gross vehicle weights when registering vehicles and allocate those miles to each WMT weight class based on their operations. When a motor carrier's estimated taxable miles across all the vehicles it operates exceeds the miles reported in WMT returns, the difference between the two mileages is the source of tax liability. With respect to the tax rate applied to the mileage liability (the difference between miles reported and taxable miles), the tax rate for the carrier's lowest declared gross vehicle weight was used to estimate the minimum tax liability, and the tax rate applicable to the declared gross weight of the carrier's most frequently used vehicle was used for the maximum tax liability. The calculated minimum tax liability in this category constituted 92.12 percent of the total tax liability estimated for the quarter and the maximum constituted 93.33 percent of the total.

Motor carriers with zero mileage reported in WMT returns, but which had vehicles with their USDOT numbers screened at a weigh station, are categorized in the Reported "0" Miles category. For Q1 of 2016, 175 motor carriers were in this category and their associated tax liability was $47,588.00. It is a small amount of potential revenue compared to tax liabilities from the previously mentioned two categories. Estimated tax liabilities for each category and quarter are presented in Table 3.17.

In 2016, $271,774,040.89 in revenue was collected. The estimated minimum amount of tax evaded for the same year was $21,310,759.66, and the maximum amount was $29,086,483.79. Aggregated tax liabilities ranged from 7.84 percent to 10.70 percent of total revenue collected. The absolute amount of estimated tax liabilities has increased since 2016 and their relative sizes compared to collected revenue has increased as well.

Table 3.17: Estimated WMT Revenue Evasion by Category (2016)

	2016			
Tax Evasion Category	***Q1***	***Q2***	***Q3***	***Q4***
No Tax Return				
Observations	7,442	13,089	7,707	8,119
Motor Carriers	493	573	643	621
Revenue (thousands)	322.13	687.78	360.96	372.03
Percent of Total Revenue Evasion	5.23%	9.10%	4.37%	5.24%
	6.86%	12.30%	6.18%	7.17%
Underreported Mileage				
Observations	425,548	452,349	469,457	433,303
Motor Carriers	6,996	7,650	8,005	7,585
Max. Revenue (thousands)	5,785.97	6,842.98	7,871.89	6,656.44
Min. Revenue (thousands)	4,324.51	4,873.49	5,443.16	4,740.40
Percent of Total Revenue Evasion	92.12%	87.14%	93.26%	91.38%
	93.99%	90.49%	95.24%	93.71%
Reported "0" WMT Miles				
Observations	1,094	554	557	1,317
Motor Carriers	175	142	169	156
Revenue (thousands)	47.59	31.27	32.36	75.08
Percent of Total Revenue Evasion	0.77%	0.41%	0.39%	1.06%
	1.01%	0.56%	0.55%	1.45%
Total				
Observations	434,084	465,992	477,721	442,739
Motor Carriers	7,664	8,365	8,817	8,362
Max. Revenue (thousands)	6,155.69	7,562.04	8,265.21	7,103.55
Min. Revenue (thousands)	4,694.23	5,592.54	5,836.48	5,187.51
Percent of Total Revenue Evasion	100.00%	100.00%	100.00%	100.00%
Min. Percent of Revenue Collected	*7.27%*	*7.98%*	*8.22%*	*7.84%*
Max. Percent of Revenue Collected	*9.53%*	*10.79%*	*11.65%*	*10.73%*
Annual Total Revenue (thousands)	***21,310.76 to 29,086.48***			
Percent of Revenue Collected	***7.84% to 10.70%***			

Table 3.18: Estimated WMT Revenue Evasion by Category (2017)

	2017			
Tax Evasion Category	***Q1***	***Q2***	***Q3***	***Q4***
No Tax Return				
Observations	8,810	13,858	9,128	13,115
Motor Carriers	654	700	707	728
Revenue (thousands)	420.70	759.45	480.61	633.68
Percent of Total Revenue Evasion	5.66%	8.89%	5.20%	8.58%
	7.37%	11.45%	6.58%	11.15%
Underreported Mileage				
Observations	428,765	449,810	476,980	423,042
Motor Carriers	7,424	7,648	8,742	7,725
Max. Revenue (thousands)	6,986.71	7,763.70	8,732.29	6,717.57
Min. Revenue (thousands)	5,257.82	5,850.56	6,793.36	5,015.29
Percent of Total Revenue Evasion	92.13%	88.19%	93.06%	88.27%
	93.96%	90.83%	94.52%	90.97%
Reported "0" WMT Miles				
Observations	520	434	413	655
Motor Carriers	154	159	159	199
Revenue (thousands)	28.74	24.27	26.08	33.01
Percent of Total Revenue Evasion	0.39%	0.28%	0.28%	0.45%
	0.50%	0.37%	0.36%	0.58%
Total				
Observations	438,095	464,102	486,521	436,812
Motor Carriers	8,232	8,507	9,608	8,652
Max. Revenue (thousands)	7,436.15	8,547.42	9,238.99	7,384.27
Min. Revenue (thousands)	5,707.26	6,634.28	7,300.06	5,681.99
Percent of Total Revenue Evasion	100.00%	100.00%	100.00%	100.00%
Min. Percent of Revenue Collected	*8.82%*	*9.34%*	*10.06%*	*8.35%*
Max. Percent of Revenue Collected	*11.49%*	*12.04%*	*12.74%*	*10.85%*
Annual Total (thousands)	***25,323.59 to 32,606.83***			
Percent of Revenue Collected	***9.16% to 11.80%***			

Table 3.19: Estimated WMT Revenue Evasion by Category (2018)

	2018			
Tax Evasion Category	***Q9***	***Q10***	***Q11***	***Q12***
	No Tax Return			
Observations	11,185	11,943	10,356	8,553
Motor Carriers	721	727	711	704
Revenue (thousands)	613.49	700.92	675.95	493.05
Percent of Total Revenue Evasion	7.20%	7.76%	5.63%	4.84%
	9.25%	9.91%	7.47%	6.24%
	Underreported Mileage			
Observations	429,774	472,824	473,367	423,100
Motor Carriers	7,770	8,001	8,480	7,874
Max. Revenue (thousands)	7,853.26	8,290.94	11,290.70	9,653.08
Min. Revenue (thousands)	5,966.64	6,329.47	8,334.37	7,368.79
Percent of Total Revenue Evasion	89.98%	89.45%	92.12%	93.27%
	92.20%	91.74%	94.06%	94.78%
	Reported "0" WMT Miles			
Observations	823	633	468	551
Motor Carriers	194	138	164	168
Revenue (thousands)	50.91	45.68	36.64	38.75
Percent of Total Revenue Evasion	0.60%	0.51%	0.31%	0.38%
	0.77%	0.65%	0.41%	0.49%
	Total			
Observations	441,782	485,400	484,191	432,204
Motor Carriers	8,685	8,866	9,355	8,746
Max. Revenue (thousands)	8,517.66	9,037.53	12,003.29	10,184.89
Min. Revenue (thousands)	6,631.05	7,076.07	9,046.97	7,900.60
Percent of Total Revenue Evasion	100.00%	100.00%	100.00%	100.00%
Min. Percent of Revenue Collected	*7.97%*	*7.98%*	*10.00%*	*9.30%*
Max. Percent of Revenue Collected	*10.23%*	*10.19%*	*13.27%*	*11.98%*
Annual Total (thousands)	***30,654.68 to 39,743.37***			
Percent of Revenue Collected	***8.83% to 11.44%***			

Because a significant portion of estimated tax liabilities is in the *Underreported* category, Table 3.20 provides a more detailed look at underreported motor carriers. Carriers are divided into three categories based on the level of evasion relative to tax reported. Those in the first category had tax evasion of less than 5 percent of their overall total, which could be within the evasion estimation model's margin of error. Those carriers comprised a small percentage (2.02 percent in Q1 of 2016) of the overall evaded liability and would not be forced to pay penalties, fees, or interest. Carriers in the 5 to 15 percent bracket constituted a higher percentage of underreported WMT taxes. In Q1 of 2016, 1,505 carriers underpaid by 5 to 15 percent of their overall total, and the $565,978.25 in evasion amounted to 13.09 percent of overall evasion in the *Underreported* category. Evasion of more than 15 percent of the reported tax is easily the largest category. Out of 6,997 motor carriers that underreported aggregated trip mileages in Q1 of 2016, 63.56 percent owed more than 15 percent of their quarterly reported tax. Moreover, the amount of tax owed by these motor carriers made up 84.89 percent of the total tax liability of the *Underreported* category.

Table 3.20: Distribution of Motor Carriers by Relative Size of Tax Evaded Compared to Reported Tax

		< 5 percent of tax reported		**5-15 percent of tax reported**		**> 15 percent of tax reported**	
		MC	***Tax Evaded (in thousands)***	***MC***	***Tax Evaded (in thousands)***	***MC***	***Tax Evaded (in thousands)***
2016	Q1	1,045	87.57	1,505	565.98	4,447	3,670.96
	Q2	1,136	103.71	1,501	698.79	5,014	4,070.99
	Q3	1,138	107.97	1,577	586.05	5,291	4,749.15
	Q4	1,112	131.50	1,555	584.16	4,919	4,024.74
2017	Q1	1,128	97.43	1,558	484.10	4,739	4,676.28
	Q2	1,145	115.59	1,525	554.97	4,979	5,180.00
	Q3	1,162	120.59	1,721	663.80	5,860	6,008.97
	Q4	1,183	129.48	1,707	494.76	4,836	4,391.06
2018	Q1	1,212	127.61	1,729	751.20	4,830	5,087.83
	Q2	1,176	181.14	1,650	845.35	5,175	5,148.60
	Q3	1,126	201.20	1,708	788.75	5,647	7,344.42
	Q4	1,140	169.24	1,588	640.71	5,147	6,558.84

3.1.3 Comparison to ODOT audit results

In this section, all the comparisons between audit data and our analysis will be done by comparing net adjustment in the audit data to the potential revenue from tax liabilities we estimated in Section 3.1.2. Our estimates do not include late fees, penalties, and interest, so they need to be compared to the net adjustment in audit data excluding additional revenue generated due to the tax liability (e.g., late fees, penalties, and interest).

3.1.3.1 Matching positive net adjustment audits to tax-evading carriers

Using the 2,301 audits conducted from 2016 to 2018, we determined the percentage of audits resulting in tax liabilities in our tax evasion category. Out of 2,301 total audits conducted, 1,975 audits came back with positive tax liabilities. The total tax liability was $13,816,659.18, with potential revenue of $19,952,782.34, including late fees, penalties, and interest, in addition to tax liabilities. Among the audits resulting in positive net adjustments (tax liabilities), 1,621 audits were matched to 2016 to 2018 WMT returns. The audits could not be matched to WMT returns if a motor carrier operated in Oregon without filing WMT returns or purchasing temporary passes. Also, if a motor carrier discontinued operations in Oregon in 2016 and the audit covered a period before 2016, we could not match the audit data with the tax data to which we had access. Due to ODOT data retention practices, we could not obtain data prior to 2016. The average audit period was 794.27 days.

We checked how many of the 1,621 motor carriers with tax liabilities were in our tax evasion categories (no tax return, underreported, and zero-mileage reported, but vehicles detected). 89.02 percent of them were listed in our tax evasion categories and only10.98 percent were in the list of in-compliance motor carriers (Table 3.21).

Table 3.21: ODOT Audit History

2016-2018	Motor Carriers
Number of Audits	2,301
Total Audits with Net Adjustment > 0	1,975
Number of Accounts in WMT Tax Return	1,621
In the Tax Evasion Category	1,443 (89.02%)
Not in the Tax Evasion Category	178 (10.98%)

3.1.3.2 Comparison of audit results to estimated evasion rates

Audit data include the beginning date and the end date of each audit period, reported fees, tax liabilities, late fees, penalties, and interest. The following three tables show how we can break down the total net adjustment of $13,816,659.18 from 2016, 2017 and 2018 audit data.

Table 3.22 shows the total net adjustment and tax evasion rates by billing year, Table 3.23 displays the same information according to the beginning year of the audit period, and Table 3.24 presents the same information by the ending year of the audit period. Number of audits, net adjustments, reported fees, and overall evasion rates are the same in all three tables as the same audit dataset was used to derive all three. However, evasion rates over each billing year, the beginning year of the audit period, and the ending year of the audit period differ significantly.

Table 3.22: Comparison of Audit Results to Estimate Evasion Rates by Billing Year

Billing Year	Audit				Estimated
	Number of Audits	*Net Adjustment*	*Reported Fees*	*Evasion Rate*	*Evasion Rate*
2016	652	$3,905,242	$57,971,234	6.74%	7.84% to 10.70%
2017	698	$5,467,250	$94,277,980	5.80%	9.16% to 11.80%
2018	625	$4,444,166	$57,297,471	7.76%	9.25% to 11.86%
Total	1,975	$13,816,659	$209,546,685	6.59%	

For example, the evasion rate for 2016 was 6.74 percent when the audit data were broken down by billing year. Breaking data down by the beginning year of an audit period yielded an evasion rate of 14.48 percent. In 2016, 234 audits were begun, and the average audit duration was 476.90 days. Considering this average duration, the evasion rate for audits beginning in 2016 and ending in 2017 or 2018 was 14.48 percent. As we calculated the evasion rate based on 234 audit results, a few motor carriers with high evasion rates may have inflated the annual evasion rate. On the other hand, our evasion rate estimate for 2016 was 7.84 percent to 10.70 percent. The higher evasion rates estimated with audits can be explained by the CCD's audit selection process. CCD conducts screening first, and only 5 percent of motor carriers, which have a higher likelihood of facing sizeable tax liabilities, are subject to audits. The selection process for audits causes upward selection bias, and the evasion rates estimated through audits may not be representative of the entire motor carrier population. This explains why the comparison between the audit evasion rates and the evasion rates estimated with commercial screening data requires caution. Evasion rates estimated using screening data are for all motor carriers with screening results, while the audits are for a subset of motor carriers. Therefore, it is not unusual to see audit tax evasion rates that are higher than the tax rates estimated with commercial truck screening data.

Considering the number of audits included in estimates of the annual evasion rate, the evasion rate for 2016 could be more accurate than the 2017 and 2018 estimates. An evasion rate of 14.48 percent was estimated using the 234 audit records with an audit period beginning in 2016. For audit periods beginning in 2017 and 2018, only 56 and 2 audits were conducted, respectively. We did not include the results in Table 3.23 due to the possibility of overestimating evasion rates because of a few carriers with extreme evasion records.

