EFFICIENT FEE HIGHWAY COST ALLOCATION STUDY 2011-2013 BIENNIUM

Prepared for
Oregon Department of
Administrative Services,
Office of Economic Analysis

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Summary of Major Findings

The 2011 Efficient Fee Highway Cost Allocation Study for Oregon finds that:

- Under an efficient fee system, each vehicle would pay a fee equal to the costs it imposes on the system. The efficient fees estimated in this report include the following components: congestion fee, wear-and-tear fee (including a bridge component), emissions fee, and administrative fee.
- For the 2011-13 biennium, under such an efficient fee system, it is projected that light vehicles (those weighing 10,000 pounds or less) would pay 66.6 percent of the total efficient fees and heavy vehicles (those weighing more than 10,000 pounds) would pay 33.4 percent of the total efficient fees.
- Under current law revenue instruments and rates, light vehicles paying full fees are projected to pay 65.7 percent of state highway user revenues, and heavy vehicles paying full fees are projected to contribute 34.3 percent during the 2011-13 biennium.
- The calculated equity ratios for the efficient fee study, defined as the ratio of the projected full-fee current law revenues to the estimated efficient fees for the vehicles in each class, are 0.9874 for light vehicles and 1.0251 for heavy vehicles as a group. This means that, under existing tax rates and fees, light vehicles are projected to underpay their responsibility by 1.3 percent. Heavy vehicles, as a group, are projected to overpay their responsibility by 2.5 percent.
- The equity ratios for the individual heavy vehicle weight classes show some classes are projected to overpay and some to underpay their responsibility relative to their efficient fee.
- The average efficient fee in cents per mile would be 2.93 cents for light vehicles, and the average efficient fee for heavy vehicles would range from 10.19 cents per mile for vehicles between 10,001 and 26,000 pounds up to 249.49 cents per mile for heavy vehicles 105,501 pounds and up. The average efficient fee for vehicles between 78,001 and 80,000 pounds would be 19.33 cents per mile.

Efficient Fee Highway Cost Allocation Study

2011-2013 Biennium

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Chapter 1

Introduction

The purpose of highway cost allocation studies (HCASs) is to determine whether each class of highway users is paying their fair share of highway user fees. Paying one's fair share is defined as contributing the same share of total revenues as the share one imposes of total costs.

For more than 70 years, Oregon has based the financing of its highways on the principle of cost responsibility. This tradition has served Oregon well by ensuring that the state's highway taxes and fees are levied in a fair and equitable manner. Periodic studies have been conducted to determine the fair share that each class of road users should pay for the maintenance, operation, and improvement of the state's highways, roads, and streets. Prior to the present study, 16 such studies had been completed, the first in 1937, the most recent in 2009.

Oregon voters ratified the principle of cost responsibility in the November 1999 special election by voting to add the following language to Article IX, Section 3a (3) of the Oregon Constitution:

> "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 2009 Legislative Assembly specified in House Bill 2001 that the 2011 HCAS should be conducted two different ways, using the traditional approach and using an alternative, efficient fee approach.[1] This report describes the results of applying the efficient fee approach. The results of applying the traditional approach are described in a separate report.

Measuring Equity

Highway cost allocation studies use a quantifiable, numeric measure of fairness and proportionality called the *equity ratio*. The equity ratio measures the extent to which each user class pays its fair share; it is the ratio of a user class's share of revenues to its share of costs. A separate equity ratio is calculated for each user class.

Each user class's share of revenues is the revenue generated by that class divided by

[1] The results of applying the traditional approach are described in a separate report: *Highway Cost Allocation Study 2011-2013 Biennium*, Prepared for Oregon Department of Administrative Services, Office of Economic Analysis.

the sum of the revenues generated by all classes. For example, during the 2011-13 biennium, full-fee-paying light vehicles (vehicles weighing 10,000 pounds or less) in Oregon are expected to generate $734 million in state user-fee revenue per year, out of $1,117 million per year from all full-fee-paying vehicles. The share of revenues for light vehicles is therefore 65.7 percent ($734 / $1,117).

Each user class's share of costs is the costs imposed by that class divided by the sum of costs imposed by all classes. This study found that light vehicles in Oregon are expected to impose $1,038 million out of $1,559 million in total annual costs, or 66.6 percent of the total.

The ratio of these two ratios, called the equity ratio, measures the extent to which a user class pays its fair share. The equity ratio for vehicles weighing less than 10,001 pounds in this study is therefore 0.657/0.666, or approximately 0.99.

If the equity ratio for a particular class is 1.0, that user class is paying exactly its fair share. If the equity ratio is more than 1.0, that class is paying more than its fair share, and if the ratio is less than 1.0, it is paying less than its fair share. Estimates of future revenues and costs always include some uncertainty, so equity ratios in the range of 0.95 to 1.05 are often considered to be equitable.

