Cap-and-Invest Issue Paper

Oregon Highway Cost Allocation Study

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Introduction

Purpose of Issue Paper

The combustion of fossil fuels for transportation, electricity generation, and interior heating releases carbon dioxide and other greenhouse gases into the atmosphere. The accumulation of these gases over the past decades has resulted in, and will continue to contribute to, global climate change.

In the absence of comprehensive policy at the national level, individual states and provinces in the United States and Canada have begun to pursue sub-national carbon mitigation policies. California, British Columbia, Ontario, and Quebec have all introduced market-based climate change policies.

"Cap-and-Trade" has often been used interchangeably with "Cap-and-Invest" in the last few years. Cap-and-Trade in its purest form is a system of capping emissions and allocating limited allowances to the firms that emit pollution. Those private firms will start trading allowances freely on an exchange. Under that version of the Cap-and-Trade system, there are no government revenues and no impact on the State Highway Trust Fund will result.

However, if the government auctions the permits, it modifies the original system by generating revenue for the government. The government collections from the price on allowances used to cover the emissions from the combustion of transportation fuels becomes a source of revenue for the State Highway Trust Fund. The Oregon State Legislature considered, but did not pass, such a system in the 2018 session that would institute a Cap-and-trade program that places a price on carbon by requiring emitters of greenhouse gases to purchase a permit from the state for each metric ton of carbon-equivalent emitted. The revenue from the sale of these permits would be directed into investments in clean energy, carbon-reducing transportation projects, and transition assistance for low-income households. Thus, the government revenues were committed to a concept of "investment." The new system was termed "Cap-and-Invest." This term will be used in this paper to describe a system by which the government auctions emissions allowances and invests the revenue in various programs, including but not limited to transportation projects.

This report will examine the impact that a Cap-and-Invest (C&I) program will have on Oregon's Highway Cost Allocation Study (HCAS). Oregon's HCAS is a biennial study of highway cost responsibility between light vehicles (cars) and heavy vehicles (heavy trucks). Light vehicles pay for roads via registration fees and fuel taxes while heavy vehicles pay for roads via registration fees and a weight-mile tax. Under C&I, light vehicles will indirectly pay for permits to cover emissions from the combustion of gasoline and diesel and heavy vehicles will pay for permits to cover emissions from the burning of diesel fuel. Those funds will then be spent on highway transportation projects.

To understand how a C&I policy would impact the allocation of cost responsibility, we revisit the 2017 HCAS and simulate the cost allocation assuming that a C&I program was recently passed. We assume that the cost of tradable permits that would be purchased by fuel distributors is passed on to vehicle operators as a per-gallon excise tax. Our analysis is a short-run simulation, which does not allow for any behavioral response to the higher fuel costs.

Background

The interaction of any carbon-based climate policy in Oregon and the Oregon Constitution needs to be carefully accounted for. Section 3a of Article IX of the Oregon Constitution requires that all revenue from taxes and fees levied on motor vehicle fuels be spent on "…construction, reconstruction, improvement, repair, maintenance, operation and use of public highways, roads, streets and roadside rest areas…" It is likely that monies spent on carbon permits that are required for the combustion of motor vehicles fuels will be subject to this requirement.

This same section of the Oregon Constitution requires the legislature to commission a study to determine whether the revenues paid by light vehicles and heavy vehicles are spent in proportion to the cost responsibility of those groups, otherwise known as the Highway Cost Allocation Study. If C&I generates a new source of revenue from vehicles, and that source of revenue is not in proportion to the cost responsibility of the different vehicle classes, the legislature would be compelled to adjust sources of revenue to ensure equity between cost and revenue allocations.

We assume that readers are familiar with Oregon's Highway Cost Allocation Studies. The 2017 Highway Cost Allocation Study contains summaries and detailed descriptions of how ECONorthwest, under the guidance of the Study Review Team, conducts the analysis. The report is also a repository of information on the varied sources of data that we use as inputs.

Modeling Cap-and-invest in HCAS

The goal of this issue paper is to understand whether Cap-and-invest is likely to change the distribution between heavy and light vehicles' cost responsibility and how a Cap-and-Invest program would impact the execution of the Highway Cost Allocation Study. We examine each of these issues in turn. In this section, we will detail the assumptions we need to make in the modeling of a C&I program in Oregon and how that translates into the HCAS model. In a subsequent section, we will use this experience to identify weaknesses in our current stable of data and recommend some changes various state agencies might need to make in order to successfully complete the HCAS under a C&I regime.

Assumptions about Cap-and-invest in Oregon

To model a C&I program's impact on HCAS, we need to make certain assumptions about the parameters and operation of the program. First, we assume that every gallon of gasoline and every gallon of diesel fuel purchased in the state of Oregon for use as transportation fuel will be covered by an emission permit. We further assume that all permits that are retired for the purpose of covering transportation fuel emissions are purchased directly from the State of Oregon and there is 100% compliance.[1]

Second, we assume that fuel distributors and retailers will be able to pass on to consumers the added cost from permit fees needed to cover emissions from the combustion of transportation fuels. This assumption is likely to hold in the near term as demand for transportation fuels is relatively inelastic in the short run. Our results will then implicitly assume that drivers do not respond to the higher prices during the study period, which means VMT is unchanged.

Third, we will assume that there would be the same rate of avoidance with the program as there was without the program. Oregon's HCAS implicitly assumes that a certain percentage of miles are traveled on Oregon roads with fuel purchased out of state. If Oregon were to pass C&I, this would likely continue.

Translating Cap-and-invest into HCAS

To translate a hypothetical C&I program into the HCAS, we need to develop two related frameworks. First, we need to build a way to allocate the revenue that would be collected from permits sold for emissions from gasoline and diesel

[1] This assumption guarantees that all revenue attributable to the combustion of transportation fuels will end up in the State Highway Trust Fund. We further assume that funds used by fuel distributors to purchase permits on the secondary market from non-state entities would not be subject to deposit into the State Highway Trust Fund.

combustion that propels light vehicles and the revenue that would be collected from the combustion of diesel fuel to propel heavy vehicles. Second, we need a method to allocate the expenditures funded by these new revenues.

Allocating Revenues

We assume that the additional cost of importing fuels into Oregon will be passed on completely to purchasers of gasoline and diesel, in proportion to their carbon content. Specifically, we model the cost pass-through from a cap-and-invest program as an excise tax on gasoline and diesel fuel.[2] The relationship can be expressed with the following equation:

$$TPG_t = PP * CC_t$$

In words, the excise tax per gallon (TPG) of fuel type t (gasoline or diesel) is equal to the permit price (PP) for one ton of carbon times the carbon content (CC) of one gallon of fuel type t. The U.S. Energy Information Agency assumes that a gallon of gasoline produces 18.9 pounds of CO2 when combusted.[3] Since there are 2204.6 pounds per metric ton, that means one gallon of gasoline generates 0.009 metric tons of CO2, so $CC_{gas} = 0.009$. Then, if for example the permit price is \$10, that means that the excise tax per gallon of gasoline, TPG_{gas} , would be \$0.09. Each assumed carbon market price will lead to a separate effective excise tax for gasoline and diesel inside the HCAS model.

		Effective Excise Tax	
Fuel Type	**Carbon per Gallon**	**\$10 Permit Price**	**\$20 Permit Price**
Gasoline	0.009 tons	\$ 0.09	\$0.18
Diesel	0.010 tons	\$ 0.10	\$0.20

Table 1: Carbon Content and Effective Excise Tax Level by Fuel Type

For weight classes over 26,000 pounds, we assume that only diesel fuel will be used and apply the diesel-based rate. For the other weight classes, we calculate an effective excise tax as a weighted average between the diesel and gasoline excise taxes, where the weights are estimated from the distribution of gallons of gasoline and diesel used within each weight class. The HCAS model will then calculate total revenue "received" from each weight class from the C&I program.

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[2] Our use of "excise tax" when referring to the increased cost from C&I is a choice we made to translate the government-imposed price into the model. We are not taking a position on the categorization of C&I as a tax.

[3] https://www.eia.gov/tools/faqs/faq.php?id=307&t=11. EIA assumes 18.9 lbs per gallon for gasoline and 22.4 lbs for diesel fuel.