Table 3.23: Comparison of Audit Results to Estimate Evasion Rates by Beginning Year of Audit

Audit Begin Year	Audit				Estimated
	Number of Audits	*Net Adjustment*	*Reported Fees*	*Evasion Rate*	*Evasion Rate*
2013	464	$3,611,049	$66,378,980	5.44%	N/A
2014	599	$4,950,149	$87,351,338	5.67%	N/A
2015	558	$3,460,005	$40,048,525	8.64%	N/A
2016	234	$1,013,490	$6,998,130	14.48%	7.84% to 10.70%
Total	1,975	$13,816,659	$209,546,684	6.59%	

Table 3.24 shows that 277 audits with an audit period ending in 2018 resulted in a 9.84 percent evasion rate. The average audit period was 800.13 days, meaning that most audit periods began in 2016 and ended in 2018. Therefore, this evasion rate is the most relevant number to compare to our estimate as it covers the evasion rate from 2016 to 2018. We estimated evasion rates of 7.84 percent to 10.70 percent for 2016, 9.16 percent to 11.80 percent for 2017, and 9.25 percent to 11.86 percent in 2018. The average evasion rate for audits ending in 2018 was 9.84 percent which is in our range of evasion rate estimates for 2016, 2017, and 2018.

Table 3.24: Comparison of Audit Results to Estimate Evasion Rates by Ending Year of Audit

Audit End Year	Audit				Estimated
	Number of Audits	*Net Adjustment*	*Reported Fees*	*Evasion Rate*	*Evasion Rate*
2015	341	$2,065,192	$16,290,477	12.68%	N/A
2016	667	$5,313,127	$109,984,799	4.83%	7.84% to 10.70%
2017	661	$4,387,953	$59,790,791	7.34%	9.16% to 11.80%
2018	277	$1,936,186	$19,675,109	9.84%	9.25% to 11.86%
Total	1,975	$13,816,659	$209,546,684	6.59%	

3.1.3.3 Comparison of individual audit results to corresponding estimated evasion rates

Audit data include the beginning date and the end date of each audit period, reported fees, tax liabilities, late fees, penalties, and interest, which let us compare audit results to our tax evasion rate estimates. Potential revenue from tax liabilities (Section 3.1.2.2) were compared to the tax liabilities in the audit data. Our estimates do not include late fees, penalties, and interest, so they need to be compared to the tax liability in audit data excluding additional revenue generated due to the tax liability. The earliest WMT data retained in the system dates to 2016, so we isolated audits with an audit period beginning after January 1, 2016. Table 3.25 shows the selected motor carriers by the type of tax they filed. Most of (84.05 percent) filed monthly WMT returns during the study period.

Table 3.25: Audits Compared to Tax Evasion Rates Estimation

2016-2018	Motor Carriers
Monthly WMT Filed	253 (84.05%)
No WMT Filed but Temporary Pass Purchased	31 (10.3%)
No WMT Filed and No Temporary Pass Purchased	8 (2.66%)
Both Monthly and Quarterly WMT Filed	6 (1.99%)
Quarterly WMT Filed	3 (1.00%)
Total	301

We matched selected audits to the WMT return filings and purchased temporary passes for the audit period. For example, if the audit of a motor carrier reviewed records spanning January 1, 2016, to June 30, 2018, we looked at tax evasion rate estimates of the specified period for comparison. However, not all audit periods start on the first day of a month and end on the last day of a month (unlike monthly WMT returns). If an audit period began after the 15th day of a month, that month is not included in the analysis because it could result in an overestimate of tax evasion rates. If an audit period extended from April 18, 2017 to August 8, 2018, the audit result was compared to WMT returns and temporary passes for May 1, 2017 to July 31, 2018. Motor carriers that filed quarterly WMT returns were excluded from our analysis as the accuracy of the comparison cannot be guaranteed due to the wide tax reporting period.

Figure 3.7 plots 1) percentage of estimated tax liability from an audit (blue line), 2) maximum estimated tax evasion rates (orange squares), and 3) minimum estimated tax evasion rates (green triangles) for the audit. If the maximum and the minimum estimated tax evasion rates for an audit are equal, a green triangle sits atop an orange square. The Pearson's correlation coefficient for the percentage of estimated tax liability out of the reported fees and the maximum estimated tax evasion rate is 0.85. Also, the Pearson's correlation coefficient for the percentage of estimated tax liability out of the reported fees and the minimum estimated tax evasion rate is 0.79. Pearson's correlation coefficient measures the strength of the statistical relationship, or the association, between two variables. Potential values range from +1 to -1. A value of +1 indicates a perfect positive linear correlation and -1 means a perfect negative linear correlation. In our case, values were close to +1, meaning that the percentages of estimated tax liability out of the reported fees and the maximum estimated tax evasion rates have a very strong association. The Pearson's coefficient for the percentages of estimated tax liability out of the reported fees and the minimum estimated tax evasion rates are relatively low, but indicate a strong association. Values between 0.5 and 0.7 indicate a moderately positive association, and values above 0.7 indicate a very strong positive association. Thus, we see an increasing trend in the maximum and minimum estimated tax evasion rates as the percentages of estimated tax liability out of the reported fees also increase. This analysis provides a robustness check on the evasion estimate model developed in Section 3.1.2 by comparing our estimates to actual audit results from CCD. The high correlation gives us confidence in the methodology used to derive those estimates.

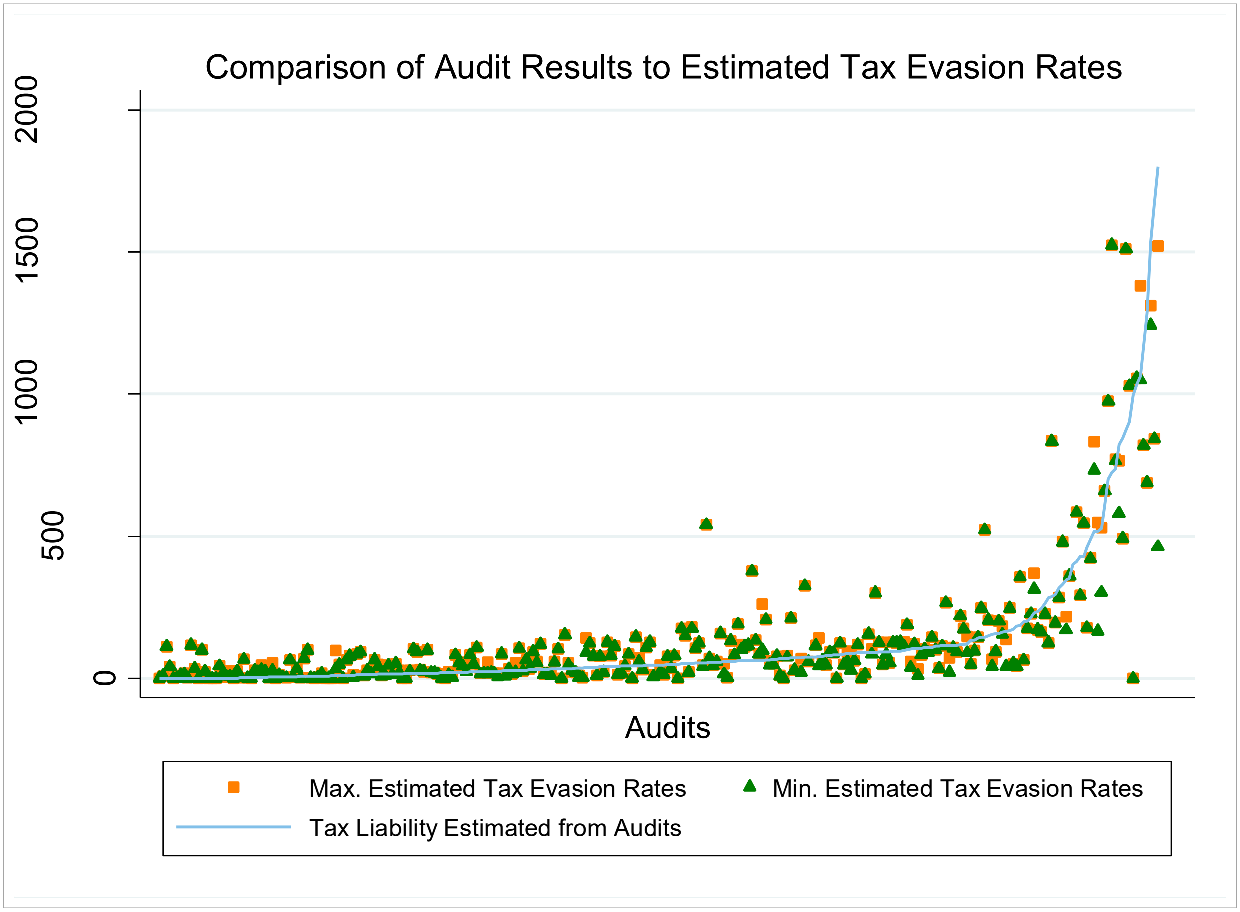

Figure 3.7: Comparison of audit results to estimated tax evasion rates

Figure 3.7 demonstrates the relationships between audit results and the estimated tax evasion rates, but it is hard to see how close the estimates are to the audit results in some cases because of the extended y-axis. To visualize how similar the estimates are to the audit results, we excluded audits that resulted in a tax liability higher than 200 percent (Figure 3.8). Some red triangles and light brown squares are located near the blue line, but some are relatively far from the blue line. One potential source of the difference between the audit results and the estimated tax evasion rates is the audit period. If an audit does not start on the first day of a month and end on the last day of a month, taxes reported in the audit data do not match the reported tax in the WMT returns. The other potential reason is that all estimates are approximations at the carrier level based on far less data than are obtained during an actual audit, during which it is normal for auditors to obtain trip receipts, fuel purchase data, and additional documentation to verify the carrier's WMT returns. At the system level, the goal is to have errors cancel each other out. The figure shows that some estimates were higher than the actual audit results and some were lower than estimated audit results.

Overall, audits of selected motor carriers that file monthly WMT returns estimated a total tax liability of $1,315,000, or 14.84 percent of the total reported fees ($8,863,224). However, our analysis showed 26.64 percent of the minimum tax evasion rate. The estimated minimum tax evasion rate was $2,488,445 and the total reported tax was $8,594,685. Total reported fees recorded in the audit data and the total reported tax in our estimates were close, but not equal, because of the audit period. While WMT returns are filed monthly or quarterly, an audit period could begin on any day of the month and any month of a quarter. Analysis was conducted to minimize the discrepancy. However, the result needs to be interpreted cautiously because of the small number of audits we used to compare ODOT audit results to evasion estimations using screening data.

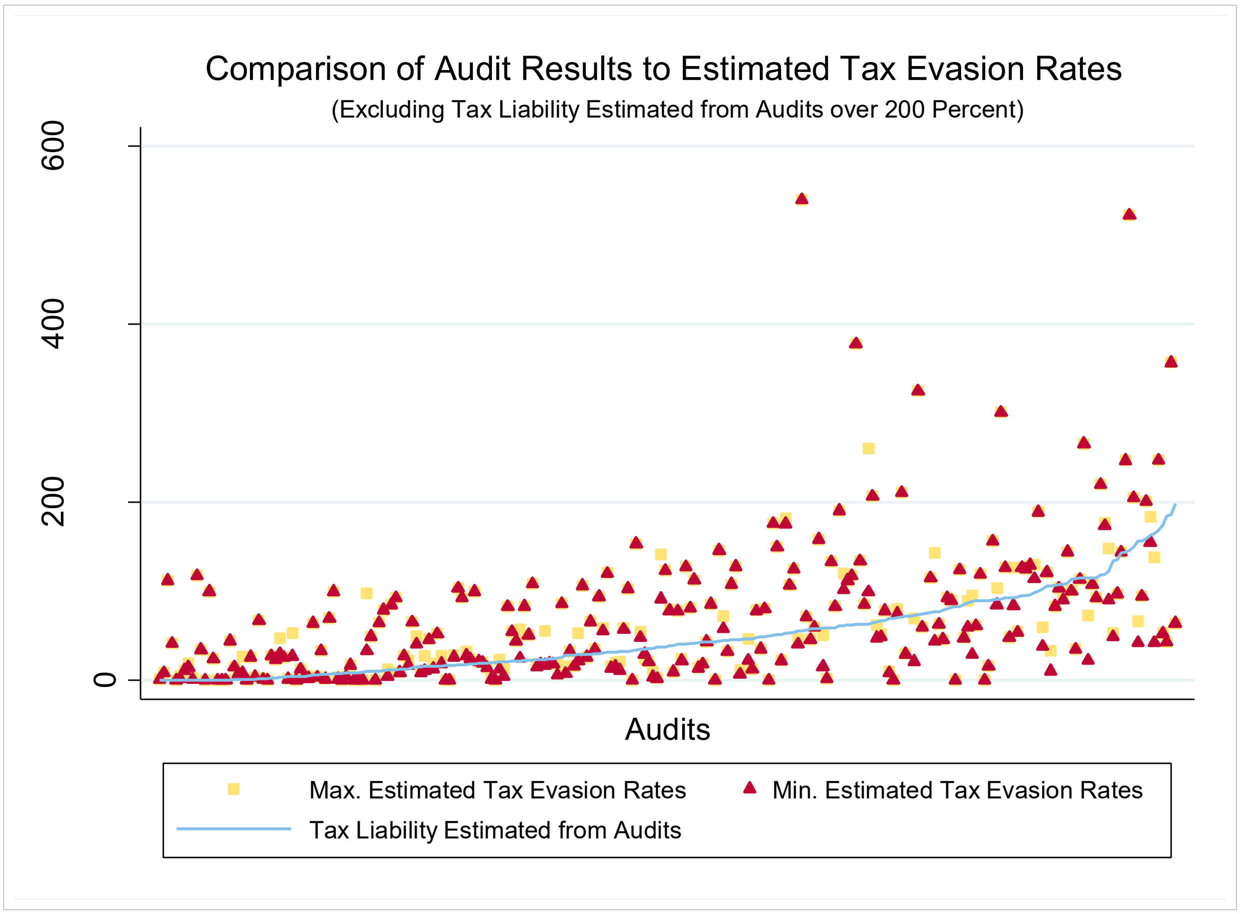

Figure 3.8: Comparison of audit results to estimate tax evasion rates (excluding tax liability estimated from audits over 200%)

In this section, we compare commercial truck screening data to WMT returns to estimate the mileage and revenue evasion rates. Mileage evasion rates were 10.66 percent, 11.69 percent, and 11.63 percent in 2016, 2017, and 2018, respectively. The ranges of revenue evasion rates were 7.84–10.70 percent, 9.16–11.80 percent, and 9.25–11.86 percent in 2016, 2017, and 2018, respectively. Evasion estimates were compared to ODOT audit records to check the validity of our estimation methods using commercial truck screening data because full audits are conducted using more information than the ones used in this analysis. Auditors have access to trip sheets, fueling receipts and a variety of other documents kept by carriers that are not accessible for every company. Among the 1,621 motor carriers with tax liabilities, 89.02 percent were listed in our tax evasion categories (no tax return, underreported, and zero-mileage reported, but vehicles detected). Just 10.98 percent were on the list of in-compliance motor carriers. Also, we compared potential revenue from tax liabilities estimated using commercial truck screening data to tax liabilities presented in the audit data using audit records which had an audit period beginning after January 1, 2016. The Pearson's correlation coefficient for revenue evasion rates estimated from audits and the minimum revenue evasion rates estimated using commercial truck screening data are 0.79. For audit and maximum revenue evasion rates estimated using commercial truck screening data, Pearson's correlation coefficient is 0.85. Considering that the values are above 0.7, they indicate a strong positive association and provide confidence in the methods and results presented in Section 3.1.