User Classes

A user class could be any subset of users. The definition of user classes determines, in part, the outcome of the study, so it is important that user classes be defined in a way that is useful to answering the questions posed for the study.

For the Oregon HCASs, user classes are defined in terms of vehicle weight to support the constitutional mandate for monitoring equity between light and heavy vehicles. Light vehicles are defined as all motor vehicles weighing 10,000 pounds or less, from motorcycles to Hummers. Vehicles weighing more than 10,000 pounds are assigned to classes in 2,000-pound increments. The classes for vehicles weighing more than 80,000 pounds are defined by weight increment and number of axles (5, 6, 7, 8, or 9+). User class definitions for heavy vehicles in Oregon use 2,000-pound increments because the rate schedules for the weight-mile tax (WMT), paid by commercial vehicles weighing between 26,001 and 105,500 pounds are expressed in 2,000-pound increments. Vehicles weighing between 80,001 and 105,500 pounds pay WMT rates from "Schedule B" that vary by both weight and number of axles. All vehicles weighing over 200,000 pounds are included in a single "over 200,000" weight class for the purposes of this study.

The Efficient Fee Approach

Traditionally, highway cost allocation studies have defined *costs imposed* to mean "budgeted future expenditures by highway agencies" and then allocated these expected expenditures to vehicle classes without regard to the adequacy or efficiency of the expenditures. This approach assumes that expenditures reflect costs, despite evidence that parts of the system are deteriorating or excessively congested (indicating that costs imposed have been exceeding expenditures) or that parts of the system are overbuilt or underutilized (indicating that expenditures have been exceeding costs imposed).

The efficient fee approach attempts to more accurately estimate the costs that are actually imposed by each class by imagining a system of fees that recover the actual costs imposed and then determining how much each class would pay under that imaginary, efficient fee system.

The concept of fairness is the same in the two approaches, but the share of cost, as expressed in the denominator of the equity ratio, is measured differently.

The efficient fee approach starts with the presumption that every vehicle could be charged a fee for each mile it travels that is equal to the costs it imposes in that mile.

The fee would vary with the time and place the vehicle operates, as well as the attributes of the vehicle, such as length, weight, and number of axles. It consists of several components:

A *congestion fee component* recovers the future costs associated with investing in additional capacity or otherwise relieving congestion. It is based on the costs a vehicle imposes on other vehicles by taking up space on a particular facility at a particular time and is a function of the amount by which that vehicle slows traffic and the value of other travelers' time. Because the congestion fee is not actually in effect, road users are not currently responding to it; the estimated collections from an imaginary congestion fee based on current congestion levels are much higher than collections under an actual congestion fee would be. For this reason, the present study uses the congestion fee each user class would pay under current congestion levels to determine that class's cost-responsible share of congestion costs, but scales the estimated collections down so they sum to the amount that would be collected if the fees were actually in place.

Wear-and-tear fee components recover the future maintenance, preservation, and capital replacement costs a vehicle imposes by wearing out the roadway it drives on. The sum of all wear-and-tear fees represents the optimal level of expenditure on maintenance and preservation and does not depend on actual expenditures in any particular biennium or the cost-effectiveness of actual maintenance and preservation programs.

An *administrative fee component* recovers the cost of highway agency activities not directly covered by the congestion or wear-and-tear fees, such as planning, administration, human resources, and information services. As in the traditional approach, there is no right way to allocate these costs to individual vehicles, so a "least wrong" allocation method must be chosen and applied.

An *emissions fee component* recovers the costs imposed on others by the emissions produced by the vehicle. In the case of electric vehicles, it may include the emissions produced in generating the electricity used to charge the vehicle.

Components representing fees for other externalities imposed by vehicles could be included as well. This study does not include fees for other externalities. The concept for other fees is the same as with emissions. To be included, the externality must be quantifiable, there must be a defined relationship between the quantity of travel and the quantity produced of the externality, and there must be a defined cost (which may be negative in the case of an external benefit) per unit of externality. Potential other externalities include the following:

- Noise
- Water pollution
- Safety

Once the appropriate levels for the efficient fees have been determined, the amount of fees that would be paid by each user class is calculated. Because the fees are set to reflect costs imposed, the estimated amount of fees each class would pay is an estimate of the costs that class would impose.

Revenue attribution, the process for determining each class's share of current-law revenues, is the same as in the traditional approach. Highway revenues come from a variety of taxes and fees defined in current law. In Oregon, these include motor fuel taxes, vehicle registration fees, vehicle title fees, weight-mile taxes, road use assessment fees, and flat fees. Revenue attribution estimates the fee amount that vehicles in each class will pay under current-law fee rates and then adds them up for each class across the various fees.