Modeling the additional cost as an excise tax is different than modeling the additional cost as a higher fuel tax rate. The current system of fuel taxes allows for exemptions. For example, payers of the weight-mile tax are exempt from the current fuel use tax (diesel tax). Within the context of our HCAS model, an excise tax is applied to all users, regardless of exemption status for existing fuel taxes.

Ultimately, the equity ratio that is paid most attention to is calculated only for full-fee paying vehicles. However, since we are assuming that there are no exemptions to the carbon fee passthrough, there will be funds that are deposited into the State Highway Trust Fund that are attributable to alternative fee and exempt vehicles. This does not impact the calculation of full-fee equity ratios, but our report of the revenue that is generated by full-fee vehicles will be understated relative to the actual amount that is collected.

This modeling choice is consistent with our assumed operation of the C&I program. Specifically, we assume that the permit cost will increase the cost of doing business for fuel suppliers and filter down to users of transportation fuels via higher retail prices. There would be no statutory tax that various end users could be exempted from.

Allocating Costs

The second main task is to allocate the funds raised from the sale of permits related to transportation fuels from a C&I program. Generally speaking, we need a spending scenario which dictates how the hypothetical permit revenues *would have been spent* if the C&I program existed. To implement any policy scenario, we need to create a set of percentages, which sum to one, that describe how funds will be spread across project types. After adding funds to specific project types, the HCAS model will automatically allocate these costs to the appropriate class of vehicles.

This is the most uncertain part of the exercise because it is not clear whether any conditions would be placed on the expenditure of the permit revenue and how the funds would be spread across various potential projects. We will explore three separate scenarios of how funds could have been expended: status-quo, aggressive greenhouse gas reduction, and climate adaptation. We will not entertain any new types of transportation investment, rather, we will consider existing project types. We will detail each of these scenarios later in this report. It must be stressed that our scenarios are speculative and should not be construed to be a suggestion or indication of future transportation spending and policy.

In the appendix to this report, we provide some context and information about the various project types that are traditionally funded. Additionally, we discuss the various allocators that are assigned to each project or "work-type." Allocators tell us how to assign costs between vehicles in different weight classes.

Use of 2017-2019 Biennium

It is informative to use a demonstration to examine how C&I would impact highway cost allocation. Since we conducted the 2017-2019 Oregon HCAS, we can readily use this period as a test case for determining how a hypothetical C&I program would have impacted highway cost allocation *if it had been operational.* Throughout this report, we will be utilizing actual and forecast data that was used to complete the 2017-2019 HCAS. We assume that the observed behavior of drivers of all types of vehicles *would not have changed* in response to higher fuel prices. This assumption is not a strong one since the demand for transportation fuels is very inelastic in the short run. Moreover, this assumption is mainly relevant to the level of revenues that we estimate will result from the C&I program, but likely not relevant to our conclusions of how revenue mechanisms will need to change in order to maintain equity.

Using the 2017-2019 HCAS as a starting point provides many benefits. First, we will learn about the shortcomings that might exist in our current data sources which lead to difficulties in estimating revenue attribution and cost responsibility. Second, it grounds the discussion of the impact of a C&I program in real-world conditions. This report is not a full economic analysis of the prospective trading program, but our results are not generated from left-field. Our estimates are meant to be informative of the general trends in the highway funding system and are not meant to be an authoritative final estimate.

Modeling Cost Scenarios

Overview of Scenario Modeling

There are many details of the Cap-and-invest program that would only be resolved once it is implemented. This uncertainty translates into our modeling and results. The actual price of carbon permits in the future cannot be known with certainty. Furthermore, the final distribution of revenues from the State Highway Fund could be done in several different ways.

To deal with this uncertainty, we have modeled several different "cost" and "revenue" scenarios. The various cost scenarios will each expend permit revenues differently, potentially impacting the cost responsibility for heavy and light vehicles in different ways. The revenue scenarios are designed to cover the range in potential permit prices that might result.

Cost Scenarios

We consulted with the Oregon Department of Transportation (ODOT) to create cost scenarios for the allocation of funds. We were provided six hypothetical scenarios and arrived at three scenarios for this issue paper: "Business as Usual," "GHG Reduction," and "Climate Adaptation."[4] ODOT's scenarios were based on analysis in the Statewide Transportation Strategy (STS) which identified strategies for reducing GHG emissions.[5]

It should be noted that ODOT's input was only for the purpose of informing the decisions of the Study Review Team and is not a prediction or commitment of how any carbon allowance money would be spent. It is not possible to know exactly how this money would be spent. The point of the scenarios is to guide our modeling choices in the direction of feasible and permissible investments and to determine whether the unknown future spending choices can be expected to impact equity ratios.

In reality there are an uncountable number of ways the money can be spent but we have chosen these three in order to provide some sensitivity analysis. In the analysis ODOT provided, they were clear that the scenarios provided were not

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[4] See *Illustrative Investment Scenarios; HCAS Cap and Invest Issue Paper*, ODOT 9/2018, Technical Report.

[5] See Oregon Department of Transportation (2013), *Oregon Statewide Transportation Strategy, A 2050 Vision for Greenhouse Gas Emissions Reduction*, Volume 1. https://www.oregon.gov/ODOT/Programs/Pages/OSTI.aspx

the “right” or “only” way to spend the revenue but are a solid basis for understanding how revenue “could” be spent.

We note that some members of the Study Review Team believe capacity expansion could reduce GHG emissions and should therefore be included in the “GHG Reduction” scenario. The ODOT STS does not consider capacity expansion to provide net reductions in GHG emissions and therefore the “GHG Reduction” and “Climate Adaption” scenarios do not allocate any of the carbon allowance dollars towards new capacity.

From a technical perspective, the exercise is analogous to the creation of a set of anonymous, hypothetical projects and assigning them to the appropriate work-type in the HCAS model. A cost scenario is simply an allocation protocol for a given amount of money across these hypothetical projects. For example, if a cost scenario calls for allocating 20% of permit revenues to culvert maintenance and repair, we calculate the dollar value that is equal to 20% of revenues, create a new project with that amount of money, and assign the appropriate work-type.

Business as Usual

The “Business as Usual” (BAU) scenario assumes that any new revenue that arrives will be distributed in the same proportion as we observed in the previous biennial study. We include this scenario as a baseline of how ODOT would likely spend additional funds without strings attached. It will inform the impact of the restriction on how funds are to be spent.

GHG Reduction

The “GHG Reduction” (GHG) scenario is geared towards transportation expenditures that are meant to reduce the emissions of harmful greenhouse gasses within the transportation system. Importantly, this scenario is limited to project types that are currently eligible for State Highway Trust Fund money.

Investment	Total Weight
Auxiliary lanes for speed smoothing and reduced delay	21.0%
Public transportation on-road infrastructure	15.0%
On-road biking and walking accessible connections to schools, jobs, downtowns, and shopping centers	15.0%
Carpool-only lanes	12.0%
Park-and-ride facilities	12.0%
Transit signal priority	6.0%
Infrastructure supporting per-mile road charges or value pricing	5.0%
Variable speed limits	3.5%
Traveler information	3.5%
Signal Timing and Ramp Metering	3.5%
Safety improvements to Reduce Intermittent Delay	3.5%

Table 2: GHG Reduction Scenario

Table 2 details the GHG Reduction scenario investments. ODOT provided spending allocations at a general level and the SRT allocated them to the investment types listed. [6] Investments that will reduce GHG emissions include expenditures on transit related facilities, bike and pedestrian centered projects, and traffic control and mitigation technologies.