3.2 COMPARISON OF WMT RETURNS AND IRP REGISTRATION FILINGS

3.2.1 Data preparation

Another approach to estimating WMT evasion is comparing a carrier's WMT returns to its annual IRP registration filings. Carriers renewing their registration must report mileage for their fleets. This mileage can be compared to WMT returns to assess evasion rates. Table 3.26 displays registration periods for each IRP jurisdiction (i.e., member states and provinces). Registration periods are important to account for because they impact the mileage reporting period. Reporting periods must be carefully aligned with WMT reporting periods. Some states have one registration period for all the IRP vehicles registered in their jurisdiction, but others stagger them either monthly or quarterly. Since the first month of the registration period determines the reporting period, it is important to identify the registration period using available data.

Table 3.26: Registration Period by Jurisdiction

Registration Period	Jurisdiction
January - December (4)	KS, NE, NV, OR
March - February (1)	MN
April - March (2)	IL / QC
June - May (2)	PA, RI
July - June (2)	MA, WV
Staggered monthly (39)	AL, AK, CA, CO, CT, DE, FL, GA, ID, IN, IA, KY, LA, ME, MI, MS, NH, NJ, NM, NY, NC, OH, OK, SC, TN, TX, VT, VA, WA, WI / AB, BC, MB, NB, NL, NS, ON, PE, SK
Staggered quarterly (9)	AZ, DC, MD, MO, MT, ND, SD, UT, WY

Ten states and one Canadian province have a single registration period for all IRP vehicles registered in their jurisdiction when the first month is between January and July. Referring to Table 2.12 and the registration period, the corresponding reporting period for 2018 IRP data is shown in Table 3.27. These registration periods are straightforward, as reporting periods are identical for each jurisdiction regardless of the registration month.

Table 3.27: Corresponding IRP Reporting Periods based on Registration Period (for States with One Registration Period for All the Vehicles)

Registration Period	Reporting Period
January 1, 2018 - December 31, 2018	July 1, 2016 – June 30, 2017
March 1, 2018 - February 28, 2019	July 1, 2016 – June 30, 2017
April 1, 2018 - March 31, 2019	July 1, 2016 – June 30, 2017
June 1, 2018 - May 31, 2019	July 1, 2016 – June 30, 2017
July 1, 2018 - June 30, 2019	July 1, 2016 – June 30, 2017

However, IRP registration and reporting periods are not as straightforward for states which stagger registration on a monthly or quarterly basis. The corresponding reporting periods for different registration periods in 30 states and 9 Canadian provinces are detailed Table 3.28. If a vehicle's first month of registration in 2018 was September or earlier, the mileage recorded with the 2018 registration indicates the distance the vehicle traveled from July 1, 2016, to June 30, 2017. If the first month of registration was October or later, the mileage recorded reflects the distance traveled between July 1, 2017, and June 30, 2018.

Table 3.28: Corresponding IRP Reporting Periods Based on Registration Period (for States with Monthly Staggered Registration)

Registration Period	Reporting Period
January 1, 2018 - December 31, 2018	July 1, 2016 – June 30, 2017
February 1, 2018 - January 31, 2019	July 1, 2016 – June 30, 2017
March 1, 2018 - February 28, 2019	July 1, 2016 – June 30, 2017
April 1, 2018 - March 31, 2019	July 1, 2016 – June 30, 2017
May 1, 2018 - April 30, 2019	July 1, 2016 – June 30, 2017
June 1, 2018 - May 31, 2019	July 1, 2016 – June 30, 2017
July 1, 2018 - June 30, 2019	July 1, 2016 – June 30, 2017
August 1, 2018 - July 31, 2019	July 1, 2016 – June 30, 2017
September 1, 2018 - August 31, 2019	July 1, 2016 – June 30, 2017
October 1, 2018 - September 30, 2019	July 1, 2017 – June 30, 2018
November 1, 2018 – October 31, 2019	July 1, 2017 – June 30, 2018
December 1, 2018 - November 30, 2019	July 1, 2017 – June 30, 2018

Nine states offer quarterly staggered registration. January, April, July, and October are the renewal months in seven states, but Washington, D.C. (Table 3.30), and South Dakota (Table 3.31) have different renewal months.

Table 3.29: Corresponding IRP Reporting Periods Based on Registration Period (for States with Quarterly Staggered Registration)

Registration Period	Reporting Period
January 1, 2018 - December 31, 2018	July 1, 2016 – June 30, 2017
April 1, 2018 - March 31, 2019	July 1, 2016 – June 30, 2017
July 1, 2018 - June 30, 2019	July 1, 2016 – June 30, 2017
October 1, 2018 - September 31, 2019	July 1, 2017 – June 30, 2018

Table 3.30. Corresponding IRP Reporting Periods Based on Registration Period for Washington, D.C.

Registration Period	Reporting Period
March 1, 2018 – February 28, 2019	July 1, 2016 – June 30, 2017
June 1, 2018 - May 31, 2019	July 1, 2016 – June 30, 2017
September 1, 2018 - August 31, 2019	July 1, 2016 – June 30, 2017
December 1, 2018 - November 30, 2019	July 1, 2017 – June 30, 2018

Table 3.31: Corresponding IRP Reporting Periods Based on Registration Period for South Dakota

Registration Period	Reporting Period
February 1, 2018 – January 31, 2019	July 1, 2016 – June 30, 2017
May 1, 2018 - April 30, 2019	July 1, 2016 – June 30, 2017
August 1, 2018 - July 31, 2019	July 1, 2016 – June 30, 2017
November 1, 2018 - October 31, 2019	July 1, 2017 – June 30, 2018

Based on the tables above, we knew that some of the 2018 IRP registration records needed to be matched to WMT return filings for July 1, 2016 to June 30, 2017, and the rest matched to WMT return filings for July 1, 2017 to June 30, 2018. However, 2018 IRP registration data received from the IRP Clearinghouse list the date when the registration fee was paid, not the first month of the 2018 registration period.[8] Consequently, we assumed that carriers pay the fee between 15 days before the due date and five days after the due date to avoid late fees. For example, if a motor carrier paid the fee for its fleet on September 19, 2018, we assumed that the registration period for the fleet was October 1, 2018 to September 30, 2018. Using these criteria, we deduced the registration period for each IRP filing.

To match 2018 IRP registration records with WMT return records, both datasets needed a common field. With very few exceptions (0.02 percent) WMT return records have USDOT numbers paired with account numbers, but an issue arose with the IRP dataset. When a motor carrier renews or modifies its IRP registration, some states require a USDOT number and an IRP account number. However, not all states have this requirement (Figure 3.9).

[8] Oregon data was collected from ODOT administrators, as Oregon does not currently participate in the IRP Clearinghouse.

Currently, 48 U.S. States, Washington, D.C., and 10 Canadian provinces participate in the IRP agreement. IRP does not require that states collect the USDOT number, leaving this decision up to the state. Figure 3.9 visualizes the percentage of IRP registration data in each IRP jurisdiction that does not include a corresponding USDOT number. Sixteen states did not submit USDOT numbers from their IRP accounts registered in their jurisdiction to the IRP Clearinghouse. The same is true for all Canadian provinces, which makes sense given that USDOT numbers are a U.S.-based credential. Only four states (Maryland, Nebraska, North Dakota, and Oregon) and Washington, D.C., submitted 100 percent of both USDOT numbers and IRP account numbers for all carriers registered in their jurisdiction. The states that saved USDOT numbers for more than 80 percent of their 2018 IRP registrations include Delaware, Maine, New Hampshire, New Mexico, South Dakota, Utah, and Vermont. The 2018 IRP registration records received from the IRP Clearinghouse and ODOT administrators contained information on 90,725 accounts. But we could not compare travel mileages reported in IRP filings to WMT return records for 35,861 IRP accounts (39.53 percent) because of these practices, even after supplementing IRP Clearinghouse data with T-files from the FMCSA's SAFER dataset, including both USDOT numbers and IRP account numbers.

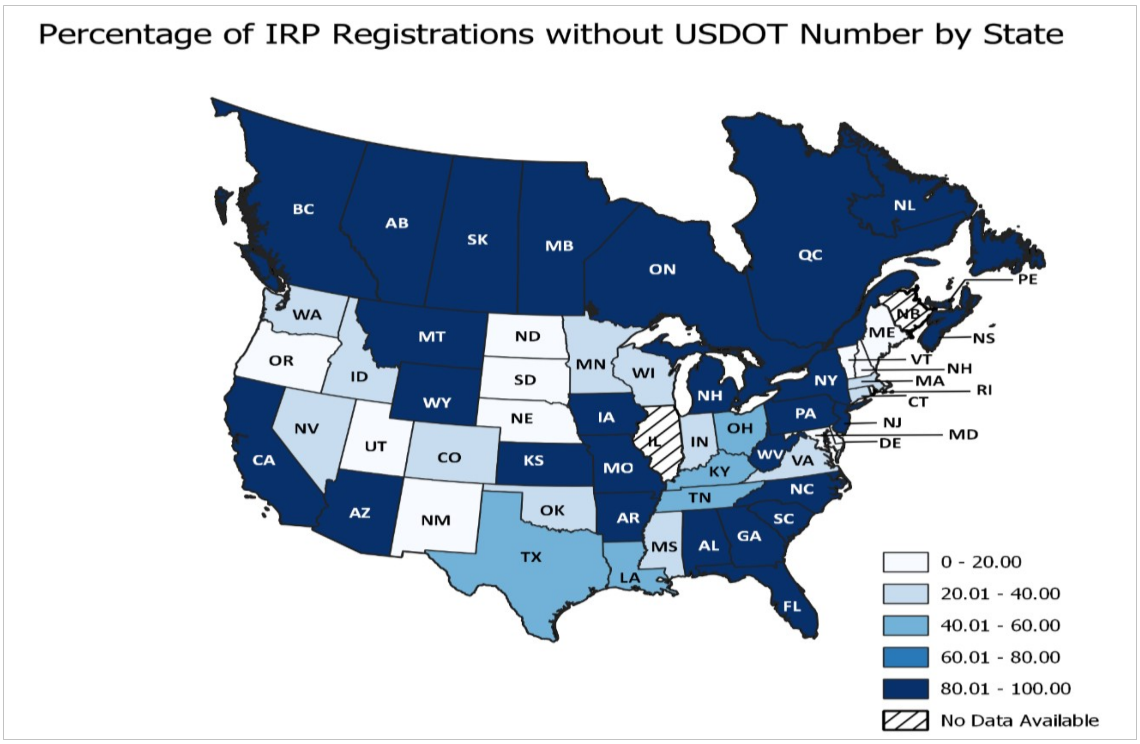

Figure 3.9: Percentage of IRP registrations without USDOT number by state

3.2.2 Results

3.2.2.1 WMT mileage evasion

The goal of this analysis was to see if motor carriers report the same mileage in IRP and WMT return filings or if impacted carriers tend to report more mileage to either IRP or

ODOT. The percentage difference is calculated by subtracting IRP-reported mileage from WMT-reported mileage and dividing the difference by the WMT-reported mileage. When calculating WMT mileage for a carrier, we excluded miles recorded for intrastate trips since IRP mileage only includes interstate trip miles. We did this by eliminating WMT returns with plates beginning with *YC*.

$$\boldsymbol{Percent\ \ difference = \frac{(WMT\ mileage - IRP\ mileage)}{WMT\ mileage} \times 100} \tag{3-1}$$

If the difference was a positive number, the motor carrier reported more miles in WMT returns than IRP. If the difference was negative, there is a possibility that a motor carrier underreported operated mileage in Oregon to reduce its WMT obligations. As shown in Table 3.32, only 11.78 percent of motor carriers reported the same mileage in IRP and WMT returns; 45.21 percent reported more fleet mileage in IRP returns than in WMT returns; while 43.00 percent recorded more mileage in WMT returns than in IRP returns. The distribution of motor carriers by the percentage difference is symmetrical.

There are a few explanations for why only 11.78 percent of motor carriers reported the same mileage in WMT returns and IRP returns. Because IRP and WMT eligibility requirements differ slightly, some motor carriers might operate fleets that do not need to be included in WMT but need to be in IRP or vice-versa. In this case, motor carriers could be in either the 0% to 5% *over reported* or *Underreported* categories. Also, if a motor carrier operates intrastate vehicles as well as interstate vehicles, mileage reported to IRP should be much less than in WMT returns. In this case, motor carriers would be in the *over reported* category, and the percentage difference could be higher depending on the ratio of intrastate fleets to interstate fleets.