How the Efficient Fee Approach Differs from the Traditional Approach

The traditional approach does not attempt to directly estimate the costs imposed on the system by different classes of vehicles. Instead, it uses planned expenditures over the study period as a proxy for the costs imposed by vehicles.

In Oregon, the expenditures traditionally included in an HCAS are the expected expenditures of state highway user fees, a portion of the expenditures of state bond revenues, expenditures of federal highway funds, and expenditures of certain local government revenues within a fiscal biennium. The studies also treat as a "cost" the difference between what alternative-fee-paying vehicles (such as publicly owned and charitable organization vehicles) would pay if they paid regular fees and what they actually pay. Also, expenditures of bond revenues are scaled so that only two years' worth of debt repayment is allocated; the remainder of the allocated cost is carried forward to future studies until the bonds are repaid (nine future studies in the case of 20-year bonds).

In reality, there are always differences between the amount expended in a biennium and the costs imposed in that biennium. There will also be differences between the proportion of total expenditures in a particular category and the proportion of total costs in that category. The expected life of a capital project will likely exceed the study horizon and most of the capital consumed in the current study period will have been paid for in prior study periods. Deferred maintenance may result in maintenance expenditures that are lower than costs in one study period and higher in another.

Users may also impose costs, such as those resulting from pollution and noise, that are not borne by highway agencies and thus are not counted among the expenditures in any time period. The traditional Oregon HCAS recognizes this is the case, but continues to define costs as expenditures because expenditures can be measured more directly (and accurately) and are closely linked to the definition of revenue.

How the Efficient Fee Approach Differs from Efficient Pricing

The efficient fee approach offers valuable insights into how different vehicles impose costs on the highway system, but, as applied in this study, it does not actually impose efficient fees on individual vehicles. Implementing efficient fees (i.e., an efficient pricing system) would yield several important advantages over the traditional highway user approach, including:

- Each vehicle would pay the costs it imposes, which is always its fair share. This is more fair than requiring only that the unfairness in what individual vehicles pay balance out over all the vehicles in a weight class.
- Each vehicle would pay the costs it imposes, which aligns each vehicle operator's behavior with what is best for society. A vehicle would travel when the benefits of the trip are greater than the cost to the traveler and to the rest of society.
- Vehicles would make different numbers of trips and some trips would be at different times or on different routes than under the traditional highway user approach, resulting in a more efficient use of existing infrastructure.
- Where carpooling, transit, biking, or walking are viable alternatives to single-occupant auto travel on congested roads, their share of trips would increase, resulting in a more efficient use of existing infrastructure.
- The fees collected from efficient congestion fees over time would adequately fund efficient infrastructure enhancements. The inherent lumpiness of construction expenditures could be handled through borrowing against future congestion fee receipts.
- The collections from efficient wear-and-tear fees would adequately fund efficient maintenance and preservation activities over time.

- Efficient emissions fees would lead to socially optimal emissions levels (maximizing the net benefits of travel less the costs of emissions) while providing additional collections that could be used to offset the administrative costs of managing the highway system.
- In the long run, efficient pricing would lead to more efficient land use and transportation infrastructure through voluntary rearrangements that are beneficial to those making the changes.

Chapter 2

Congestion Fee

When a road becomes congested, the congestion imposes significant costs on the users of the road. In many cases, the cost of adding capacity to the congested road is less than the cost of congestion borne by the users of the road, and spending highway user fees on adding capacity is warranted and cost-beneficial. A large part of the Oregon Department of Transportation's (ODOT's) capital construction budget is spent on adding capacity to facilities that have become congested.

Congestion costs are the incremental costs that users' vehicles impose on other vehicles within the traffic stream in which they operate. An individual user bears his own portion of the total increase in delay by being delayed himself in the traffic stream. But his presence in the stream imposes costs in the form of additional delay on all other users in the stream as well. These costs arise as a consequence of the inherently congestible nature of roads but will only be significant when traffic volumes approach the capacity of the roadway.

Under the efficient fee approach to highway cost allocation, cost responsibility is allocated as it would be if efficient prices were levied for highway use. Efficient pricing would levy fees differentially depending upon the vehicle's specific burden on capacity and maintenance. A key aspect of the efficient fee approach is that a vehicle is charged for its contribution to a roadway's congestion. Because that contribution to current congestion is what drives the need for new capacity, this congestion fee can be thought of as a capacity fee. The efficient fee approach to capacity fees (called congestion pricing) will result in fees that are greater on congested road segments. Congestion fees will also be greater if the vehicle is slow, large, or otherwise uses up more scarce capacity. In contrast, no vehicle will pay a capacity fee if traffic is sparse enough that it doesn't interfere with the progress of other vehicles.