Climate Adaptation

The "Climate Adaptation" (ADAPT) scenario is meant to mimic a strategy of allocating allowance revenues to projects dedicated to the mitigation of and adaptation to the effects of extreme precipitation events that may result from climate change. Extreme precipitation can lead to flooding, inundation, scour, and additional need for snow and ice removal. Like the GHG Reduction scenario, projects in this scenario are limited to those that are currently eligible for State Highway Trust funds.[7]

Investment	Total Weight
Culvert maintenance, repair and replacement	35.0%
Planting and managing vegetation to stabilize slopes and sequester carbon	20.0%
Stabilizing slopes to prevent or lessen the severity of landslides	20.0%
Vegetation management such as clearing out underbrush	8.0%
Bridge work for areas at risk of flooding, higher sea levels, and seismic danger	5.0%
Recycled asphalt for road maintenance and repair	4.0%
Stormwater runoff and management	4.0%
Snow/Ice Removal	4.0%

Table 3: Climate Mitigation Scenario

Revenue Scenarios

The amount of revenue that flows into the State Highway Fund will depend on the price of carbon allowances. We assume the revenue that is attributable to motor vehicles will be in direct proportion to the carbon content of the fuels used. For relatively high allowance prices, vehicles would indirectly be generating higher amounts of revenue.

Since we do not know the future price of carbon permits, we examine two scenarios: $10 and $20. Permits on the Western Climate Initiative exchange have recently traded around $15 so the choice of $10 and $20 as lower and upper bounds provides plausible bookend scenarios.

VMT Distribution

The operative assumption of this analysis is that the cost that fuel suppliers incur by having to purchase allowances will be passed on to fuel consumers in direct

[6] SRT is not endorsing, projecting, or recommending that any projects be funded or not funded from any real or potential expenditure plan. This scenario is for illustrative purposes only and there is no guarantee that there will be enough projects to actually expend all of the funds in that particular project category.

[7] The above disclaimer applies again.

proportion to the average carbon content of the fuel. In effect, we assume the Cap-and-invest program will act as if there were an excise tax on each gallon of fuel. The amount of revenue collected from each weight class will be a function of the amount of fuel consumed by each weight class. The fuel consumed by each weight class will be related to the VMT of each weight class.

Declared Weight			VMT	Percent of Total
1	to	10,000	35,133,836,928	92.63%
10,001	to	26,000	726,085,169	1.91%
26,001	to	78,000	282,237,183	0.74%
78,001	to	80,000	1,256,641,522	3.31%
80,001	to	104,000	246,158,186	0.65%
104,001	to	105,500	282,426,079	0.74%
105,501	and	up	3,308,161	0.01%
Total			37,930,693,228	
10,001	and	up	2,796,856,301	7.37%
26,001	to	80,000	1,538,878,705	4.06%
80,001	to	105,500	528,584,265	1.39%
26,001	to	105,500	2,067,462,971	5.45%
26,001	and	up	2,070,771,132	5.46%

Table 4: 2017-2019 Annual VMT by Weight Class for Full-Fee Vehicles

Table 4 reports the VMT estimation results from the 2017-2019 Oregon HCAS. Light vehicles, those under 10,000 pounds, account for 92.63% of the VMT in the state. Conversely, only 7.37% of the VMT in the state are attributed to vehicles over 10,000 pounds.

Declared Weight			Avg. MPG
1	to	10,000	19.1
10,001	to	26,000	11.8
26,001	to	78,000	6.5
78,001	to	80,000	5.5
80,001	to	104,000	5.3
104,001	to	105,500	5.1
105,501	and	up	4.7
Total			
10,001	and	up	7.2
26,001	to	80,000	5.7
80,001	to	105,500	5.7
26,001	to	105,500	5.6
26,001	and	up	5.6

Table 5: Model Fuel Efficiency by Weight Class

Table 5 displays the fuel efficiency assumed by the HCAS model by weight class. While heavy vehicles have lower miles per gallon which leads to more fuel consumption, the overwhelming imbalance in VMT indicates that the revenue attribution will tilt towards light vehicles as they pay a greater share of the Cap-and-invest allowance pass-through.

Declared Weight			Gallons Consumed
1	to	10,000	1,864,282,855
10,001	to	26,000	69,281,440
26,001	to	78,000	49,936,133
78,001	to	80,000	228,683,737
80,001	to	104,000	47,108,666
104,001	to	105,500	56,638,011
105,501	and	up	713,381
	Total		2,316,644,224
10,001	and	up	452,361,368
26,001	to	80,000	278,619,870
80,001	to	105,500	103,746,677
26,001	to	105,500	382,366,547
26,001	and	up	383,079,928

Table 6: Fuel Consumption by Weight Class

Table 6 confirms this intuition. Here we've tabulated the gallons of fuel (gasoline and diesel combined) by weight class. While the carbon content of diesel is higher, and heavy vehicles use disproportionately more diesel than gasoline, the total balance of fuel use is skewed towards light vehicles. Accordingly, we would expect light vehicles to have a larger share of revenue attribution from the carbon allowance fees.

Results

Overview of Results

The results of our simulations come in many forms and we will present them in turn. First, we will discuss how the revenue is attributed to vehicles of various weight classes under the two revenue scenarios. Second, we will look at how the three cost allocation scenarios take the expenditure of those revenues and allocate them across weight classes. Third, we will examine how the combination of these factors impact the equity ratio calculations. Finally, we will discuss what changes to fuel and weight-mile taxes could be used to restore balance to equity ratios.

Revenue Type	2017 Results	$10 Permit	$20 Permit
Total Revenue	$1,173,087,853	$1,382,035,116	$1,590,982,378
Full-Fee User Revenue	$1,173,087,853	$1,173,087,853	$1,173,087,853
Revenue from Carbon Allowances	$0	$208,947,263	$417,894,525

Table 7: Revenue by Weight Class

Table 7 tabulates the total amount of user fees collected by weight class under the various scenarios. Our previous study for the 2017-2019 biennium estimated that there were approximately $1.2 billion in fees collected from light and heavy vehicles. If the market for carbon allowances reached an equilibrium price of $10, the allowance revenue collected from full-fee paying vehicles would reach $209 million. At a carbon price of $20, the total revenue would total $418 million.

				Annual Full Fee Cost Responsibility					
			Permit Revenue	$10 Permit			$20 Permit		
Declared Weight			Allocation	BAU	GHG	ADAPT	BAU	GHG	ADAPT
1	to	10,000	79.3%	67.2%	96.3%	85.6%	67.2%	96.3%	85.5%
10,001	to	26,000	2.8%	4.2%	0.8%	2.6%	4.2%	0.8%	2.6%
26,001	to	78,000	2.1%	3.5%	0.4%	1.3%	3.5%	0.4%	1.3%
78,001	to	80,000	10.8%	15.1%	1.8%	6.8%	15.1%	1.8%	6.8%
80,001	to	104,000	2.2%	4.0%	0.3%	1.6%	4.0%	0.3%	1.6%
104,001	to	105,500	2.6%	5.7%	0.4%	2.0%	5.7%	0.4%	2.0%
105,501	and	up	0.0%	0.4%	0.0%	0.1%	0.4%	0.0%	0.1%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
10,001	and	up	20.7%	32.8%	3.7%	14.4%	32.8%	3.7%	14.5%
26,001	to	80,000	12.9%	18.6%	2.2%	8.1%	18.6%	2.2%	8.1%
80,001	to	105,500	4.9%	9.7%	0.7%	3.7%	9.7%	0.7%	3.7%
26,001	to	105,500	17.8%	28.3%	2.9%	11.7%	28.3%	3.0%	11.8%
26,001	and	up	17.8%	28.6%	2.9%	11.9%	28.6%	2.9%	11.9%

Table 8: Revenue Attribution and Cost Allocation of Only Carbon Allowance Revenue

To help understand how the overall results will be affected by the introduction of the permit revenue and associated expenditures, it's helpful to understand the distribution of responsibility of the new funds in isolation. Table 8 displays the revenue attribution and the cost responsibility for *only the carbon allowance revenue.*

The money derived from carbon allowances is roughly 80% attributed to light vehicles and 20% to heavy vehicles. By comparison, the Business as Usual scenario expends those new funds at a ratio of roughly 67% to light vehicles and 33% to heavy vehicles. This suggests that light vehicles equity ratios will increase relative to the 2017-2019 study. Conversely, for the GHG and ADAPT scenarios, the cost responsibility for light vehicles is a higher ratio than the revenue attribution. We would expect the equity ratios for light vehicles to fall in these scenarios.

Revenue Attribution Results

We begin with the results of revenue attribution. Table 9 displays the allocation of user fees by weight class for three scenarios: 2017-2019 study results, $10 carbon allowance price, and $20 carbon allowance price. The 2017-2019 results can also be thought of as a scenario where the carbon permit price is $0.