Table 3.32: Motor Carriers by Differences between Mileages in WMT Returns and IRP Registration Filings

		No. of Motor Carriers	Percentage of MC
Over reported	Over 15%	6,743	29.53%
	5% to 15%	1,601	7.01%
	0% to=5%	1,982	8.68%
	No diff.	2,691	11.78%
Underreported	-5% to 0%	2,194	9.61%
	-15% to -5%	1,524	6.67%
	Below -15%	6,103	26.72%
Total		22,838	100.00%

Figure 3.10 shows the distribution of motor carriers that underreported and over reported mileage in terms of mileages, but not the percentage difference. For 29.18 percent of motor carriers, the difference between the mileage reported in WMT returns and to IRP

was less than 200. The difference for 50.96 percent of motor carriers was less than 1,000 miles. 68 percent of motor carriers lay within 1 standard deviation of the mean, which is between underreporting of 2,411.06 miles and over reporting of 1,234.41 miles.

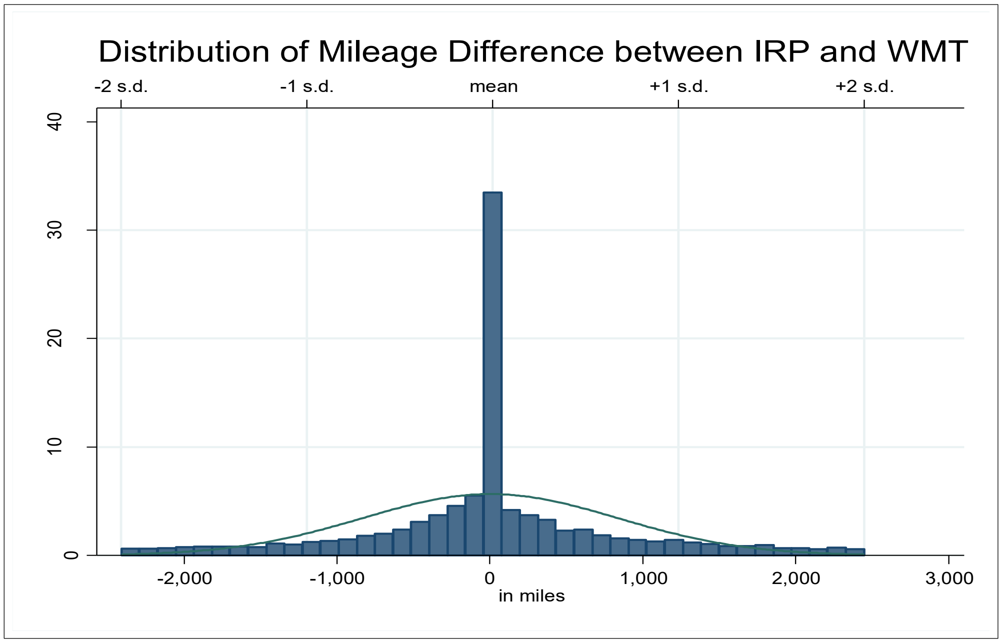

Figure 3.10: Distribution of mileage difference between IRP and WMT

Table 3.33: Percentage of Motor Carriers by Mileage Difference Category (WMT=IRP Comparison)

	Difference in mi	**MC**	**Percentage of MC**
Over reported	1,000	351	1.54%
	800	517	2.26%
	600	622	2.72%
	400	885	3.88%
	200	1,784	7.81%
	No diff.	2,691	11.78%
Underreported	-200	2,190	9.59%
	-400	1,004	4.40%
	-600	675	2.96%
	-800	525	2.30%
	-1,000	394	1.73%

The total mileage over reported or underreported in each category is symmetrical as well (Table 3.34). Aggregated data show that the tendencies to either over report or underreport are similar. From ODOT's point of view, the categories of interest are the bottom three, where motor carriers that underreport mileages in WMT return filings are positioned. We estimated that 202,664,677 miles were underreported, but results were adjusted based on data excluded from the analysis for lack of USDOT number information. In the 2018 IRP registrations, 1,885,358,063.04 miles were reported across all fleets. However, USDOT numbers for motor carriers that operated 9.16 percent of the total (172,725,045.43 miles) could not be found. Therefore, mileages calculated in Table 3.34 were adjusted using a multiplier of 1.10. The adjusted total underreported mileage was 223,104,120, or 11.94 percent of mileage reported in WMT returns from Q3 of 2017 to Q2 of 2018.

Table 3.34: Overall Mileages over Reported or Underreported in WMT Compared to IRP

		Miles Over/Underreported	Adjusted Mileage	Subtotal
Over reported	Over 15%	190,043,315	209,209,850	222,413,348
	5% to 15%	9,377,131	10,322,848	
	0% to=5%	2,616,743	2,880,651	
	No diff.	0	0	
Underreported	-5% to 0%	-2,573,056	-2,832,558	-223,104,120
	-15% to -5%	-11,012,111	-12,122,721	
	Below -15%	-189,079,510	-208,148,842	
	Total			-690,772

Table 3.34 shows the aggregated results disregarding different base jurisdictions. However, analysis by state revealed that motor carriers registered in certain states have a clear tendency to over report or underreport miles in WMT returns compared to IRP returns. We calculated the ratio of carriers underreporting WMT miles to carriers over reporting WMT miles for each state. Figure 3.11 shows the ratio of underreported miles to over reported miles for the top 10 states where motor carriers registered based on the state having a strong tendency to underreport in WMT returns. Among the 440 motor carriers from Missouri, 203 carriers filed more mileage in WMT returns than in IRP returns, while 190 carriers filed less mileage in WMT returns. However, the magnitude of underreporting was significantly larger than over reporting among Missouri carriers. Total over reporting (the difference between mileage in WMT and IRP) was 1,076,113 miles whereas total underreporting was 19,262,532 miles. Underreported miles were approximately 18 times more than the total over reported miles. The height of the red bar on the graph shows the ratio of underreported miles to over reported miles, and the height of the blue bar indicates the ratio of over reported miles to underreported miles. For Missouri, the red bar is 18 times taller than the blue bar. Motor carriers in Oregon are on the top ten list as well. Total over reported mileage was 24,958,425 miles while underreported mileage was 61,852,691 miles (2.5 times over reported mileage). The ratio between them was less extreme than for Missouri carriers, but Oregon is ranked at 6th when it comes to the relative size of underreported miles compared to over reported miles.

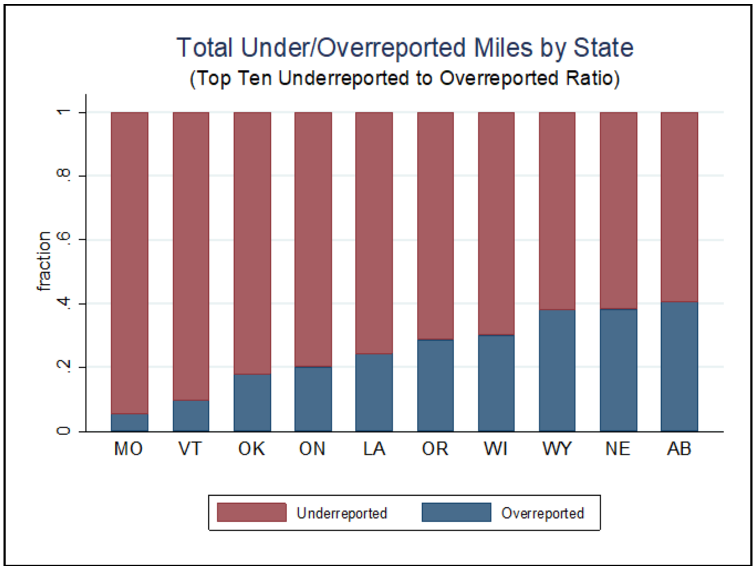

Figure 3.11: Total under/over reported miles by state (top ten underreported to over reported ratio)

Motor carriers in Maryland, New Hampshire, Ohio, Mississippi, Rhode Island, Iowa, Nevada, Tennessee, Manitoba, and Georgia exhibited a strong tendency to report more mileage in WMT returns than in IRP filings (Figure 3.12). Maryland carriers over reported 490,829 miles and underreported 13,895 miles. The ratio of underreported miles to over reported miles was one to 35.32. The height of the blue bar in Figure 3.12 is thus 35.32 times that of the red bar, indicating the ratio of underreported miles compared to over reported miles. The ratio of underreported miles to over reported miles was smaller for Georgia (1:6.52). Over reported miles were 204,817, and underreported miles were 31,418.

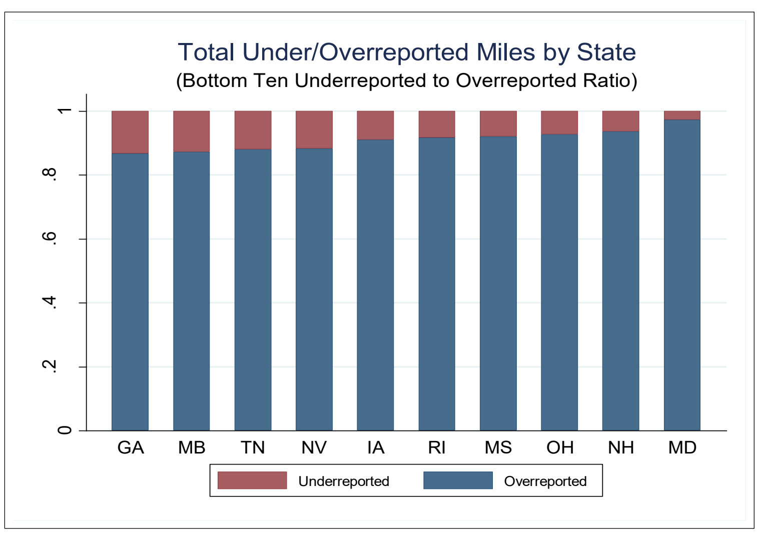

Figure 3.12: Total under/over reported miles by state (bottom ten underreported to over reported ratio)

3.2.2.2 WMT revenue evasion

Potential revenues from tax liabilities were estimated by multiplying underreported miles by weight distance tax rates (Table 2.1 and Table 2.2). When a motor carrier's reported miles in IRP registration filings exceed mileage reported in WMT returns, the difference between the two mileages is the source of tax liability. With respect to the tax rate that should be applied to the mileage liability (the difference between miles reported to IRP and in WMT returns), the tax rate for the carrier's lowest declared gross vehicle weight was used to estimate the minimum tax liability, and the tax rate applicable to the declared gross weight of the carrier's most frequently used vehicle was used for the maximum tax liability.

Based on mileage evasion estimated in Section 3.2.2.1, minimum potential revenue from tax liability was $22,624,574 and maximum potential revenue from tax liability was $29,650,071. A portion of 2018 IRP registration filings was compared to WMT returns for the period spanning Q3 of 2016 to Q2 of 2017. Remaining 2018 IRP registration filings were compared to WMT returns for the period extending from Q3 of 2017 to 2018 Q2. When total potential revenue was compared to the total reported tax for Q3 of 2017 to Q2 of 2018 WMT returns excluding revenue from intrastate vehicles, it constituted a minimum of 8.13 percent to a maximum of 10.66 percent.

Table 3.35: WMT Revenue Evasion (IFTA=IRP Comparison)

	Revenue	**Percent Revenue Evasion**
Total Revenue Reported (excluding intrastate trips)	$296,471,603	
Min. Revenue Evaded	$22,624,574	8.13%
Max. Revenue Evaded	$29,650,071	10.66%

Comparing carrier mileage in WMT returns and IRP filings is complicated for several reasons. The data are difficult to compare because of the labyrinthine nature of IRP registration and reporting periods, the necessity of using the registration paid date to estimate the registration start date, and the pervasiveness of missing USDOT numbers. Nevertheless, we compared WMT and IRP records for 22,646 carriers. Complicating matters further are reasons why IRP and WMT miles may not match. A carrier's share of intrastate vehicles is one factor. Another is vehicles belonging to for-hire carriers under 26,0001 pounds picking up and dropping off freight in other states – vehicles required to be included in IRP reports but not WMT returns. Leasing arrangements for IRP vehicles is another potential confounding factor. We found a reporting disparity of about 223 million miles due to WMT mileage being lower than IRP mileage for companies where matching was possible, a potential WMT evasion rate of up to 11.94 percent. We concede that what percentage of the potential evasion is due to actual WMT as opposed to potential discrepancies in fleet composition and reporting periods is unknowable. However, this figure roughly aligns with WMT evasion estimates using commercial screening data presented in Sections 3.1.1 to 3.1.3. Also, motor carriers may have reported the actual mileage on their WMT returns and inflated the Oregon mileage on IRP registrations. When calculating a motor carrier's total IRP fee, the annual fee of a jurisdiction where its vehicles traveled and the percentage of miles logged in each jurisdiction were considered. If more miles were recorded in a jurisdiction with a higher annual fee, the total IRP fee is higher than when more miles were recorded in a jurisdiction with a lower annual fee. Oregon offers a lower IRP annual fee compared to adjacent states. For example, full fees for a 78,001 lbs. to 80,000 lbs. registration when filing schedule B (not prorated for a partial registration year) are as follows: Oregon ($998.00), California ($2,236.00), Idaho ($3,360.00), and (Washington: $1,845.00).[9] As a result, motor carriers benefit from reporting more miles in Oregon when calculating total fees. Therefore, a small portion of underreported miles may need to be excluded from the calculation. Unfortunately, due to limited data, we cannot differentiate motor carriers that inflate Oregon miles on IRP registrations to lower IRP fees from those motor carriers which underreport WMT miles to avoid WMT tax liability.

3.3 COMPARISON OF WMT RETURNS AND IFTA RETURNS

3.3.1 Data preparation

In this section, we compare the mileage reported in WMT returns to trip distances in Oregon (as reported in IFTA returns listing Oregon as a travel jurisdiction) to determine whether there is a tendency to report more miles in either WMT or IFTA. Although Oregon does not require motor carriers to pay a fuel tax, IFTA mandates that carriers report mileage logged in all jurisdictions. Therefore, interstate carriers must track the number of miles their fleets travel in Oregon and report it to IFTA. To compare mileages recorded in the two datasets, we used the USDOT number as a common field. WMT return data have USDOT numbers for 99.80 percent of the filings, but we could not find USDOT numbers for 26.58 percent to 28.56 percent of the IFTA accounts each quarter (Table 3.36). Also, a large portion of accounts was dropped from the analysis during the matching process of WMT to IFTA data. Fortunately, we were able to retain 54.98 to 58.35 percent of the original IFTA data despite limitations posed by available data. The remaining dataset is therefore large enough to accurately estimate quarterly underreporting or over reporting by motor carriers as well as the magnitude of underreporting and over reporting.