The purpose of this chapter is to describe a method and data sources that may be used to estimate the efficient fees for congestion that would prevail given current capacity, expected traffic volumes, and no change in behavior. Because efficient fees will not be charged during the study period, behavior will not change, so the efficient congestion fee approach estimates responsibility for capacity costs under current law revenue instruments, which is the goal of a highway cost allocation study.

When projects that add capacity are paid for through traditional revenue instruments (e.g., fuel taxes and registration fees), users of every road in the state contribute to the funding of congestion relief, even if they themselves never contribute to congestion by traveling on congested roads at congested times.

Using the efficient fee method does not solve the problem of charging individual users for capacity costs they do not impose, but it does allow for more accurate estimation of the cost responsibilities attributable to vehicle classes. Planned expenditures on capacity vary from year to year and may not represent optimal investment levels in any year. Instead of spreading those expenditures over vehicle classes, the efficient fee method estimates the cost responsibility for individual vehicles on individual road segments and aggregates them up to vehicle classes.

If congestion fees are properly set and investments are managed efficiently, congestion fees will generate just enough collections to finance capacity throughout time. The logic of this conclusion is subtle but important. The key point is that pricing and investment are both focused on balancing user costs and benefits.

Congestion fees indicate the value of new capacity. If congestion fees are high, it is because traffic delays are great. Hence, if these costs could be relieved through investment, the cost savings would be a benefit of the investment.

Optimal investment policy balances these benefits against the investment cost of providing additional capacity (or relieving congestion in other ways). The investment rule says simply that road improvements should be undertaken if their benefits exceed their cost. Capacity improvements won't tend to be built, therefore, unless the costs imposed by the insufficiency of existing capacity exceed the cost of building additional capacity.

Efficient fee pricing tends to generate sufficient collections to finance highway improvements if investment follows the investment rule. The technical conditions under which this occurs have been studied by a number of researchers, and they are easily met. The lumpiness of capacity investments often requires the use of financing methods to make large investments in single years that are funded by efficient fees collected over many years (it makes no sense to add one tenth of a lane each year for ten years).

The relevance of all this to highway cost allocation is that the relative importance of capacity costs and preservation and maintenance costs is determined automatically under the efficient fee method and does not vary with random changes in construction budgets. Capital construction projects tend to be expensive and durable. In years when large capital projects are built, there is less money available to spend on preservation, but that is made up for in other years when fewer capital projects are built. These swings in project-type emphasis change the cost allocation under the traditional approach but do not affect the results of the efficient fee approach, except by lowering future congestion fees after capacity increases.

Implementing the Efficient Pricing Approach

To precisely implement the efficient pricing approach, it is necessary to do the following:

1. Determine the level of congestion for each road segment for each moment of the day for each day of the study period. The level of congestion is measured as the ratio of volume to capacity and thus depends on both traffic levels (measured in passenger-car equivalents [PCEs]) and the capacity of each segment (also measured in PCEs).
2. Determine the delay imposed on other vehicles by the addition of one vehicle to the traffic stream for each road segment at each moment of each day for each day of the study period. This is the marginal total delay minus the delay experienced by the marginal vehicle and is a function of both the volume of traffic and the ratio of volume to capacity, as well as the length of the segment and the speed at which traffic flows on that segment when there is no congestion.

3. Determine the value of the delay imposed on other vehicles by the addition of one vehicle to the traffic stream for each road segment at each moment of each day for each day of the study period. This is the number of minutes each of the other vehicles is delayed multiplied by the value of time per minute for each of the other vehicles. The result is the efficient congestion fee for using that road segment at that time.
4. Determine the total amount of congestion fees that would be collected from each vehicle class if the efficient fee were imposed on each vehicle on each road segment at each moment of each day. The collections amount must be determined in two ways: as if vehicles did and didn't change their behavior as a result of the fee. The total amount of fees that would be collected if vehicles did change their behavior is the amount that should be collected in total, and the amount that would be collected from each class if they didn't change their behavior determines the proportion of the total that each class should be allocated for the purpose of determining cost responsibility under current law rates.

Although the precise implementation of the efficient fee approach is easy to describe, it is impossible to accomplish with available data. To develop a feasible implementation using available data, we must add some complication and make some assumptions.

Determining the Level of Congestion

We must move from available traffic count and road-capacity data to a characterization of congestion on different roads at different times. Data are not available for every segment, but each road segment is assigned to one of 12 functional classes based on whether it is rural or urban and whether it is a freeway, arterial, collector, or local street. The likelihood that a road segment will experience congestion is highly correlated with its functional classification. For example, segments on urban freeways and arterials are much more likely to experience congestion than are segments on rural collectors and local roads. Functional classification is included in all the relevant data and the traditional approach estimates study-period vehicle miles of travel (VMT) for each combination of weight class and functional class. Traffic volumes and levels of congestion by time period are estimated for the segments for which there are data and the other segments of the same functional classification are assumed to have similar congestion levels and patterns. Fortunately, the functional classifications for which data are least available are those that are least likely to experience congestion.