Declared Weight			Annual Full-Fee User Fees		
			2017 Results	$10 Permit	$20 Permit
1	to	10,000	64.5%	66.7%	68.4%
10,001	to	26,000	4.7%	4.4%	4.2%
26,001	to	78,000	2.6%	2.5%	2.5%
78,001	to	80,000	19.6%	18.2%	17.3%
80,001	to	104,000	3.8%	3.6%	3.4%
104,001	to	105,500	4.6%	4.3%	4.1%
105,501	and	up	0.2%	0.2%	0.2%
Total			100.0%	100.0%	100.0%
10,001	and	up	35.5%	33.3%	31.6%
26,001	to	80,000	22.2%	20.8%	19.7%
80,001	to	105,500	8.4%	7.9%	7.5%
26,001	to	105,500	30.6%	28.7%	27.2%
26,001	and	up	30.8%	28.8%	27.4%

Table 9: Revenue Attribution by Weight Class

A key effect of a carbon allowance price visible in these results is that as the carbon price increases from $0 to $20, the revenue attribution for light vehicle increases while the attribution for heavy vehicles falls. In the 2017-2019 biennium, light vehicles were supplying 64.5% of full-fee revenues. That amount increases to 66.7% with a $10 carbon allowance price and 68.4% with a $20 carbon allowance price. Within the heavy vehicle class, the *relative* revenue attribution does not vary materially across heavy vehicle weight classes.

Cost Allocation Results

The results of the cost allocation exercise depend on the permit price and the cost scenario. With two carbon allowance prices and three cost allocation scenarios, we have six sets of cost allocation results.

Declared Weight			2017 Results	$10 Permit BAU	$10 Permit GHG	$10 Permit ADAPT	$20 Permit BAU	$20 Permit GHG	$20 Permit ADAPT
				Annual Full Fee Cost Responsibility					
1	to	10,000	64.0%	64.3%	67.6%	66.4%	64.6%	70.6%	68.3%
10,001	to	26,000	4.3%	4.3%	3.9%	4.1%	4.3%	3.6%	4.0%
26,001	to	78,000	3.4%	3.4%	3.1%	3.2%	3.4%	2.8%	3.0%
78,001	to	80,000	16.2%	16.1%	14.6%	15.1%	16.0%	13.3%	14.3%
80,001	to	104,000	5.0%	4.9%	4.5%	4.7%	4.8%	4.1%	4.4%
104,001	to	105,500	6.4%	6.4%	5.8%	5.9%	6.3%	5.2%	5.5%
105,501	and	up	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%
Total			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
10,001	and	up	36.0%	35.7%	32.4%	33.6%	35.4%	29.4%	31.7%
26,001	to	80,000	19.6%	19.5%	17.6%	18.3%	19.4%	16.1%	17.3%
80,001	to	105,500	11.5%	11.3%	10.3%	10.6%	11.1%	9.3%	9.9%
26,001	to	105,500	31.1%	30.8%	27.9%	28.9%	30.5%	25.4%	27.2%
26,001	and	up	31.7%	31.4%	28.5%	29.5%	31.1%	25.9%	27.7%

Table 10: Cost Allocation Results

Table 10 displays the cost responsibility ratios for each of the six scenarios as well as the 2017-2019 biennium results. First, it should be noted that the BAU cost responsibility is essentially identical to that of the 2017-2019 results. This outcome is not surprising; the BAU case is specifically constructed to mimic the 2017-2019 biennium.[8]

Focusing on the $10 carbon allowance price, the results reveal that both the GHG and ADAPT scenarios provide higher cost responsibility to light vehicles compared to the BAU case. Between the two, the GHG scenario is relatively more weighted towards light vehicle cost responsibility than the ADAPT scenario. These relative patterns are repeated within the $20 carbon allowance price scenario.

When comparing the $10 carbon allowance price results to the $20 carbon allowance price results, Table 10 reveals that the higher carbon allowance price leads to more cost responsibility on light vehicles in both the GHG and ADAPT scenarios. If both the GHG and ADAPT scenarios tilt cost responsibility towards light vehicles when the price is $10, this means that the new revenue is being allocated more towards light vehicles *relative* to the BAU case. When the permit

[8] One reason that the allocations aren't exactly the same is that the revenue that we push through the model is only from state and local sources, not federal sources. This distorts the cost responsibility slightly relative to the 2017-2019 actuals.

price is $20 this effect is twice as strong.

Equity Ratio Results

Ultimately, HCAS is concerned with the relative balance of the ratios of cost responsibility and revenue attribution between light and heavy vehicles.[9] The main result from any Oregon HCAS is the equity ratio between light and heavy vehicles. For the 2017-2019 study, the light vehicles' equity ratio was 1.0076 and the heavy vehicles' equity ratio was 0.9865. In other words, light vehicles were overpaying by 0.76% and heavy vehicles were underpaying by 1.35%.

Declared Weight			2017 Results	Equity Ratios					
				$10 Permit			$20 Permit		
				BAU	GHG	ADAPT	BAU	GHG	ADAPT
1	to	10,000	1.0076	1.0371	0.9864	1.0047	1.0582	0.9692	1.0006
10,001	to	26,000	1.0993	1.0364	1.1387	1.0815	0.9899	1.1807	1.0702
26,001	to	78,000	0.7705	0.7454	0.8314	0.8039	0.7268	0.8918	0.8356
78,001	to	80,000	1.2065	1.1332	1.2507	1.2037	1.0790	1.2992	1.2066
80,001	to	104,000	0.7513	0.7207	0.7876	0.7621	0.6983	0.8266	0.7753
104,001	to	105,500	0.7219	0.6835	0.7545	0.7308	0.6552	0.7898	0.7423
105,501	and	up	0.3133	0.2881	0.3106	0.3013	0.2687	0.3107	0.2926
Total			1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10,001	and	up	0.9865	0.9331	1.0285	0.9907	0.8936	1.0737	0.9987
26,001	to	80,000	1.1310	1.0654	1.1780	1.1347	1.0170	1.2285	1.1427
80,001	to	105,500	0.7348	0.6998	0.7690	0.7446	0.6739	0.8060	0.7568
26,001	to	105,500	0.9847	0.9314	1.0275	0.9916	0.8920	1.0737	1.0021
26,001	and	up	0.9712	0.9190	1.0134	0.9781	0.8804	1.0589	0.9885

Table 11: Equity Ratios by Weight Class

Table 11 displays the equity ratios for various weight classes across the scenarios considered in this study. We've replicated the results from the 2017-2019 in the first column. Next, we present the equity ratios for the six scenarios, first separating by carbon allowance price and then by cost allocation scenario.

Overall, Table 11 makes it clear that the cost scenario matters. Within each permit price assumption, the BAU cost scenario leads to light vehicles overpaying and heavy vehicles underpaying. For the GHG and ADAPT scenarios, the equity ratios are closer to 1. GHG leans towards heavy trucks overpaying while ADAPT leans towards light vehicles overpaying.

[9] The Study Review Team has defined light vehicles as those between 1 and 10,000 pounds and heavy vehicles as those over 10,000 pounds.

The permit price has the biggest impact on equity ratios under the BAU scenario. As the permit price increases with that cost scenario, light vehicles' overpayment and heavy vehicles underpayment increases in magnitude. The permit price doesn't influence the results for the ADAPT scenario owing to the fact that the cost allocation in that scenario tracks the distribution of revenues from carbon allowances. Since the GHG scenario, amongst the three cost scenarios, tilts towards most heavily towards light vehicles, higher allowance prices push equity ratios more in the favor of heavy vehicles.

The simulation results underscore the importance of both the permit price and the cost scenarios. For the same level of revenue, the way in which those funds are spent can lead to very different equity ratio outcomes.

Equity Balancing Revenue Changes

Each of the scenarios that we have run lead to different outcomes for equity ratios. In order to put those new equity ratios into context, we have calculated hypothetical changes that would be required to restore equity for the main tax instruments: fuel taxes and weight-mile taxes. There are many ways in which equity can be restored. We have focused on one method below. Specifically, for each scenario, we calculate the change fuel and weight-mile taxes that will be as close to "revenue neutral" as possible. For example, if light vehicles are underpaying, we calculate the simultaneous increase in fuel taxes and decrease in weight-mile taxes that will restore equity and not increase total revenue collected.