[9] This is an example from the Oregon Department of Transportation Commerce and Compliance Division. (2020). Motor Carrier Registration and Tax Manual. https://www.oregon.gov/ODOT/Forms/Motcarr/9924.pdf. Jurisdictions offer different annual fee depending on registration weight, purchase price, age of vehicle, etc. Also, while these fees are the IRP fees for jurisdictions as of 2020, IRP jurisdictions do periodically change truck registration fees.

Table 3.36: IFTA Returns in the Analysis

		Total Account	Account w/o USDOT		Motor Carriers Matched to WMT	
2016	Q1	26,546	7,144	(26.91%)	14,825	(55.85%)
	Q2	28,750	8,013	(27.87%)	15,808	(54.98%)
	Q3	28,640	7,694	(26.86%)	15,954	(55.71%)
	Q4	27,753	7,418	(26.73%)	15,356	(55.33%)
2017	Q1	27,170	7,299	(26.86%)	15,514	(57.10%)
	Q2	28,815	8,011	(27.80%)	16,107	(55.90%)
	Q3	29,208	7,958	(27.25%)	16,448	(56.31%)
	Q4	27,884	7,568	(27.14%)	15,578	(55.87%)
2018	Q1	27,341	7,267	(26.58%)	15,954	(58.35%)
	Q2	29,799	8,511	(28.56%)	16,727	(56.13%)
	Q3	30,104	8,259	(27.43%)	17,253	(57.31%)
	Q4	28,819	7,792	(27.04%)	16,511	(57.29%)

Figure 3.13 shows the percentage of IFTA accounts without USDOT numbers by state. IFTA transmittal data include IFTA number, jurisdiction, total miles, and return period, among other information. However, they lack a USDOT number, which is needed to match IFTA returns to WMT returns. IFTA demographic data contain both an IFTA number and USDOT number as well as a legal name, business name, IFTA account status, jurisdiction (state or province), and the IFTA status and expiration dates. Before IFTA transmittal data were matched to WMT data, we linked IFTA numbers to USDOT numbers using IFTA demographic data. States and provinces had a different level of matching success rate. In Figure 3.13, the states with darker shading have a higher percentage of missing data (USDOT number). With a few exceptions (California, Louisiana, New York, Pennsylvania, and Vermont), states have a relatively lower percentage of accounts without matching USDOT numbers. However, Canadian provinces have higher percentages of accounts without USDOT numbers because they have little utility for provinces. Lack of USDOT numbers means that the accounts were excluded from the ensuing analysis. Therefore, the results apply to the motor carriers in the U.S. more than Canada.

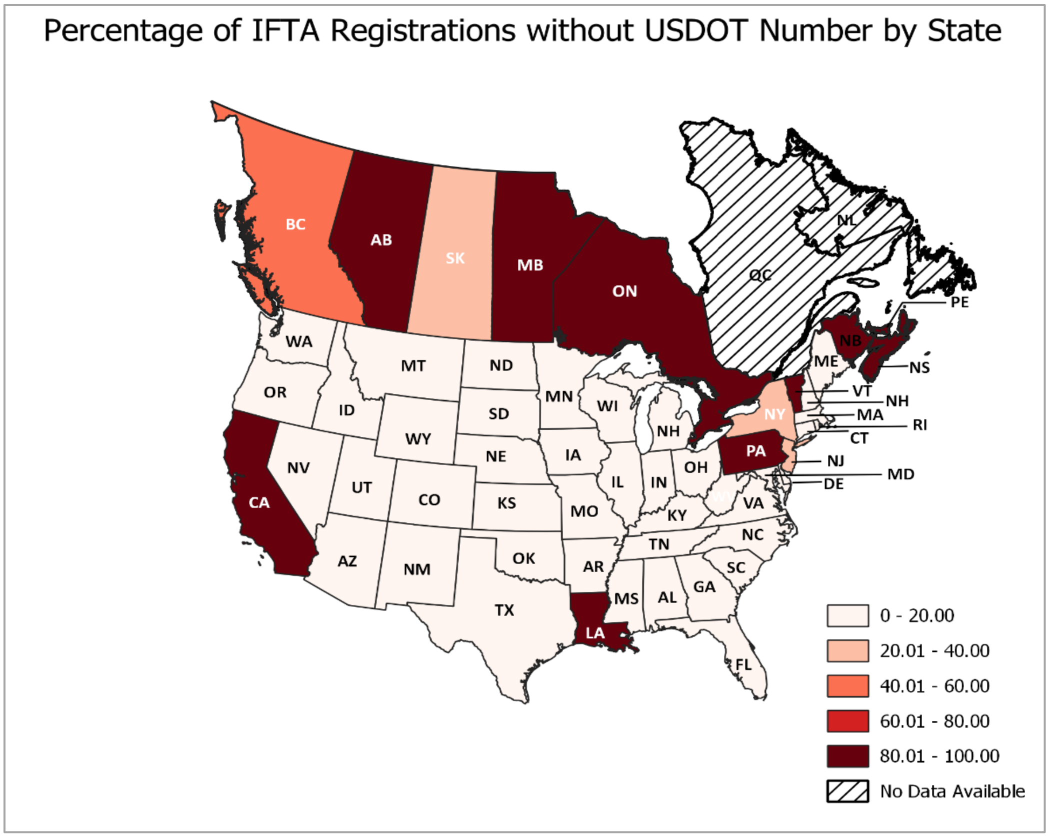

Figure 3.13: Percentage of IFTA registrations without USDOT number by state

3.3.2 Results

3.3.2.1 WMT mileage evasion

This analysis sought to determine if motor carriers report the same mileage in IFTA filings and WMT returns or if they tend to report greater mileages in either. The percentage difference was calculated by subtracting IFTA-reported mileage from mileage reported in WMT returns and then dividing that number by the mileage reported in WMT returns.

$$\boldsymbol{Percent\ difference = \frac{(WMT\ mileage - IFTA\ mileage)}{WMT\ mileage} \times 100}$$

(3-2)

In Figure 3.14, bars with various intensities of blue indicate the percentage of motor carriers that filed more miles in WMT returns than in IFTA returns. The middle bar, indicating 0 percent difference, shows that around 40 percent of the motor carriers reported the same mileage in WMT returns and IFTA returns throughout the study period. The percentage of motor carriers reporting the same mileage was higher in this analysis than in the analysis of WMT returns and IRP filings described in the previous section because the filing systems for IFTA and WMT are similar. Motor carriers must file the distance traveled in each state every quarter; motor carriers operating in Oregon must file trip mileage either monthly or quarterly. It was relatively straightforward to match IFTA returns to quarterly WMT returns or bundled monthly WMT returns. Temporary passes were assigned to an appropriate quarter and added to reported WMT miles.

The top three categories in the stacked bar graph in Figure 3.14 show the percentage of motor carriers that filed less mileage in WMT returns than in IFTA returns. These are the categories of interest to ODOT since full-scale audits of motor carriers in these categories are more likely to uncover tax liabilities. The category marked with dark red is particularly important because it encompasses motor carriers with potential evasion rates higher than 15 percent. In Q1 of 2016, 16.18 percent of the motor carriers were in this category; 5.23 percent were in the 5 percent to 15 percent underreported category; and 9.93 percent fell in the 0 percent to 5 percent underreported category.

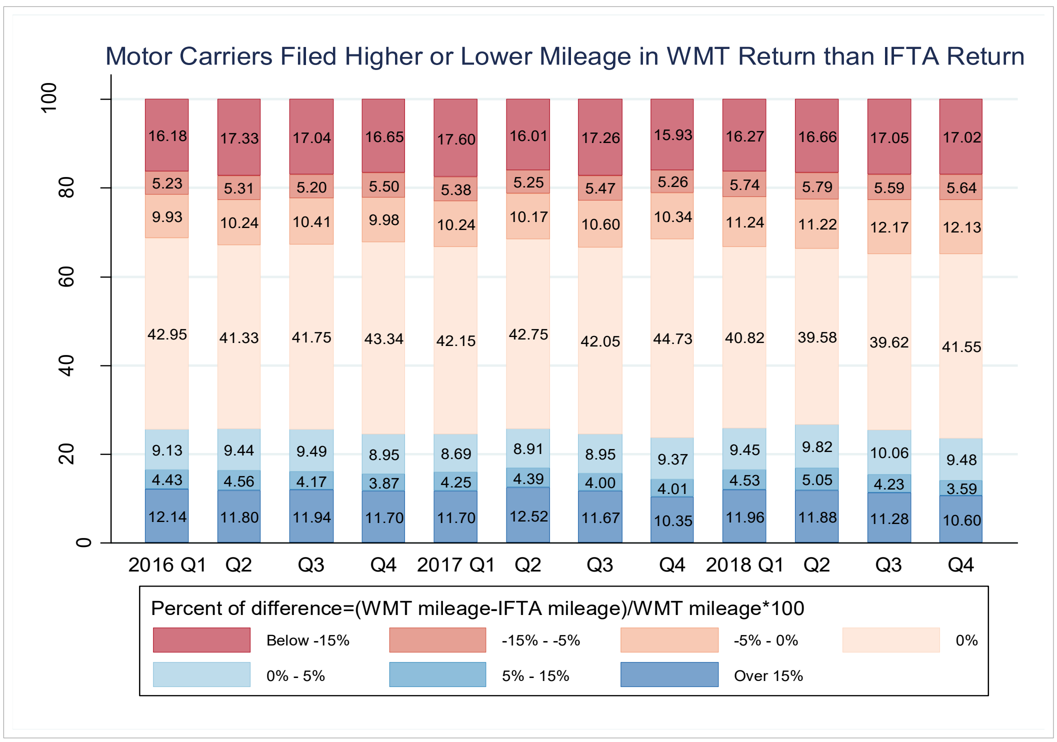

Figure 3.14: Percent of motor carriers filed lower or higher mileage in WMT return than IFTA return

Throughout the study period, the percentage of motor carriers that over reported was consistently lower than those that underreported. Approximately 24 to 26 percent of motor carriers over reported, while 31 to 34 percent underreported. The difference between over reporting and underreporting becomes more visible by looking at the total miles over reported or underreported every quarter. Total miles underreported exceeded over reported miles by nearly a factor of two (Table 3.37). Unlike the analysis in the previous section where the total over reported miles were very close to the underreported miles, underreported miles in WMT returns compared to IFTA returns were very different from the over reported miles.

Table 3.37: Total Under/Over reported Miles by Quarter (IFTA=WMT Comparison)

		Over reported (in miles)	Underreported (in miles)
2016	Q1	15,259,397	31,036,214
	Q2	17,716,504	33,913,263
	Q3	17,636,955	46,229,188
	Q4	17,121,485	31,163,960
2017	Q1	17,251,225	32,060,071
	Q2	15,509,632	34,880,236
	Q3	25,486,746	38,099,076
	Q4	17,830,257	32,909,243
2018	Q1	19,434,588	31,727,822
	Q2	17,290,165	33,502,803
	Q3	17,278,689	35,057,305
	Q4	14,734,905	32,576,777

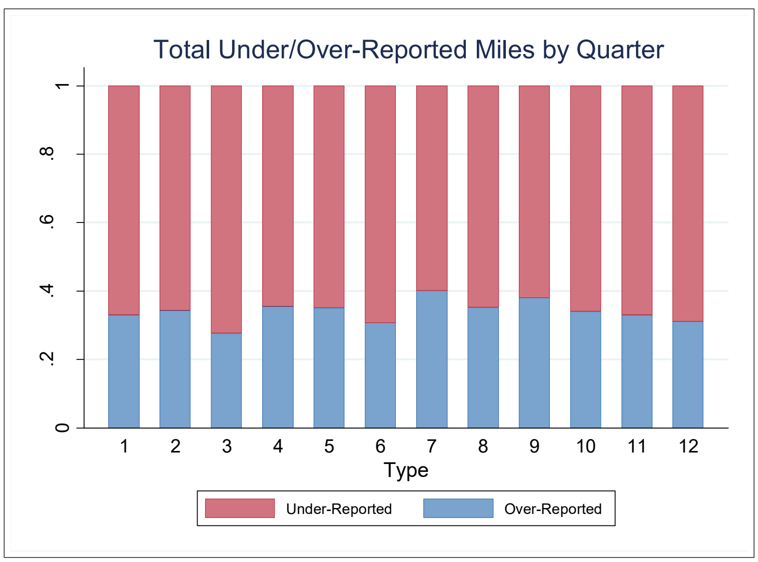

Figure 3.15: Total under/over reported miles by quarter (WMT= IFTA comparison)

From 2016 to 2018, the average total mileage reported in WMT returns and temporary passes (excluding miles from intrastate vehicles) was 1,657,740,803 miles. Based on the comparison of IFTA mileage and WMT mileage, the percentage of potential revenue loss from underreported miles was 8.59 percent in 2016, 8.32 percent in 2017, and 8.01 percent in 2018.

The same analysis was conducted for motor carriers in different states to see if the physical location of motor carriers influenced the tendency to over report or underreport in WMT returns. In British Columbia, 317 motor carriers submitted both WMT returns and IFTA filings with miles traveled in Oregon during the first quarter of 2016. Only 8 motor carriers over reported, while 303 motor carriers underreported in WMT returns. The total mileage over reported was 4,696 miles while there were 5,023,707 underreported miles. Among the 10 states with the highest ratio of underreported miles to over reported miles, Oregon, Wyoming, and Wisconsin motor carriers are on the list of the 10 states with severe underreporting in WMT returns compared to IFTA filings (Figure 3.16).