The Highway Performance Monitoring System (HPMS) database contains information about 34,855 road segments in Oregon, including functional classification and capacity. Operable 24-hour automated traffic recorders (ATRs) are permanently installed at fewer than 150 locations in Oregon, all on HPMS segments, and have been temporarily installed at a variety of other locations. Each location is associated with a functional class. From the ATR data, we can develop profiles of traffic volumes and volume-capacity ratios over hours of the day and days of the week for HPMS segments. Those can then be aggregated over functional classes to produce functional-class-specific profiles that may be used to characterize road segments that are not in the HPMS database.

Determining the Delay Imposed on Other Vehicles

The time an individual vehicle requires to traverse a road segment may be estimated from the length of the segment, its free-flow speed (the speed at which vehicles travel when there is no congestion), and the ratio of volume to capacity (a measure of congestion). The time required is referred to by traffic engineers as "delay" and this relationship is called the volume-delay function (VDF). The amount of delay increases as speed decreases with congestion.

Without congestion, the time it takes (in hours) to traverse a segment is the length of the segment (in miles) divided by its free-flow speed (in miles per hour). As congestion increases, the time it takes (delay) increases at a faster rate than volume increases. A common and useful volume-delay function, called the BPR function, is:

$$delay = \frac{L}{FF}\left(1 + \alpha\left(\frac{V}{C}\right)^{\beta}\right)$$

where:

$delay$ is the time in hours it takes to traverse the segment

L is the length of the segment in miles

FF is the free-flow speed in miles per hour

V is the volume of traffic in PCEs

C is the capacity of the segment in PCEs

α and β are parameters appropriate to the segment

Standard values of alpha and beta have been estimated for different functional classes to allow the use of the volume-delay function on segments for which sufficient data do not exist to estimate segment-specific parameters. For example, using an alpha value of 0.1 and a beta value of 10.0 works well for freeways. With those parameters, a length of 1 mile and a free-flow speed of 65 mph, a freeway segment would take 55 seconds to traverse when uncongested (65 mph), 61 seconds when volume is at capacity (59 mph), 107 seconds when volume is at 125 percent of capacity (34 mph), and 375 seconds when volume is at 150 percent of capacity (10 mph). Adding an additional vehicle has little effect when the volume is under the road's capacity, but a large effect when the volume is over capacity. Each additional vehicle has a larger effect than the one before it.

Traffic engineers define the capacity of a road as the volume at which throughput (vehicles passing a point in an hour) is highest. It is not the highest number of vehicles that can fit onto the road. It is therefore possible to have traffic volumes in excess of capacity. Capacity is measured in PCEs. Automobiles are always one PCE each and most heavy trucks are in the range of 2.5 to 4.0 PCEs each.

The delay experienced by all vehicles using a road segment during a time period (the total delay function) may be obtained by multiplying the volume-delay function by the volume (delay per vehicle times number of vehicles equals total delay). The change in total delay associated with the marginal vehicle is then the first derivative of the total delay function with respect to volume, evaluated at the observed volume. The delay imposed on other vehicles by the marginal vehicle is the increase in total delay associated with the marginal vehicle minus the delay experienced by that marginal vehicle itself (obtained from the original volume-delay function). Using the volume-delay function described above, this reduces to:

$$delay\ on\ others = \frac{\alpha\beta L}{FF}\left(\frac{V}{C}\right)^{\beta}$$

Exhibit 2-1 shows estimates of the delay imposed on others by the marginal vehicle at various levels of congestion on a freeway segment that is 1 mile long and has a free-flow speed of 65 mph.

Exhibit 2-1: Delay Imposed on Other Vehicles

Volume-Capacity Ratio	Delay per Vehicle (seconds)	Speed (mph)	Marginal Total Delay (seconds)	Marginal Delay Imposed on Others (seconds)
0.50	55	65	55	0
0.75	56	65	59	3
1.00	61	59	116	55
1.25	107	34	623	516
1.50	375	10	3,569	3,194

Determining the Value of Delay Imposed on Other Vehicles

The value of the delay imposed on other vehicles is the delay imposed on other vehicles (in hours) multiplied by the average value of time (in dollars per hour) for the other vehicles. Individual vehicles' values of time depend on the number of occupants in the vehicle and on the individual occupants' values of time. Information about an individual's overall value of time is revealed by their wage rate (the value at which they sell their time in the labor market), but may vary depending on the trip purpose, whether they are already late, the penalty they might face for being late, and the relative pleasantness of the time spent traveling. Because many people want to get to work on time and find driving in heavy traffic to be less pleasant, observed values of time are higher during peak commuting periods than at other times.