In these exercises, we calculate the simultaneous proportional change needed in fuel taxes and the proportional change needed in Table A and Table B weight-mile taxes. We do not change RUAF, registration fees, or flat-fees. Those are certainly policy levers available. However, for ease of illustration, we focus on just the fuel and weight-mile taxes.

In the appendix, we present results for other methods of restoring equity. Specifically, we consider two sets of policies. First, we calculate the change only in fuel taxes needed to restore equity. Second, we repeat the exercise with only changing the schedule of weight-mile taxes.

Business As Usual

First, we begin with the BAU scenario. At a permit price of $10, this scenario resulted in light vehicles overpaying by 3.7% and heavy vehicles underpaying by approximately 6.7%. Here, to restore equity, we would need to lower fuel taxes and raise weight-mile taxes.

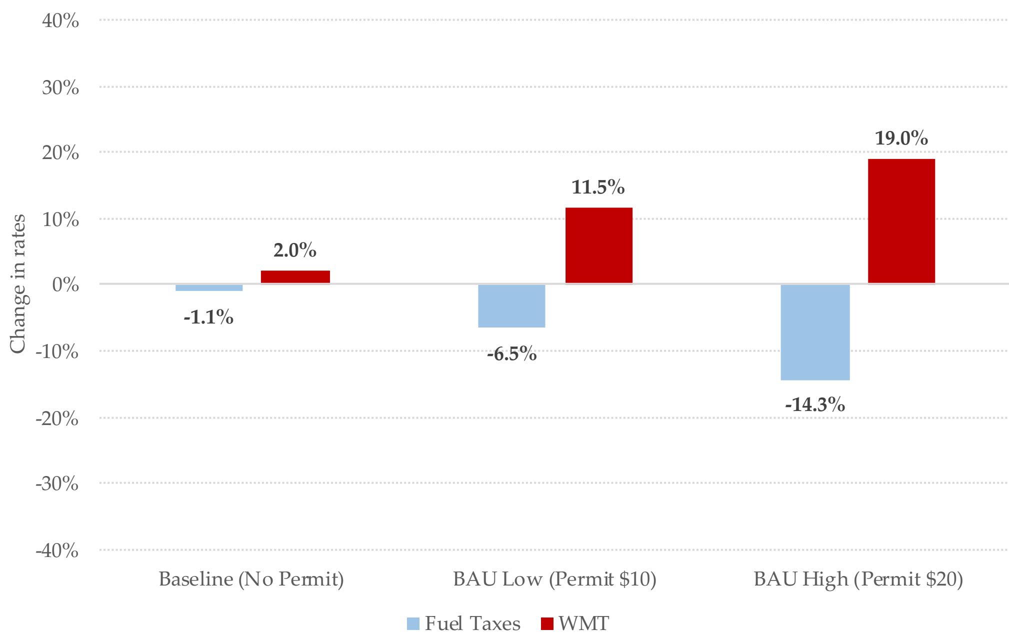

Figure 1: Business As Usual Rate Changes

Figure 1 displays the required changes in rates to achieve equity. The left-most panel presents the changes we would need in the absence of a permit program. These are non-zero because the 2017-2019 equity ratios were not exactly equal to one. So, when looking at the results with a positive permit price, we need to compare them to the changes we would have made to achieve exact equity. Those changes are indeed small adjustments. In fact, the 2017-2019 study did not result in any legislative action to adjust rates.

Under the BAU scenario, we would need large increases to the weight-mile tax: 11.5% for the $10 allowance price and 19% for the $20 permit price. Those changes in fees come with large reductions in the fuel tax in order to maintain revenue neutrality.

GHG Reduction

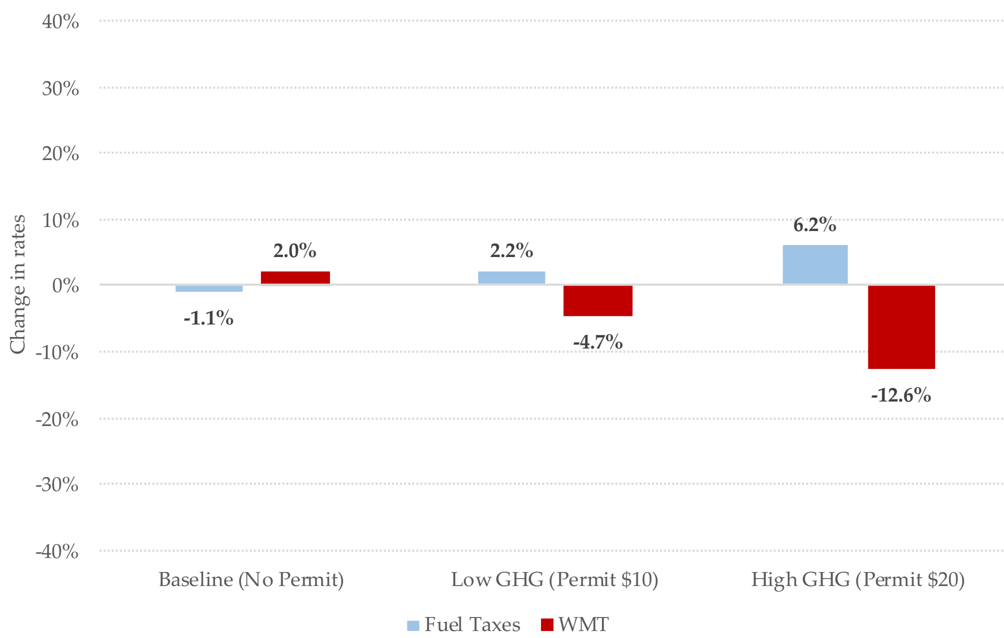

Figure 2: GHG Reduction Scenario Rate Changes

Changes in the rate structure move in the opposite direction for the GHG reduction scenario. Since the equity ratios indicated overpayment by heavy vehicles, we would need to reduce the weight-mile taxes and increase the fuel taxes on cars. These changes are of smaller magnitude than for the BAU case. Under the low permit price, the tax adjustments are similar to the adjustments indicated in the baseline, which were not acted upon. With a high permit price, those are twice as large and might meet the threshold for legislative action.

Adaptation

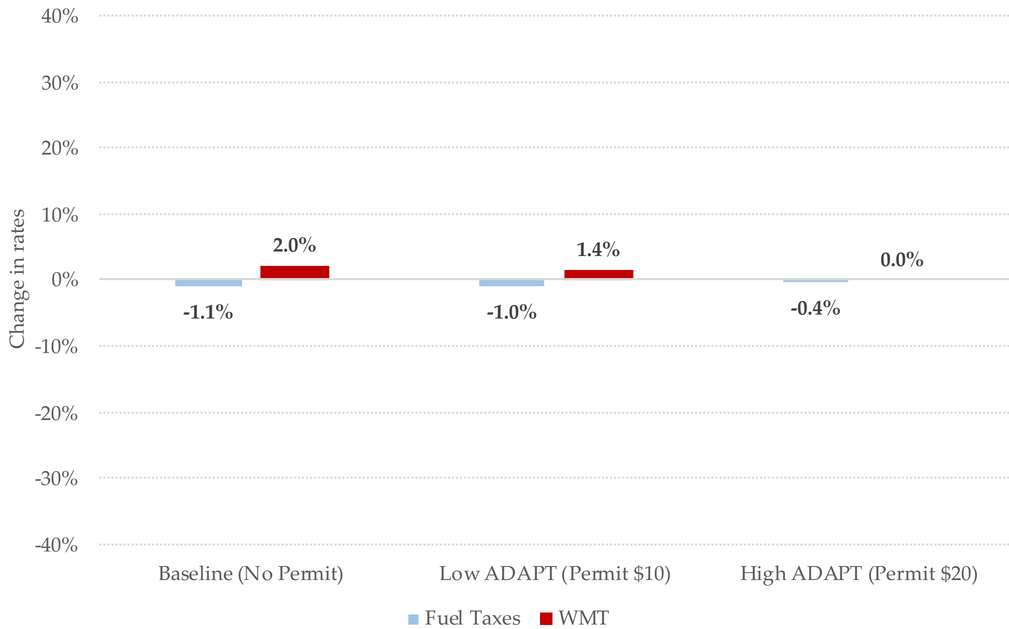

Figure 3: Adaptation Scenario Rate Changes

The Climate Adaptation Scenario led to overpayment by light vehicles and underpayment by heavy vehicles. Accordingly, the model recommends increasing the weight-mile tax and decreasing the fuel tax. For the low and high permit price, the magnitude of the proposed changes is similar to that of the baseline which was deemed small enough to not act.