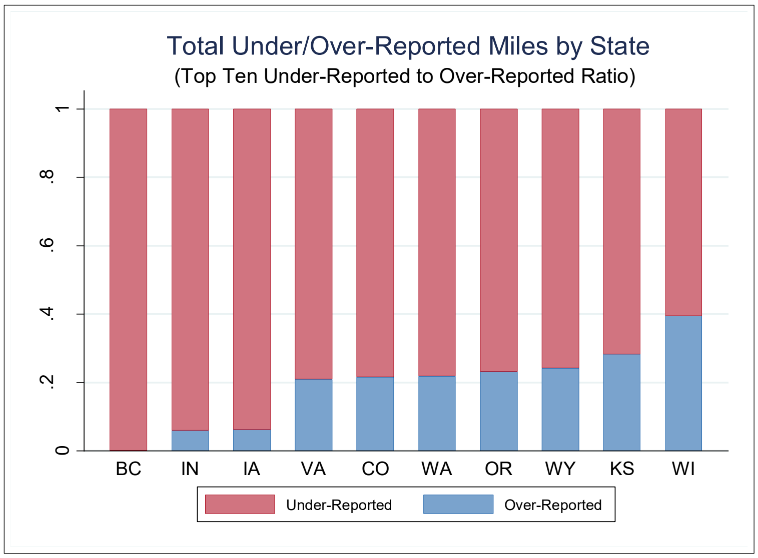

Figure 3.16: Total under/over reported miles by state in 2016 Q1 (top ten underreported to over reported ratio)

Figure 3.17 shows the 10 states where motor carriers tended to file more miles in WMT returns than in IFTA filings. During Q1 of 2016, 444 motor carriers filed WMT returns; of these, 35.59 percent reported more miles in WMT returns than in IFTA filings. A similar percentage of motor carriers filed fewer miles in WMT returns (33.78 percent). However, total miles underreported and over reported were significantly different. For Utah carriers, total underreported mileage was 85,168 miles, while the 252,419 miles were over reported. In this case, the over reported miles were more than enough to compensate for the underreported miles. Tennessee, Ohio, Georgia, Nevada, and Maryland on this list are also in the list of states where motor carriers had a strong tendency to over report in WMT returns compared to IRP filings (Figure 3.12).

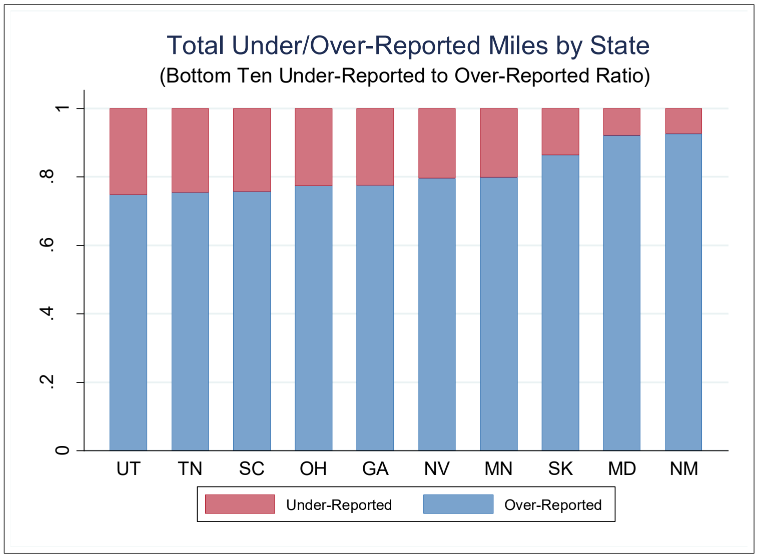

Figure 3.17: Total under/over reported miles by state in 2016 Q1 (bottom ten underreported to over reported ratio)

3.3.2.2 WMT revenue evasion

Potential revenues from tax liabilities were estimated by multiplying underreported miles by weight distance tax rates (Table 2.1 and Table 2.2). When a motor carrier's reported miles in IFTA returns exceed miles reported in WMT returns in a quarter, the difference between the two mileages is the source of tax liability. With respect to the tax rate applied to the mileage liability (the difference between miles reported to IFTA and those reported in WMT returns), the tax rate for the carrier's lowest declared gross vehicle weight was used to estimate the minimum tax liability, and the tax rate applicable to the declared gross weight of the carrier's most frequently used vehicle was used for the maximum tax liability.

In Q1 of 2016, the estimated minimum tax liability calculated with underreported mileage was $2,867,426.12 and the maximum tax liability was $4,709,076.57. Aggregated reported tax from WMT returns from interstate vehicles in the same quarter was $61,518,399.82. The minimum revenue evasion rate stayed around 5.00 percent and the maximum revenue evasion rate was around 7.00 percent throughout the study period except for Q3 of 2016. The revenue evasion rate for this quarter was higher than both the previous quarter and the following quarter, before falling to a level similar to previous quarters.

Table 3.38: WMT Revenue Evasion (WMT= IFTA Comparison)

		Total Revenue Reported (excluding intrastate trips)	Min. Revenue Evaded	Max. Revenue Evaded
2016	Q1	61,518,399.82	2,867,426.12 (4.66%)	4,709,076.57 (7.65%)
	Q2	66,448,265.20	3,240,941.91 (4.88%)	4,717,998.79 (7.10%)
	Q3	67,206,836.58	4,887,385.88 (7.27%)	6,819,319.50 (10.15%)
	Q4	63,212,772.91	3,410,086.94 (5.39%)	4,915,818.25 (7.78 %)
2017	Q1	61,950,824.16	3,195,342.61 (5.16%)	4,565,133.03 (7.37%)
	Q2	67,409,481.57	3,224,582.56 (4.78%)	4,573,499.30 (6.78%)
	Q3	68,626,410.37	3,833,343.32 (5.59%)	5,031,099.15 (7.33%)
	Q4	64,653,793.85	3,018,605.89 (4.67%)	4,306,329.06 (6.66%)
2018	Q1	79,254,922.51	3,749,242.95 (4.73%)	4,701,377.94 (5.93%)
	Q2	83,936,477.26	4,091,062.77 (4.87%)	5,409,324.22 (6.44%)
	Q3	85,590,557.69	3,874,150.27 (4.53%)	5,731,691.97 (6.70%)
	Q4	81,090,680.98	3,934,796.16 (4.85%)	5,322,701.89 (6.56%)

Overall, IFTA data were much easier to match with WMT returns than IRP data. Whereas only 11.78 percent of carrier IRP mileage lined up WMT mileage, about 40 percent of the Oregon carriers traveling in Oregon and filing IFTA returns could be matched to their WMT returns. Nevertheless, there are discrepancies in the reporting for a large percentage of carriers. As with IRP, specific reasons explain why carrier mileage may differ from WMT mileage. For Oregon carriers, having intrastate vehicles could be a factor, although it would be more likely to show up as over reporting mileage relative to WMT rather than underreporting if those vehicles constitute a significant percentage of a carrier's fleet. Also, motor carriers may inflate miles traveled in Oregon in their IFTA filings to reduce fuel taxes owed to other states. Oregon does not have a fuel tax for commercial vehicles while other states charge from $0.17 (Missouri) to $0.795 (California) for diesel (International Fuel Tax Association, Inc., 2020). Motor carriers that report more miles in states with higher fuel tax rates are required to pay a higher overall tax burden than the ones reporting more miles in states with lower fuel taxes, since commercial carriers are required to pay fuel taxes proportional to the miles driven in each state. There are vehicle, fuel and distance exemptions in some jurisdictions, although Oregon notably has none given the absence of a fuel tax.

For the study period, the overall potential evasion rate (as a percentage of miles) ranged from 8.01 to 8.59 percent. Evasion estimates were consistent with the lower range of the screening-observation-based evasion estimates and slightly lower than IRP estimates. As with IRP, there is no way to determine what component of the difference results from WMT evasion as opposed to differences in fleet composition or reporting requirements. However, possible exemptions here are less numerous than for IRP.

3.4 COMPARISON OF TAX EVASION RATE ESTIMATIONS USING ODOT COMMERCIAL TRUCK SCREENING DATA, IRP REGISTRATION FILINGS, AND IFTA RETURNS

In the previous three sections, we analyzed the tax evasion rates by comparing WMT returns to ODOT commercial truck screening data, IRP registration filings, and IFTA returns, respectively. Each analysis presented tax evasion rates in terms of miles evaded and revenue evaded. Tax liabilities were calculated as ranges instead of point estimates. All three analyses were done at the carrier level, not the vehicle level. After we estimated the mileage underreported in WMT for a carrier, it was not possible to compare mileages of specific vehicles operated by carriers as the screening, IRP, and IFTA data are not fine-grained enough. Each analysis had potential sources of error, including the mileage estimate based on vehicle screening and estimated mileage ratio, IRP registration reporting, and IFTA tax returns. Furthermore, with respect to the IFTA and IRP there is no way to know the degree of compositional similarity between fleets being compared with WMT fleets. Nevertheless, our analyses are rich with useful data and we can draw general conclusions from the three methods of estimating evasion.

3.4.1 WMT mileage evasion

For 2016 to 2018, we had WMT tax return data, ODOT commercial truck screening data, and IFTA returns data. IFTA returns are filed quarterly, while WMT tax returns are filed either monthly or quarterly. Our analyses estimated mileage evasion rates for each quarter (see results in Table 3.39). Mileage evasion rates estimated using IFTA were consistently lower (7.76 to 10.88 percent) than those estimated using ODOT commercial truck screening data (9.73 to 13.18 percent). These results are similar to the annualized results reported in Section 3.1.2.1.

Unlike WMT and IFTA returns, for IRP filings total travel mileage during a reporting period is filed only once a year. We had access to only the 2018 IRP registration filings and estimated a mileage evasion rate for the 2018 registration year as a whole, rather than by quarter. Compared to IRP, 223,104,120 miles were underreported in WMT returns for the 2018 IRP registration year. This was 11.94 percent of all miles reported in WMT returns from 2017 Q3 to 2018 Q2. The analysis's mileage estimation rate was closer to those estimated using ODOT commercial truck screening data.

Table 3.39: Comparison of Mileage Evasion Rates

		ODOT Commercial Truck Screening Data		IFTA	
		Total Miles Reported	***Total Miles Evaded***	***Total Miles Reported (excluding intrastate trips)***	***Total Miles Evaded***
2016	Q1	411,662,178	40,061,541 (9.73%)	388,718,357	31,036,214 (7.98%)
	Q2	447,349,557	48,372,294 (10.81%)	420,047,125	33,913,263 (8.07%)
	Q3	453,593,584	51,656,815 (11.39%)	424,864,395	46,229,188 (10.88%)
	Q4	422,028,555	44,763,415 (10.61%)	399,270,967	31,163,960 (7.81%)
2017	Q1	412,818,774	47,085,689 (11.41%)	391,344,497	32,060,071 (8.19%)
	Q2	453,202,164	53,462,856 (11.80%)	426,299,517	34,880,236 (8.18%)
	Q3	462,643,768	59,043,521 (12.76%)	433,548,106	38,099,076 (8.79%)
	Q4	433,883,968	46,419,209 (10.70%)	408,150,125	32,909,243 (8.06%)
2018	Q1	434,183,803	43,163,709 (9.94%)	408,802,259	31,727,822 (7.76%)
	Q2	459,344,119	46,284,951 (10.08%)	429,932,868	33,502,803 (7.79%)
	Q3	462,571,069	60,967,121 (13.18%)	433,096,766	35,057,305 (8.09%)
	Q4	433,535,967	50,666,303 (11.69%)	409,147,426	32,576,777 (7.96%)

For 2018 IRP Registration Filings, the total underreported miles were 223,104,120. This was 11.94 percent of the total miles reported in WMT returns from 2017 Q3 to 2018 Q2.

3.4.2 WMT revenue evasion

Based on the estimated mileage evaded, potential tax revenue was calculated using weight distance tax rates (Table 2.1 and Table 2.2) for each quarter. Comparisons of revenue evasion rates from the three analyses was similar to the comparison of mileage evasion rates. The percentage of tax liability estimated using ODOT commercial truck screening data ranged from 7.27 to 9.53 percent for the first quarter of 2016, while it ranged from 4.66 to 7.65 percent when we compared WMT returns to IFTA returns. Evasion rates estimated using ODOT truck screening data were consistently higher than those obtained using IFTA returns for the entire study period. But analysis using 2018 IRP registration filings estimated an 8.13 to 10.66 percent tax evasion rate, which is close to the one analysis used in ODOT commercial truck screening data.

Table 3.40: Comparison of Revenue Evasion Rates

		Commercial Truck Screening Data		IFTA	
		Min. Revenue Evaded	***Max. Revenue Evaded***	***Min. Revenue Evaded***	***Max. Revenue Evaded***
2016	Q1	4,694,227 (7.27%)	6,155,687 (9.53%)	2,867,426 (4.66%)	4,708,943 (7.65%)
	Q2	5,592,540 (7.98%)	7,562,036 (10.79%)	3,240,942 (4.88%)	4,718,604 (7.10%)
	Q3	5,836,484 (8.22%)	8,265,214 (11.65%)	4,887,386 (7.27%)	6,818,641 (10.15%)
	Q4	5,187,506 (7.84%)	7,103,545 (10.73%)	3,410,087 (5.39%)	4,915,883 (7.78%)
2017	Q1	5,707,261 (8.82%)	7,436,151 (11.49%)	3,195,343 (5.16%)	4,565,072 (7.37%)
	Q2	6,634,276 (9.34%)	8,547,416 (12.04%)	3,224,583 (4.78%)	4,573,253 (6.78%)
	Q3	7,300,063 (10.06%)	9,238,989 (12.74%)	3,833,343 (5.59%)	5,030,698 (7.33%)
	Q4	5,681,990 (8.35%)	7,384,267 (10.85%)	3,018,606 (4.67%)	4,306,688 (6.66%)
2018	Q1	6,631,048 (7.97%)	8,517,662 (10.23%)	3,749,243 (4.73%)	4,703,332 (5.93%)
	Q2	7,076,066 (7.98%)	9,037,532 (10.19%)	4,091,063 (4.87%)	5,409,576 (6.44%)
	Q3	9,046,966 (10.00%)	12,003,289 (13.27%)	3,874,150 (4.53%)	5,731,554 (6.70%)
	Q4	7,900,598 (9.30%)	10,184,887 (11.98%)	3,934,796 (4.85%)	5,323,233 (6.56%)

Compared to the 2018 IRP registration filings, the evaded tax revenue calculated from the corresponding WMT tax returns range from $22,624,574 to $29,650,071, which constitute 8.13 to 10.66 percent of the revenue already collected.