Information from other settings where travelers' values of time are revealed (where, for example, they have a choice of paying a toll to use a faster lane or staying in a congested lane for free) was used to develop a rough estimate of the average value of time for vehicles traveling on congested roads at congested times in Oregon. That estimate is $20.00 per hour.

The value of the delay imposed on other vehicles by the marginal vehicle is the efficient congestion fee for that road segment. From the example above, if the average value of time for other vehicles (taking into account occupancy, functional class, and time of day) is $20.00 per hour, the efficient congestion fee would be $0.02 per mile at 75 percent of capacity, $0.31 per mile at 100 percent of capacity, and $2.86 per mile at 125 percent of capacity. The fee is essentially zero when the segment is at 50 percent of capacity or less.

Determining the Amount of Fees that Would be Collected from Each Vehicle Class

To estimate the total fees that would be collected from each vehicle class under an efficient congestion fee, one multiplies the per-mile fee for each vehicle class (which takes into account PCE per vehicle) and each functional class at each time of day by the volume (in VMT) of vehicles in that class on that functional class at that time of day, and sums them over all functional classes and times of day.

Data Limitations

The main challenge in implementing the efficient congestion fee in highway cost allocation is that the necessary data are not available for every road segment. There are numerous limitations to the available data in the context of an efficient pricing approach:

- Hourly vehicle counts, by vehicle type, are available for fewer than 150 road segments out of the 34,855 segments in the HPMS database. Therefore, it is necessary to apply the vehicle activity distributions from a limited number of segments to all the segments in the Oregon system.
- Vehicle count information is available for 14 vehicle types (13 federal configurations plus triples), but not by weight class. Consequently, it is necessary to link vehicle types to vehicle weight classes.
- There are no officially adopted volume-delay relationships for each road segment. It is necessary to attribute such relationships using functional-class information from the HPMS. For the efficient fee method, standard BPR volume-delay relationships were applied to each segment with standard parameters appropriate to the segment's functional classification; these do not account for facility grade or other unique features.

The necessary statistics are derived by combining data from two sources: the ATR data collected at various stations around Oregon and the HPMS database produced by ODOT, which contains data and expansion factors for more than 30,000 road segments in the state. All freeway segments and most arterial segments are included in the HPMS database. Smaller roads are sampled and the expansion factors allow scaling up the information from the samples to obtain estimates for all roads. Fortunately for this project, the functional classifications where congestion is most likely to occur are the ones that are censused or most heavily sampled, and thus have the most reliable information.