Logistical Recommendations

Overview of Study Recommendations

The simulation exercise that we have completed is valuable for understanding where existing gaps in data or methodology would become problematic if a Cap-and-invest program were implemented. There are some assumptions that we had to make to complete the simulation that would be unnecessary if the program were in effect. Conversely, there are other areas where assumptions would still need to be made even with reasonable expectations on the data generated and collected by an operational carbon pricing mechanism. All of our recommendations have to do with the revenue side of the question. Expenditures would be reported through the normal channels. The largest areas that we forecast to be deficient for revenue attribution relate to fuel consumption, VMT estimates, fuel efficiency estimates, and the prevalence of diesel engines in light and medium weight classes.

Fuel Consumption Estimates

Currently, our estimates of gallons of fuel consumed rely on our estimates of MPG and the forecast of revenue and VMT from ODOT. Doing HCAS under a cap-and-invest system would be improved if we had access to better estimates of gasoline and diesel gallons used by full fee vehicles. During HCAS SRT meetings this biennium it has been revealed that DEQ and ODOT have different methods and different estimates of the quantity of fuel used in the State of Oregon. Work is ongoing to understand that discrepancy, but accurate independent estimates of these figures would be useful to our study.

VMT/Mileage Calculations

VMT data for weight-classes subject to the weight-mile tax can be, and has been, reasonably trustworthy. VMT for the 10,001-pound to 26,000-pound weight class needs to be estimated from a combination of data sources: MPG estimates, taxed fuel gallons data, and DMV registrations data. Importantly, we make assumptions on the annual mileage that each vehicle registered with DMV contributes to the total. Our assumption on the number of miles per registration informs our estimate of the total VMT of that weight class. Combined with our MPG estimate, we arrive at an estimate of diesel gallons and gasoline gallons. With each of these, we multiply the appropriate carbon allowance "fee" and sum to get the revenue contribution for this class.

Having more accurate VMT data for this weight class would improve our ability to determine the share of carbon allowance revenue to attribute to this group. This is an existing problem that would be exacerbated by Cap-and-invest.

MPG Calculations

Currently, our base MPG calculations are derived from the Vehicle Inventory and Use Statistics (VIUS) 2002 data. We use linear regression to model the distribution between weight and fuel economy and then project fuel economy for each weight class in the study. This procedure yields an estimate of MPG that is applied to previously calculated VMT estimates to arrive at the amount of fuel consumed by each weight class. Revenue for the weight class is figured by applying the carbon allowance "fee" to the number of gallons of fuel.

If our MPG estimates are wrong, then we are miscalculating the amount of fuel consumed. If we are miscalculating fuel, our revenue attribution results will be wrong. The Study Review Team should explore an updated method or data source that could be used for the calculation of fuel economy. Moreover, the ability to separately account for gasoline engine and diesel engine fuel economy will improve accuracy.

Gasoline and Diesel Engine Distribution

Currently, the HCAS model does employ information from the DMV on the number of diesel and gasoline engine vehicles in each weight class. As mentioned above, however, we do not have separate MPG estimate for each engine type. When this model feature is coupled with the fact that the fuel taxes on gasoline and diesel are the same amount, the distinction between diesel and gasoline engines has diminished importance.

Under our assumptions, we apply a different carbon allowance passthrough for diesel and gasoline. If Cap-and-invest were to pass in a form similar to what we've assumed, we would need to pay more attention to the differences between gasoline and diesel engines. Specifically, we would need to get estimates of MPG that differ by engine type and we would need to have better understanding of the VMT breakdown for the weight classes of 1 – 10,000 pounds and 10,001 – 26,000 pounds.

Recommendations

We have a few recommendations on procedural steps that might be feasible for the state government to undertake that would lead to filling some of the gaps we have in the data. The recommendations revolve around getting better information on VMT and MPG for various weight classes.

Registration Information

Currently we employ counts of registrations from the Division of Motor Vehicles. Part of our model requires us to make assumptions about the annual VMT for each registration type. It would be feasible for DMV to collect odometer information from each registration application. With a reasonable sample of registrations by weight class, we could estimate an average annual VMT. This data would be particularly useful for medium-heavy vehicles, those from 10,001 to 26,000 pounds.

Light/Medium Heavy Vehicle MPG Estimates

Division of Motor Vehicles has information about the type of vehicle for each vehicle registered in the State of Oregon. ODOT has access to Vehicle Identification Number (VIN) decoders that will identify key pieces of information for each registered vehicle. Matching this data to official MPG estimates can improve our estimates of fuel consumption in different weight classes.

MPG for Heavy Vehicles

New Survey

Our estimates of MPG for Heavy Vehicles are based on the discontinued Vehicle Inventory and Use Statistics survey, last completed in 2002. The dataset was constructed from a survey of private and commercial trucks. ODOT could undertake a similar survey of heavy vehicles registered in the State of Oregon. This would provide an estimate of MPG that reflects improvements in technology since 2002 and segment the heavy truck population by weight class.

IFTA Estimates

IFTA compiles estimates of MPG by weight class based on the information that they collect. This data is readily available. However, there is concern that the sample of vehicles that are used to calculate the IFTA data are "long-haul" truckers that are achieving higher MPG than the median heavy vehicle. Work can be done to determine an intelligent method of adjusting the IFTA estimates in order to get a better estimate. Alternatively, there may be opportunities to work directly with IFTA to leverage additional information that they might have access to.

Conclusions

C&I legislation will have many impacts on the State of Oregon. The results and execution of the Highway Cost Allocation Study is no different. Such a program will introduce a new source of revenue into the Highway Trust fund. There will also be a corresponding increase in spending on transportation projects. The distribution of the revenues and expenditures between light and heavy vehicles could impact the recommendations made by the Study Review Team to the Oregon Legislature.

In this report we simulated the 2017-2019 HCAS under several counterfactual scenarios with the aim of informing and bounding the ways that Cap-and-invest could potentially impact the results and execution of HCAS. Our scenarios were constructed in such a way as to identify how resultant carbon market prices would affect equity ratios. Furthermore, we entertained three separate cost scenarios to ascertain the impact that spending choices would impact the balance between heavy and light vehicles.

Our simulations indicate that the bulk of new revenue coming from the sale of carbon allowances for transportation fuels would be allocated to light vehicles. This class of vehicles accounts for over 93% of the vehicle miles traveled in the State. While heavy vehicles have lower fuel economy, the difference is not sufficient to counteract the disparity in VMT.

The scenario analysis was helpful in revealing the importance of expenditures on the final calculation of equity ratios. Even though the revenue from carbon allowances fell heavily on light vehicles, one of the three cost scenarios we ran allocated expenditures in a way that more than compensated for the revenue imbalance. This cost scenarios led to an underpayment by heavy vehicles in spite of the revenue burden falling heavily on light vehicles.

In sum, while we can be fairly confident that the majority of carbon allowance revenue will be coming from light vehicles, the ultimate impact on equity ratios and proposed changes to highway funding sources will depend on the expenditure allocation. At this time, we cannot forecast how those additional dollars will be spent. As we describe earlier, the distribution of expenditures has a large impact on how carbon allowance revenue influences equity ratios.

We can, however, identify that there are several areas for improvement in the execution of HCAS. Specifically, improving our ability to estimate fuel economy, diesel and gasoline engine prevalence, and the vehicle miles traveled for vehicles not paying the weight mile tax will improve the precision and accuracy of our revenue attribution exercise. From a cost perspective, we believe that the necessary elements would continue to be available.