Estimating WMT evasion by comparing mileage reports to multiple data sources boosted our confidence in the estimates. We developed methods for comparing WMT returns to mileage estimates derived from ODOT screening data, IRP registration reporting, and IFTA returns. The ODOT screening data offers several advantages: 1) they are collected by ODOT rather data self-reported by carriers; 2) they were much easier to match with WMT returns than IRP or IFTA data; 3) they provide information on interstate and intrastate vehicle mileage; 4) they make it easier to determine whether a particular vehicle is subject to the tax (compared to IRP or IFTA). The biggest challenge associated with using ODOT screening data was that approximately 30 of carriers filing WMT returns had no screening data for estimating milage. Estimating evasion rates for these carriers will require additional investigation. Many of these carriers include a higher share of intrastate vehicles, which is expected because in-state operations are more likely to rely on local or state routes where there are no screening sites.

The IRP estimates have greater affinities with the WMT estimates than the IFTA estimates. However, given current data constraints, we cannot determine to what extent the disparity between WMT returns and IRP reports is due to differences in fleet composition and difficulty in matching reporting periods as opposed to actual WMT evasion. IFTA data matched more closely to WMT returns, as differences in carrier fleet composition are less pronounced and reporting periods line up more cleanly. The estimated evasion for IFTA is likely lower than WMT evasion on the whole because the data we have provide evidence of higher rates of evasion for carriers with intrastate vehicles than interstate vehicles. Nevertheless, both estimates are roughly similar to ODOT screening data estimates. Another element of the analysis that confirms the reliability of the WMT evasion estimates derived from screening data is the comparison of the data with actual audit data. The correlation between the audit data and evasion estimates were quite high, which is a good indicator an estimate is reliable.

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APPENDIX A. INSPECTIONS, CITATIONS, AND WARNINGS BY WEIGH STATION

Scale	Scale Name	Inspection	Citation	Warning	Total	Percentage
0101	Baker	3	4	14	21	0.01%
0201	Philomath	208	75	56	339	0.21%
0202	Blodgett EB	47	44	23	114	0.07%
0203	Blodgett WB	9	96	26	131	0.08%
0204	Adair	66	11	13	90	0.06%
0304	Rock Creek	427	176	256	859	0.54%
0307	Brightwood WB	227	30	27	284	0.18%
0308	Brightwood EB	166	53	50	269	0.17%
0403	Seaside	65	58	25	148	0.09%
0453	US101 South Rest Area Portable	0	1	1	2	0.00%
0503	Deer Island	12	12	14	38	0.02%
0504	Alston	0	29	11	40	0.03%
0551	Longview Fiber Mainline Jct. & OR47 Portable	0	1	0	1	0.00%
0602	Bandon	33	146	183	362	0.23%
0603	Myrtle Point	37	133	137	307	0.19%
0605	Coaledo	19	82	79	180	0.11%
0606	Hauser	91	149	169	409	0.26%
0701	Prineville	28	29	71	128	0.08%
0803	Rainbow Rock	11	23	32	66	0.04%
0804	Brookings	11	50	56	117	0.07%
0854	Port Orford	0	4	1	5	0.00%
0902	Sisters	73	165	423	661	0.42%
0905	Horse Ridge	20	10	20	50	0.03%
0906	Bend	1,357	292	548	2,197	1.39%
0957	Dry Canyon Portable	2	11	12	25	0.02%
1007	Booth Ranch SB	4,089	1,681	2,185	7,955	5.04%
1008	Booth Ranch NB	965	1,174	1,562	3,701	2.34%
1009	Brockway	35	239	344	618	0.39%
1011	Glide	7	172	240	419	0.27%
1012	Schofield Portable	0	6	10	16	0.01%
1058	Dodge Creek Portable	0	3	19	22	0.01%
1059	Brush Creek Portable	15	20	25	60	0.04%
1072	Glendale	8	47	79	134	0.08%
1101	Arlington	0	10	2	12	0.01%
1102	Arlington Portable	41	0	0	41	0.03%
1201	John Day	23	6	10	39	0.02%
1252	John Day Pull-Out Portable	0	1	1	2	0.00%

Scale	Scale Name	Inspection	Citation	Warning	Total	Percentage
1301	Burns	1	10	4	15	0.01%
1402	Wyeth	3,185	1,553	1,527	6,265	3.97%
1404	Cascade Locks POE	4,823	3,656	3,195	11,674	7.39%
1451	Hood River Portable	0	2	6	8	0.01%
1453	OR35 MP 88 Portable	0	2	2	4	0.00%
1504	Ashland NB99	24	67	29	120	0.08%
1506	Ashland SB	1,572	1,120	1,262	3,954	2.50%
1507	Ashland POE	3,270	3,511	4,123	10,904	6.91%
1509	Lake Creek	45	138	115	298	0.19%
1513	Sports Park	16	69	32	117	0.07%
1514	Eagle Point NB	13	11	6	30	0.02%
1515	Eagle Point SB	25	100	92	217	0.14%
1551	Sam's Valley Portable	26	42	27	95	0.06%
1603	Juniper Butte NB	1,035	313	568	1,916	1.21%
1604	Juniper Butte SB	2,086	643	1,355	4,084	2.59%
1703	Wilderville	16	105	70	191	0.12%
1704	Selma	19	35	22	76	0.05%
1752	Grants Pass Portable	8	3	6	17	0.01%
1805	Klamath Falls SB	1,335	747	1,278	3,360	2.13%
1807	Klamath Falls POE	3,890	1,096	3,430	8,416	5.33%
1811	Swan Lake	0	42	18	60	0.04%
1853	Lake of the Woods Portable	0	35	56	91	0.06%
1903	Silver Lake	0	5	1	6	0.00%
1904	Lakeview NB	8	19	14	41	0.03%
2002	Walterville	497	97	93	687	0.44%
2003	Cheshire Portable	8	7	9	24	0.02%
2005	Lowell	1,132	76	64	1,272	0.81%
2006	Noti	525	85	84	694	0.44%
2055	Long Tom Portable	7	2	1	10	0.01%
2103	Waldport	5	53	34	92	0.06%
2104	Siletz Portable	10	12	7	29	0.02%
2205	Foster	46	63	46	155	0.10%
2206	Scio	8	2	3	13	0.01%
2304	Vale	117	352	330	799	0.51%
2305	Olds Ferry	1,278	1,038	563	2,879	1.82%
2306	Farewell Bend POE	5,497	2,723	6,946	15,166	9.60%
2307	Burns Junction	318	342	142	802	0.51%
2308	Nyssa	8	42	3	53	0.03%

Scale	*Scale Name*	*Inspection*	*Citation*	*Warning*	*Total*	*Percentage*
2353	OR201 Portable	0	2	1	3	0.00%
2402	Hubbard SB	1,211	277	204	1,692	1.07%
2403	Gates	251	66	114	431	0.27%
2407	Hubbard NB	568	171	155	894	0.57%
2408	Woodburn NB	2,505	1,476	1,355	5,336	3.38%
2409	Woodburn POE	9,298	4,013	3,686	16,997	10.76%
2601	Rocky Point	1,043	717	455	2,215	1.40%
2701	Eola	1,253	134	117	1,504	0.95%
2704	Fort Hill	537	112	168	817	0.52%
2851	Moro SB Portable	43	11	10	64	0.04%
2903	Tillamook	39	28	19	86	0.05%
2904	Pleasant Valley	78	285	178	541	0.34%
3002	Pilot Rock	2	33	5	40	0.03%
3004	Cold Springs	323	1,824	714	2,861	1.81%
3005	Emigrant Hill	1,367	1,795	1,006	4,168	2.64%
3006	Umatilla POE	8,401	6,880	4,173	19,454	12.32%
3050	Umatilla County Portables	27	25	3	55	0.03%
3052	Hwy 11 Portable	72	47	25	144	0.09%
3053	OR207 Pull-Out Portable	32	19	19	70	0.04%
3103	La Grande	2,703	1,006	1,067	4,776	3.02%
3104	Elgin	14	14	1	29	0.02%
3203	Minam	84	23	3	110	0.07%
3252	Lostine EB Portable	0	1	0	1	0.00%
3402	North Plains	127	109	98	334	0.21%
3602	Dayton	607	117	70	794	0.50%
Total		69,533	42,446	45,933	157,912	100.00%

APPENDIX B. AVERAGE INTERSTATE TRIP MILES, INTRASTATE TRIP MILES, AND WEIGHTED SUM MILEAGE BY WEIGH STATION

Scale	*Scale Name*	*Interstate Trip Mileage*		*Intrastate Trip Mileage*		*Weighted Sum Mileage*
0101	Baker	123.04	(P)	121.67	(L)	121.67
0150	Baker County Portables	188.80	(P)	132.15	(P)	132.15
0151	Richland Portable Site	17.44	(P)	114.95	(P)	114.95
0201	Philomath	271.36	(M)	72.42	(M)	148.71
0202	Blodgett EB	271.36	(M)	79.63	(M)	202.40
0203	Blodgett WB	134.10	(L)	80.07	(M)	92.03
0204	Adair	210.59	(M)	157.44	(M)	184.01
0250	Benton County Portables	185.55	(P)	82.57	(P)	148.51
0304	Rock Creek	32.31	(M)	42.62	(M)	39.57
0307	Brightwood WB	143.73	(M)	127.65	(M)	135.07
0308	Brightwood EB	145.30	(M)	140.13	(M)	142.38
0350	Clackamas West County Portable	145.40	(P)	101.57	(P)	114.53
0403	Seaside	45.10	(M)	57.69	(M)	53.86
0450	Clatsop County Portables	104.32	(P)	102.28	(P)	102.90
0453	US101 South Rest Area Portable	119.75	(P)	82.10	(L)	82.10
0455	N/A	96.64	(P)	65.83	(P)	75.20
0456	N/A	93.37	(P)	34.55	(P)	52.43
0503	Deer Island	23.30	(M)	19.06	(L)	22.41
0504	Alston	47.50	(M)	60.90	(L)	49.17
0551	Longview Fiber Mainline Jct. & OR47 Portable Site	24.60	(L)	151.02	(P)	24.60
0602	Bandon	125.40	(M)	83.77	(M)	93.20
0603	Myrtle Point	143.10	(M)	72.12	(M)	80.90
0605	Coaledo	79.75	(L)	58.60	(M)	60.83
0606	Hauser	215.14	(M)	89.70	(M)	105.65
0607	Catching Slough Portable	41.99	(P)	77.91	(P)	74.12
0650	Coos County Portables	161.43	(P)	74.22	(P)	93.97
0701	Prineville	252.52	(M)	129.47	(M)	173.69
0750	Crook County Portables	169.13	(P)	122.74	(P)	139.42
0802	Brookings NB	101.22	(P)	59.31	(P)	97.99
0803	Rainbow Rock	26.72	(L)	82.85	(M)	59.89
0804	Brookings	7.45	(M)	78.61	(L)	12.92
0850	Curry County Portables	102.05	(P)	81.41	(P)	89.66
0854	Port Orford Portable	54.00	(L)	78.80	(L)	68.88
0902	Sisters	388.65	(M)	137.04	(M)	265.32
0905	Horse Ridge	306.55	(M)	188.79	(L)	287.71
0906	Bend	327.11	(M)	115.09	(M)	270.37

Scale	***Scale Name***	***Interstate Trip Mileage***		***Intrastate Trip Mileage***		***Weighted Sum Mileage***
0950	Deschutes County Portables	276.55	(P)	99.10	(P)	113.30
0957	Dry Canyon Portable	352.85	(L)	90.91	(L)	111.86
1007	Booth Ranch SB	302.11	(M)	133.10	(M)	252.14
1008	Booth Ranch NB	304.11	(M)	106.73	(M)	266.20
1009	Brockway	167.10	(M)	63.89	(M)	74.91
1011	Glide	147.31	(L)	75.28	(M)	79.75
1012	Schofield Portable	105.55	(L)	150.40	(L)	139.19
1057	Fair Oaks Portable	40.60	(P)	45.18	(P)	44.90
1058	Dodge Creek Portable	84.10	(L)	52.39	(L)	58.15
1059	Brush Creek Portable	253.67	(L)	111.23	(M)	146.84
1072	Glendale	83.55	(L)	50.66	(M)	56.55
1101	Arlington	71.40	(L)	81.28	(L)	76.34
1201	John Day	235.00	(L)	130.62	(L)	189.50
1251	Mount Vernon Portable	255.73	(P)	127.38	(P)	199.78
1252	John Day Pull-Out Portable	243.40	(L)	13.80	(L)	128.60
1301	Burns	307.00	(L)	187.90	(L)	299.06
1402	Wyeth	373.20	(M)	161.11	(M)	347.88
1404	Cascade Locks POE	371.42	(M)	156.88	(M)	337.23
1450	Hood River County Portables	154.67	(P)	124.25	(P)	131.85
1451	Hood River Portable	63.70	(L)	69.70	(L)	65.95
1452	OR35 & Odell Hwy Jct Portable	147.49	(P)	123.65	(P)	129.61
1453	OR35 MP 88 Portable	78.90	(L)	79.53	(L)	79.38
1454	OR35 MP 95 Portable	136.87	(P)	118.15	(P)	129.85
1456	N/A	124.03	(P)	119.47	(P)	123.31
1457	N/A	97.54	(P)	123.34	(P)	107.21
1504	Ashland NB99	302.06	(M)	19.38	(M)	231.39
1506	Ashland SB	302.11	(M)	98.08	(M)	296.69
1507	Ashland POE	304.67	(M)	59.01	(M)	300.00
1509	Lake Creek	100.25	(M)	96.13	(M)	97.39
1513	Sports Park	75.43	(M)	59.24	(M)	65.46
1514	Eagle Point NB	245.43	(L)	45.35	(L)	118.72
1515	Eagle Point SB	47.83	(M)	74.41	(M)	62.40
1550	Jackson County Portables	83.09	(P)	84.12	(P)	83.80
1551	Sam's Valley Portable	75.30	(L)	97.40	(M)	91.35
1571	Dead Indian Memorial County	212.99	(P)	42.86	(P)	209.76