Method for this Study

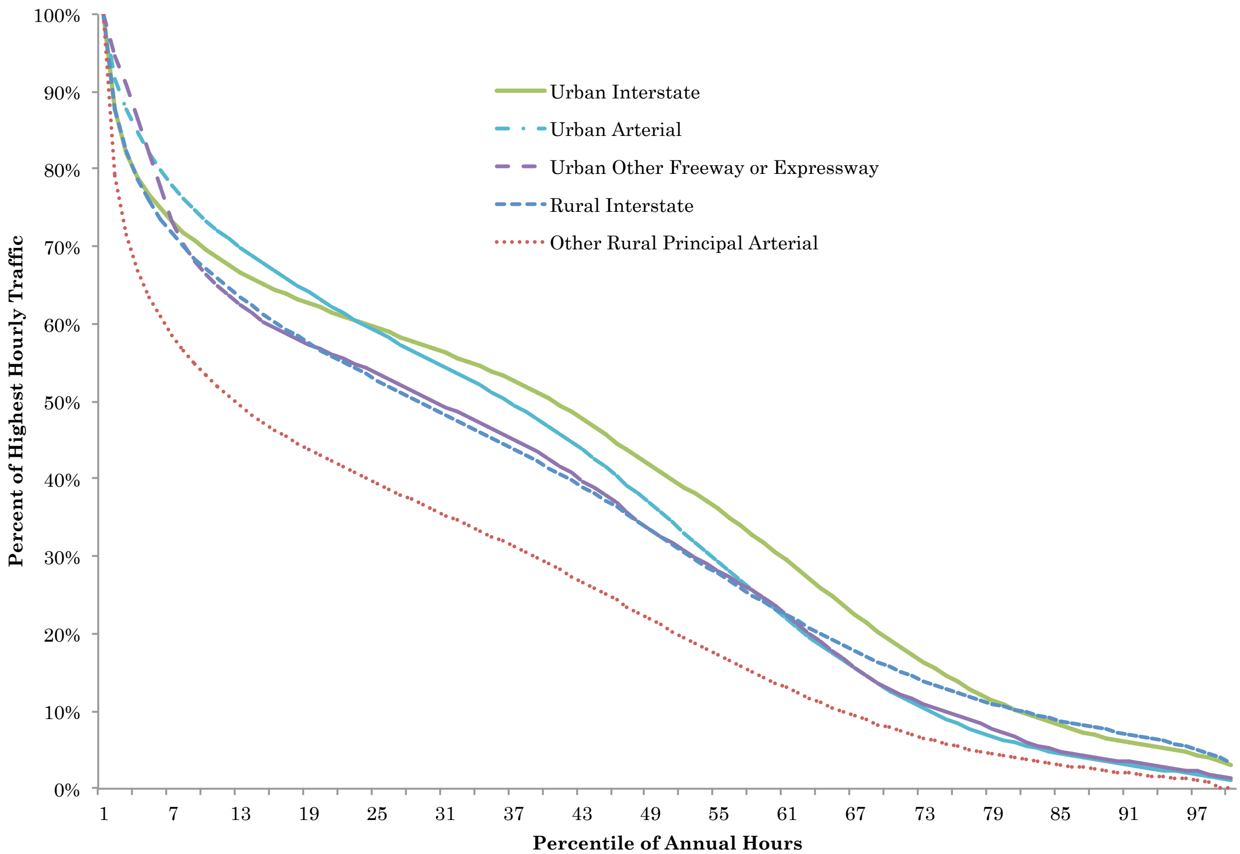
With the limited ATR data available in Oregon, it was necessary to use statistical methods to apply patterns observed in the small number of road segments with ATR stations to a much larger number of road segments in order to adequately represent the extent of traffic congestion on Oregon's roads. To accomplish this, the ATR data was used to construct "profiles" to represent the distributions of traffic volumes for each of the five most-congested functional classes: Rural Interstate, Rural Other Principal Arterial, Urban Interstate, Urban Other Freeway, and Urban Arterial. These profiles were then applied to every HPMS segment in those functional classes, along with their segment lengths and scaling factors, to estimate congestion fee collections statewide by functional class. For the purpose of this study, congestion fee collections from the seven least-congested functional classes were assumed to be zero.

For the purpose of estimating congestion fee collections, it is not necessary to model the changes in traffic levels over the course of a day, the days of a week, or the seasons of the year. We care about the total amount of fees collected in each hour of the year, but not about the order those hours come in. This simplifies the modeling because the hourly counts can be ordered from highest to lowest and all the issues related to diurnal traffic patterns or seasonal differences can be ignored. To construct the profiles, each hourly traffic count was converted to its percent of average annual daily traffic at that station. The resulting measure, which represents the share of average daily traffic in that hour, may be compared to the same measure from other ATR stations. All the observations were then combined for each of the five functional classes modeled and each set was sorted from highest to lowest (see Exhibit 2-2). Each functional class's profile consisted of 100 observations drawn at equal intervals from the sorted observations, that is, the 99.5th percentile observation down to the 0.5th percentile observation.

By combining the appropriate profile with the data available for each HPMS segment in the five functional classes, we were able to produce a set of 100 traffic volumes and corresponding volume-capacity ratios for each direction on each segment. Each observation represents 1/100 of the hours in the year (87.6 hours) and every hour is represented equally. The model assumes that 1/100 of the hours of the year will exhibit the congestion represented in the first observation, 1/100 of the hours will exhibit the congestion represented in the second observation, and so on.

For each direction of travel in each segment, the formulas described above were used to calculate the toll amount and toll collections at the observed, untolled traffic volumes. The toll amount, toll collections, and tolled traffic volumes were then estimated by repeatedly reducing the volume by one vehicle and recalculating the toll until the implied elasticity (percent change in traffic volume per percent

Exhibit 2-2: Functional Class Traffic Level Profiles



change in travel cost) equaled the assumed elasticity. The assumed elasticity was -0.04, which was obtained from the "Traffic Choices" congestion-pricing experiment conducted in the Seattle area.[1]

Toll collections at untolled and tolled volumes for the 100 observations for each combination of direction and segment were added together, divided by 100, and multiplied by 8,760 hours and the segment's expansion factor (see Exhibit 2-3). The expansion factor is 1.0 for all freeway segments, which are censused in the HPMS, and greater than 1.0 for HPMS segments in other functional classifications where the HPMS segments represent a sample of all segments in that classification.