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Appendix

Alternate Tax Changes

In this section of the appendix we consider alternative changes to the system of taxes that would restore equity in each of our six scenarios. First, we consider changes in only the fuel taxes that would be required to achieve equity. Second, we consider changes in only the full weight-mile tax schedules. This contrasts with the analysis in the main body of the text where we consider simultaneous changes in both sets of tax rates.

Below we present two charts for each of the six scenarios. Each bar represents the change in tax rates that would be needed *if that were the only rate to change in that scenario.* This contrasts with Figures 1 – 3 where *both changes needed to take place.*

Changing Only Fuel Taxes

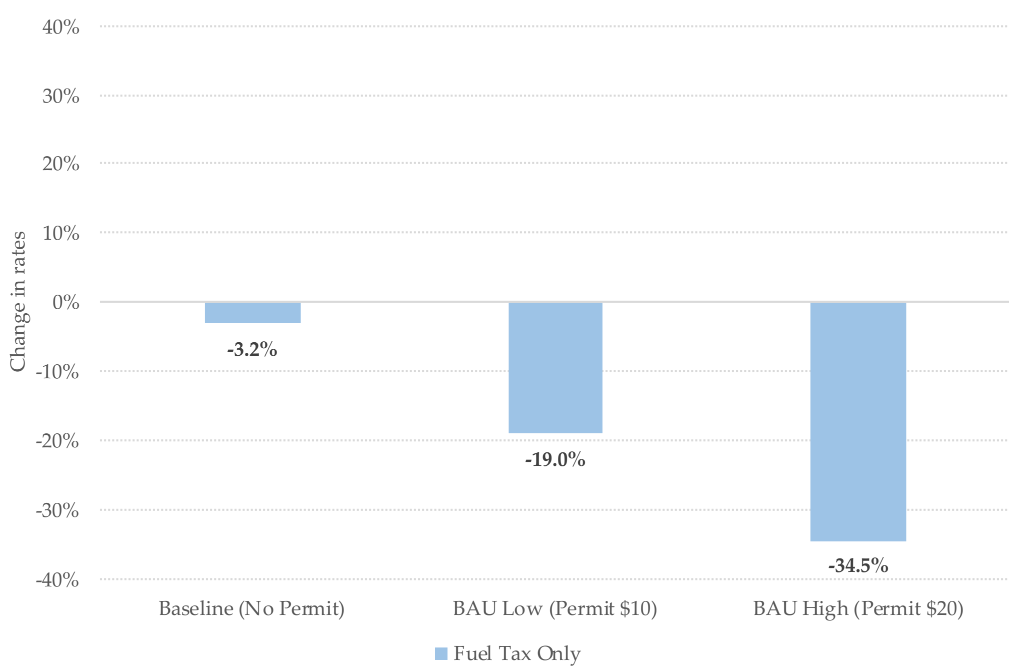

Figure 4:Changes in Fuel Taxes Required for Equity; Business As Usual Scenario

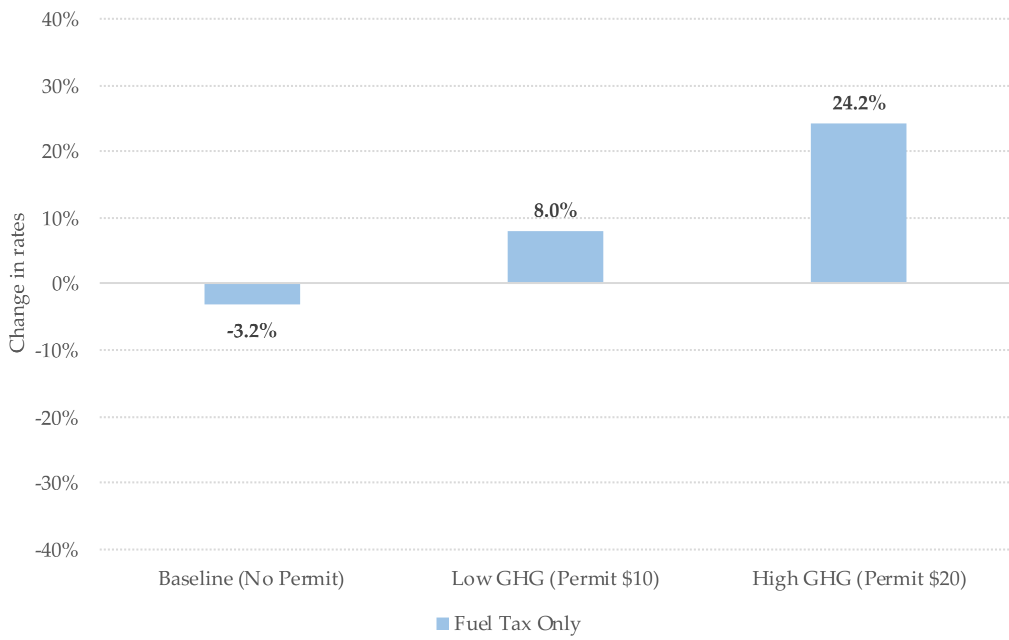

Figure 5: Changes in Fuel Taxes Required for Equity; GHG Reduction Scenario

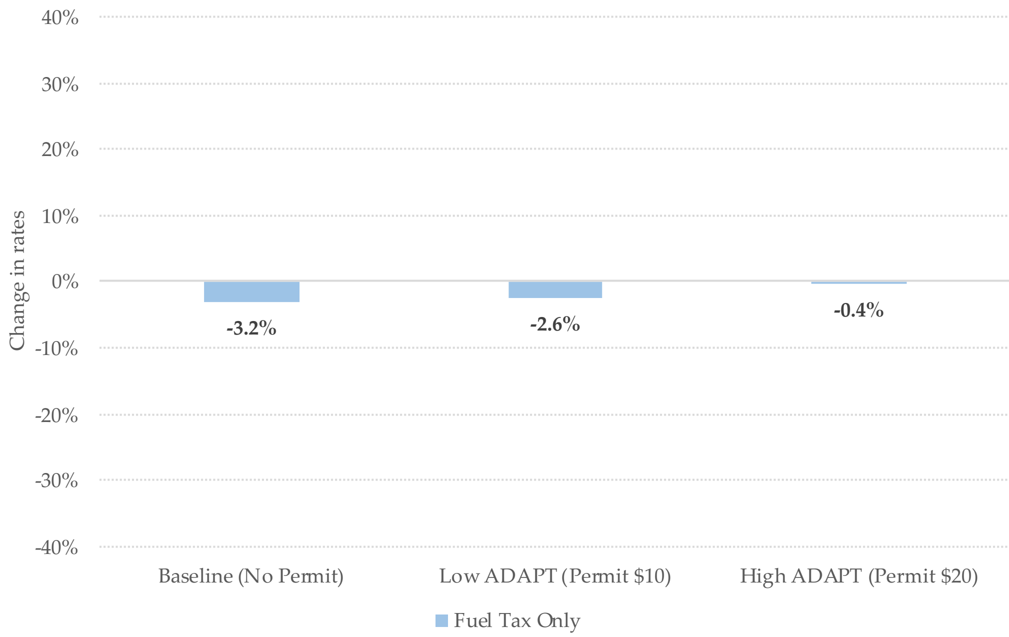

Figure 6: Changes in Fuel Taxes Required for Equity; Climate Adaptation Scenario

Changing Only WMT Tables A and B

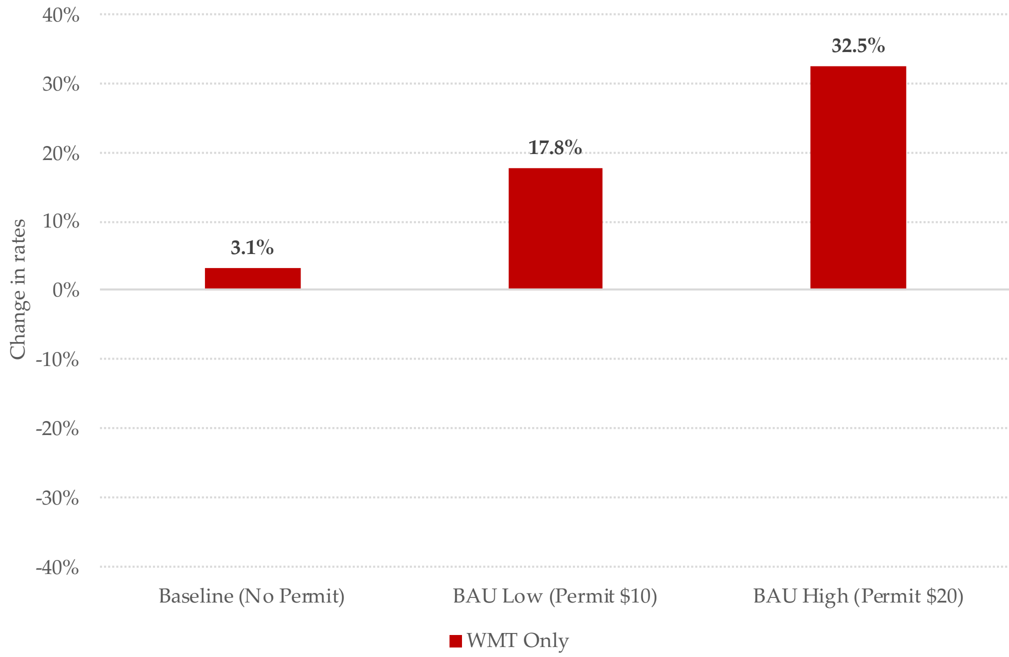

Figure 7: Changes in WMT Taxes Required for Equity; Business as Usual Scenario

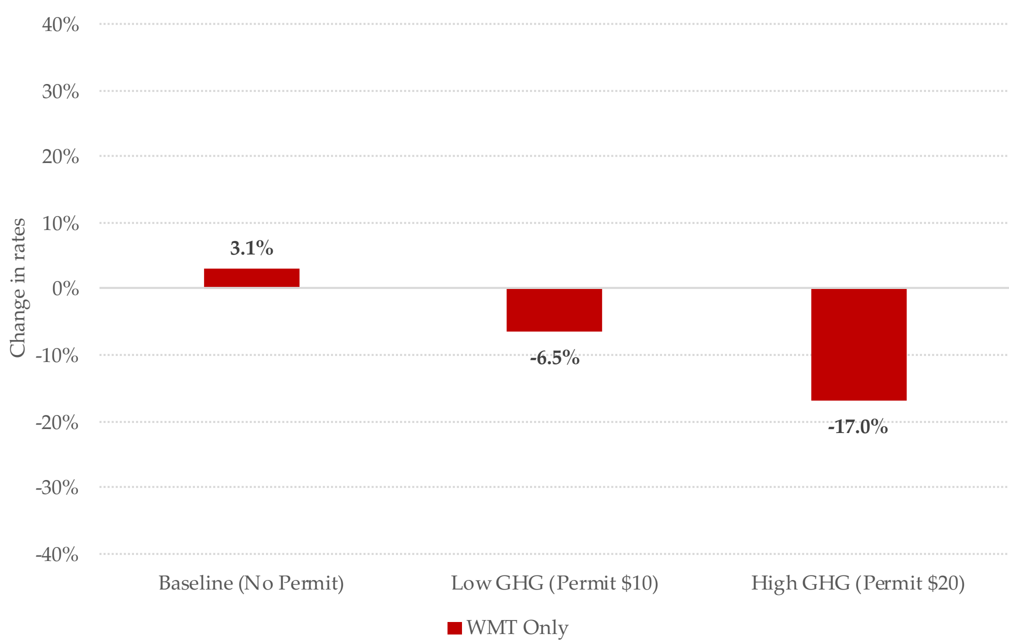

Figure 8: Changes in WMT Taxes Required for Equity; GHG Adaptation Scenario

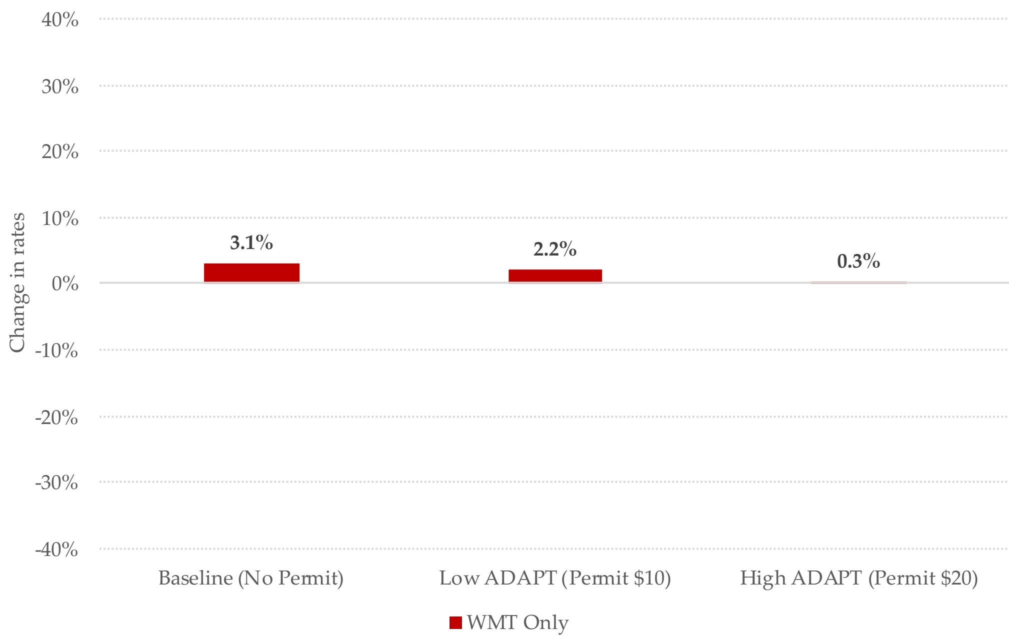

Figure 9: Changes in WMT Taxes Required for Equity; Climate Adaptation Scenario

Understanding Allocators

Weight Class			Cost Allocation			
			All VMT	Uphill PCE	Congested PCE	Basic VMT
1	to	10,000	92.1%	65.0%	83.3%	100.0%
10,001	to	26,000	2.2%	4.0%	3.1%	0.0%
26,001	to	78,000	1.0%	3.2%	2.0%	0.0%
78,001	to	80,000	3.3%	16.9%	7.7%	0.0%
80,001	to	104,000	0.6%	3.5%	1.6%	0.0%