Scale	Scale Name	Interstate Trip Mileage		Intrastate Trip Mileage		Weighted Sum Mileage
1574	Table Rock Road County Fixed	114.60	(P)	36.03	(P)	71.51
1575	Applegate Road County Fixed	0.00	(P)	38.19	(P)	22.47
1576	N/A	114.34	(P)	35.99	(P)	71.37
1580	Hanley Rd County Portables	126.95	(P)	61.89	(P)	91.27
1581	South Stage Rd County Portable	215.75	(P)	35.45	(P)	116.88
1603	Juniper Butte NB	304.38	(M)	125.71	(M)	248.80
1604	Juniper Butte SB	291.00	(M)	144.57	(M)	259.73
1703	Wilderville	69.91	(M)	75.54	(M)	73.03
1704	Selma	69.96	(L)	69.23	(M)	69.48
1750	Josephine County Portables	0.00	(P)	62.96	(P)	41.42
1751	O'Brien Portable	68.21	(P)	61.34	(P)	63.69
1752	Grants Pass Portable	293.45	(L)	89.70	(L)	173.60
1805	Klamath Falls SB	289.00	(M)	174.92	(M)	276.27
1806	N/A	190.50	(P)	167.71	(P)	187.96
1807	Klamath Falls POE	302.29	(M)	188.20	(M)	292.53
1811	Swan Lake	64.90	(L)	79.35	(M)	75.74
1850	Klamath County Portables	214.14	(P)	122.90	(P)	183.73
1852	Keno Portable	45.48	(P)	76.34	(P)	48.93
1853	Lake of the Woods Portable Site	214.20	(L)	209.36	(M)	210.58
1901	Lakeview EB/WB Portable	158.62	(P)	158.05	(P)	158.46
1903	Silver Lake	224.85	(L)	98.80	(L)	182.83
1904	Lakeview NB	252.35	(M)	161.94	(L)	228.09
1950	Lake County Portables	207.35	(P)	195.25	(P)	204.11
2002	Walterville	385.63	(M)	85.91	(M)	147.86
2003	Cheshire Portable	26.97	(L)	56.27	(L)	55.05
2005	Lowell	302.29	(M)	154.45	(M)	257.43
2006	Noti	187.01	(M)	71.40	(M)	89.72
2007	N/A	235.46	(P)	47.22	(P)	55.06
2008	N/A	235.46	(P)	47.22	(P)	55.06
2050	Lane County Portables	222.88	(P)	89.52	(P)	122.86
2051	Mapleton	222.76	(P)	89.84	(P)	123.07
2055	Long Tom Portable	86.36	(L)	71.42	(L)	74.41
2072	N/A	260.30	(P)	77.88	(P)	204.94
2073	N/A	216.77	(P)	45.14	(P)	164.69

Scale	Scale Name	Interstate Trip Mileage		Intrastate Trip Mileage		Weighted Sum Mileage
2074	N/A	321.57	(P)	46.48	(P)	103.34
2075	Clear Lake County MES	214.45	(P)	47.54	(P)	54.50
2103	Waldport	103.63	(L)	93.37	(M)	95.60
2104	Siletz Portable	14.49	(L)	33.83	(L)	33.16
2150	Lincoln County Portables	164.31	(P)	66.26	(P)	90.37
2205	Foster	117.00	(M)	81.12	(M)	93.16
2206	Scio	33.10	(L)	111.09	(L)	105.09
2304	Vale	251.12	(M)	133.59	(M)	239.21
2305	Olds Ferry	206.42	(M)	130.20	(M)	201.39
2306	Farewell Bend POE	211.50	(M)	210.79	(M)	211.49
2307	Burns Junction	121.29	(M)	298.58	(L)	121.95
2308	Nyssa	0.51	(M)	8.34	(L)	0.95
2350	Malheur County Portables	121.29	(P)	293.82	(P)	121.93
2353	OR201 Pull-Out Portable	78.10	(L)	23.19	(P)	78.10
2402	Hubbard SB	280.84	(M)	56.60	(M)	153.61
2403	Gates	351.54	(M)	123.68	(M)	185.01
2407	Hubbard NB	277.88	(M)	42.90	(M)	135.42
2408	Woodburn NB	302.29	(M)	97.59	(M)	247.93
2409	Woodburn POE	302.32	(M)	123.86	(M)	246.49
2413	Ehlen Road EB County	145.38	(P)	51.65	(P)	116.06
2414	Ehlen Road WB County	145.38	(P)	51.67	(P)	116.06
2450	Marion County Portables	75.72	(P)	61.15	(P)	71.85
2550	Morrow County Portables	124.80	(P)	103.77	(P)	116.69
2551	Boardman Rest Area	230.04	(P)	104.18	(P)	181.49
2552	Boardman Rest Area	230.04	(P)	104.18	(P)	181.49
2601	Rocky Point	53.30	(M)	40.40	(M)	45.48
2701	Eola	263.81	(M)	63.27	(M)	135.01
2704	Fort Hill	120.84	(M)	63.99	(M)	76.38
2750	Polk County Portables	91.16	(P)	77.83	(P)	84.49
2851	Moro SB Portable	320.62	(M)	175.64	(L)	288.91
2903	Tillamook	80.58	(M)	75.78	(M)	77.62
2904	Pleasant Valley	60.14	(M)	71.10	(M)	68.41
2950	Tillamook County Portables	135.84	(P)	65.27	(P)	92.35
3002	Pilot Rock	132.90	(L)	116.47	(L)	123.86
3003	N/A	94.09	(P)	120.58	(P)	95.22
3004	Cold Springs	53.90	(M)	67.83	(M)	54.50
3005	Emigrant Hill	212.63	(M)	134.31	(M)	207.37

Scale	***Scale Name***	***Interstate Trip Mileage***		***Intrastate Trip Mileage***		***Weighted Sum Mileage***
3006	Umatilla POE	206.97	(M)	129.70	(M)	206.53
3050	Umatilla County Portables	58.23	(M)	36.24	(L)	48.64
3051	Weston Portable	97.88	(P)	114.88	(P)	104.14
3052	Hwy 11 Portable	78.88	(M)	88.18	(M)	82.30
3053	OR207 Portable	246.51	(M)	140.55	(L)	205.64
3054	US730 EB Portable	115.51	(P)	93.78	(P)	106.03
3057	Pendleton 395 SB	166.35	(P)	94.83	(P)	127.01
3058	N/A	129.67	(P)	87.41	(P)	127.87
3103	La Grande	206.43	(M)	158.68	(M)	203.14
3104	*Elgin*	*97.08*	*(L)*	*149.01*	*(L)*	*116.78*
3150	Union County Portables	168.77	(P)	94.64	(P)	140.65
3203	Minam	97.09	(L)	63.40	(M)	72.28
3250	Wallowa County Portables	154.26	(P)	88.69	(P)	154.26
3251	Snow Hollow Portable	98.72	(P)	137.91	(P)	98.72
3252	Lostine EB Portable	116.30	(L)	88.94	(P)	116.30
3253	Lostine WB Portable	163.26	(P)	88.94	(P)	163.26
3350	Wasco County Portables	182.76	(P)	132.05	(P)	144.72
3352	The Dalles Bridge Portable	241.58	(P)	91.89	(P)	185.45
3402	North Plains	75.55	(M)	56.47	(M)	67.72
3450	Washington County Portables	105.88	(P)	47.02	(P)	81.74
3602	Dayton	61.62	(M)	54.76	(M)	57.07

(Note: "M' indicates that the average miles are estimated with equal to or more than 30 records and "L" indicates that the estimation is based on less than 30 records. "M" is from "More Certain" and "L" is from "Less Certain". If no records were available for a weigh station, geographically weighted regression method was used to predict the average trip miles. "P" is from "Predicted".)

APPENDIX C. REGRESSION STATISTICS

Regression Statistics	
Observations	97
F(5, 91)	46.01
Prob > F	0.0000
R-square	0.3427

	Coefficients	*Std Error*	*t stat*	*p-values*
Intercept	107.77	18.73	5.75	0.000
Truck AADT	0.02	0.00	4.88	0.000
Rural Minor Arterial	-57.92	24.63	-2.35	0.021
Rural Major Collector	-142.03	36.15	-3.93	0.000
Urban Minor Arterial	107.11	11.88	9.01	0.000
Distance to State Border	0.95	0.27	3.57	0.001

	VIF	*1/VIF*
Truck AADT	1.08	0.9253
Rural Minor Arterial	1.06	0.9438
Rural Major Collector	1.01	0.9871
Urban Minor Arterial	1.01	0.9916
Distance to State Border	1.03	0.9736

GWR Statistics	
Bandwidth	2.53
R-square	0.5534
R-square adjusted	0.4344

Scale	*Predicted*	*Coefficients*						*Local R^2*
		Intercept	**Truck AADT**	**Rural Minor Arterial**	**Rural Major Collector**	**Urban Minor Arterial**	**Distance to State Border**	
0101	123.04	108.50	0.01	-44.90	-136.83	98.60	1.53	0.49
0150	188.80	112.79	0.01	-46.78	-147.22	94.60	1.54	0.49
0151	17.44	107.52	0.01	-46.02	-132.55	100.10	1.50	0.49
0250	185.55	90.71	0.01	-68.95	-135.21	127.37	1.00	0.37
0350	145.40	114.74	0.01	-80.90	-146.12	119.91	1.11	0.40
0450	104.32	93.21	0.00	-69.29	-119.17	147.34	1.11	0.48
0453	119.75	87.86	0.01	-65.76	-118.49	147.07	1.06	0.45
0455	96.64	88.51	0.00	-65.80	-115.71	150.46	1.09	0.48

Scale	Predicted	Coefficients						Local R^2
0456	93.37	89.57	0.00	-66.59	-116.28	150.00	1.09	0.48
0607	41.99	68.98	0.02	-54.86	-130.40	132.19	1.00	0.38
0650	161.43	63.26	0.02	-51.21	-128.17	134.99	1.00	0.39
0750	169.13	134.35	0.01	-76.92	-172.14	92.13	1.19	0.35
0802	101.22	52.18	0.03	-42.45	-130.72	134.52	1.05	0.41
0850	102.05	53.63	0.02	-44.51	-128.19	136.51	1.04	0.41
0950	276.55	131.27	0.01	-80.35	-171.13	93.78	1.14	0.34
1057	40.60	88.78	0.02	-66.85	-144.76	117.33	1.00	0.34
1251	255.73	121.11	0.01	-48.94	-159.06	90.55	1.49	0.45
1450	154.67	127.20	0.00	-78.13	-153.98	111.18	1.19	0.41
1452	147.49	127.12	0.00	-77.42	-152.91	112.09	1.20	0.42
1454	136.87	127.12	0.00	-75.96	-151.22	113.36	1.22	0.43
1456	124.03	122.52	0.00	-78.48	-147.07	118.73	1.19	0.43
1457	97.54	127.17	0.00	-74.91	-150.25	113.98	1.23	0.43
1550	83.09	92.00	0.02	-66.10	-155.63	107.86	1.04	0.33
1571	212.99	85.82	0.02	-60.83	-155.79	108.86	1.05	0.34
1574	114.60	83.58	0.02	-61.01	-151.22	112.59	1.04	0.35
1575	-72.78	72.82	0.02	-53.60	-146.56	118.09	1.05	0.37
1576	114.34	83.57	0.02	-60.99	-151.25	112.57	1.04	0.35
1580	126.95	81.68	0.02	-59.67	-150.57	113.42	1.04	0.35
1581	215.75	81.55	0.02	-59.36	-151.02	113.11	1.04	0.35
1750	-60.34	67.80	0.02	-51.59	-141.20	123.12	1.04	0.38
1751	68.21	61.20	0.03	-47.39	-137.53	127.26	1.05	0.39
1806	190.50	106.78	0.02	-70.59	-170.94	94.35	1.07	0.31
1850	214.14	114.58	0.02	-76.45	-169.80	94.29	1.06	0.31
1852	45.48	100.17	0.02	-66.53	-168.64	97.22	1.07	0.32
1901	158.62	133.19	0.02	-72.28	-197.35	72.75	1.17	0.31
1950	207.35	136.93	0.01	-72.08	-193.87	74.03	1.23	0.34
2008	235.46	95.80	0.01	-71.82	-143.19	119.14	1.00	0.35
2008	235.46	95.80	0.01	-71.82	-143.19	119.14	1.00	0.35
2050	222.88	79.09	0.02	-61.34	-130.96	131.04	0.98	0.37
2051	222.76	80.39	0.02	-62.21	-131.87	130.11	0.98	0.37
2072	260.30	95.58	0.02	-71.31	-145.89	116.27	1.00	0.34
2073	216.77	105.09	0.01	-76.45	-151.52	111.32	1.02	0.34
2074	321.57	99.95	0.01	-74.15	-146.04	116.56	1.01	0.35
2075	214.45	94.70	0.01	-71.24	-141.84	120.48	1.00	0.35
2150	164.31	87.42	0.01	-66.44	-126.87	136.67	1.01	0.40

Scale	***Predicted***	***Coefficients***						***Local R^2***
2413	145.38	106.62	0.01	-78.15	-139.33	126.31	1.08	0.40
2414	145.38	106.72	0.01	-78.20	-139.41	126.23	1.08	0.40
2450	75.72	107.18	0.01	-78.49	-141.91	123.26	1.07	0.39
2550	124.80	123.20	0.01	-45.50	-149.48	97.09	1.45	0.43
2551	230.04	122.89	0.01	-43.47	-144.16	100.50	1.45	0.43
2551	230.04	122.89	0.01	-43.47	-144.16	100.50	1.45	0.43
2750	91.16	95.79	0.01	-72.22	-135.01	128.71	1.02	0.38
2950	135.84	87.83	0.01	-66.08	-121.00	144.01	1.04	0.44
3003	94.09	111.95	0.01	-32.95	-132.86	102.42	1.55	0.43
3051	97.88	100.40	0.01	-27.99	-120.96	106.32	1.62	0.45
3054	115.51	115.78	0.01	-35.98	-136.56	101.62	1.52	0.43
3057	166.35	109.04	0.01	-33.56	-133.97	101.22	1.58	0.44
3058	129.67	114.00	0.01	-35.21	-136.35	101.15	1.54	0.43
3150	168.77	100.61	0.01	-32.64	-122.23	105.48	1.59	0.46
3250	154.26	99.31	0.01	-35.25	-117.04	107.70	1.54	0.47
3251	98.72	98.40	0.01	-35.56	-87.53	109.83	1.51	0.46
3253	163.26	100.16	0.01	-37.13	-117.70	107.30	1.53	0.47
3350	182.76	128.36	0.00	-79.68	-158.78	106.50	1.17	0.39
3352	241.58	130.61	0.00	-71.05	-154.17	108.12	1.25	0.43
3450	105.88	104.79	0.00	-77.05	-135.03	131.11	1.09	0.42