104,001	to	105,500	0.7%	7.1%	2.2%	0.0%
105,501	and	up	0.0%	0.2%	0.0%	0.0%
Total			**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 12: Cost Responsibility by Weight Class for Common Allocators

In this section we provide some context for the common allocators that we use. Table 12 details how an allocator spreads cost responsibility across weight classes for 4 common allocators: All VMT, Uphill PCE, Congested PCE, and Basic VMT. For example, if a project is assigned an “All VMT” allocator, then 92.1% of the cost of that project is allocated to light vehicles and 7.9% of the cost is spread over the heavy vehicle classes. Conversely, a project that is assigned the Basic VMT allocator has 100% of the cost assigned to light vehicles. Table 13 lists example projects by dominant allocator type.

Example Work Types and Allocators
All VMT
Bike/Pedestrian Projects
Bridge --All Vehicles Share
Bridge --All Vehicles Share (no added capacity)
Drainage Facilities Maintenance
Extraordinary Maintenance
Fish and Wildlife Enabling Projects
Fish, Wildlife Enabling Projects
Highway Planning
Miscellaneous Maintenance
Other Administration
Other Common Costs
Planning
Railroad Safety Projects
Reserve Money, Fund Exchange, Immediate Opportunity Fund
Roadside Improvements
Roadside Items Maintenance
Safety Items Maintenance
Sanding and Snow and Ice Removal (maintenance)
Seismic Retrofits
Seismic Retrofits on Structures
Structures Maintenance
Basic VMT
Other--Basic Only
Studded Tire Damage
Congested PCE
Bridge --All Vehicles Share (added capacity)
Grading and Drainage
Multimodal
New Shoulders-Flexible
New Shoulders-Rigid
Safety Improvements
Traffic Service Improvements
Traffic Service Items Maintenance
Transit and Rail Support Projects
Transportation Demand & Transportation System Management
Uphill PCE
Climbing Lanes

Table 13: Example Projects by Allocator