Exhibit 2-3: Tolled and Untolled Congestion Fees, by Functional Class

Functional Class	Congestion Fees at Untolled Volume	Congestion Fees at Tolled Volume	Percent Difference
Rural Interstate	2,733,463	2,326,120	-14.9%
Rural Other Principal Arterial	1,204,413	987,005	-18.1%
Urban Interstate	44,088,425	32,176,618	-27.0%
Urban Other Freeway	349,524,920	142,231,030	-59.3%
Urban Arterial	40,421,868	31,762,146	-21.4%
Total	437,973,088	209,482,918	-52.2%

Findings

The congestion fee, as modeled, had substantial effects on congestion. It

[1] Puget Sound Regional Council. (2008). *Traffic Choices Study*. Prepared by the Puget Sound Regional Council for the Value Pricing Pilot Program, Federal Highway Administration, US DOT.

reduced the statewide cost of congestion-related delay by 51.5 percent, while reducing statewide travel by only 0.8 percent. The Urban Other Freeways and Expressways functional class, which includes Highway 217 and the portion of Highway 26 from Hillsboro to downtown Portland, accounted for 79.8 percent of the statewide delay cost, 67.9 percent of the toll collections, and 91.0 percent of the delay reduction from tolling. Urban Interstate Freeways (e.g., urban portions of I-5 and I-84) accounted for 15.4 percent of toll collections, and Urban Other Principal Arterials (e.g., Powell Boulevard in Portland) accounted for 15.2 percent. Rural freeways and arterials together accounted for less than 2 percent of statewide congestion fee collections.

Collections from the modeled congestion fee totaled $209.5 million per year (see Exhibit 2-4). Light vehicles would pay 96.0 percent of the congestion fees, or $201.2 million per year. Vehicles weighing between 10,001 and 26,000 pounds (e.g., delivery trucks) would pay 1.2 percent of congestion fees, or $2.4 million per year. Heavy trucks would pay 2.8 percent of congestion fees, or $5.9 million per year.

Under the congestion fee, for a given road at a given time, trucks would pay a higher fee per vehicle-mile than would cars because one truck uses up more of the available road capacity than does a car. The largest, heaviest trucks would pay 4.3 times per mile what a car on the same road at the same time would pay. A typical single-unit truck would pay about twice as much per mile as a car and a typical single-trailer semi would pay about three times as much per mile as a car. But because the mix of cars and trucks varies for different roads at different times, and cars are more likely to be present on congested roads, average fees per mile are nearly equal for cars and trucks.

Detailed results for the congestion fee can be found in Exhibits 7-4 and 7-5 of this report.

Exhibit 2-4: Annual Congestion Fees and Cents Per Mile, by Declared Weight Class[2]

Declared Weight (pounds)			Annual Congestion Fees	Share	Cents per Mile
1	to	10,000	201,183,857	96.0%	0.57
10,001	to	26,000	2,422,408	1.2%	0.39
26,001	to	78,000	1,321,276	0.6%	0.35
78,001	to	80,000	3,038,427	1.5%	0.26
80,001	to	104,000	659,452	0.3%	0.28
104,001	to	105,500	836,472	0.4%	0.31
105,501	and	up	21,026	0.0%	0.65
All			209,482,918	100.0%	0.55
10,001	and	up	8,299,061	4.0%	0.31
26,001	to	80,000	4,359,704	2.1%	0.28
80,001	to	105,500	1,495,924	0.7%	0.30
26,001	to	105,500	5,855,627	2.8%	0.29
26,001	and	up	5,876,654	2.8%	0.29

[2] The term *declared weight* is used in the tables throughout this report because it is the type of weight at which a good majority of the heavy VMT is reported and taxed. Technically, the weight applicable to vehicles up to 26,000 pounds is their registration weight, and the weight applicable to vehicles above 105,500 pounds (RUAF vehicles) is their permit gross weight.

Chapter 3

Wear-and-Tear Fee for Pavements

Transportation infrastructure may be built using a variety of designs, materials, construction techniques, and specifications. The resulting products serve the same purpose (carrying vehicles) but differ in capacity, strength, durability, resistance to environmental damage, construction cost, maintenance cost, and useful life.

The wear and tear imposed on a road by traffic in a year depends on the number of vehicles, the weight of the axle loads, the speed of the vehicles, and the weather. Heavier axle loads are much more damaging to pavements than are lighter loads (damage increases in approximate proportion to the cube of weight), but the amount of damage depends on the characteristics of the pavement (how thick it is and what it's made of), the strength and stability of the base under the pavement, and the condition of the pavement (once pavement starts to break apart, it deteriorates rapidly). If pavements were perfectly smooth, vehicle speed would not matter, but they aren't, and the force with which a tire strikes an irregularity on the surface is proportional to the square of speed. Studded tires grind ruts into the surface of pavements when there is not a layer of snow or ice between the studs and the pavement. This damage increases with the square of speed, all else equal.

Given expected levels and compositions of traffic over time, a set of environmental conditions, and a set of prices for materials, labor, etc., the optimal investment strategy for a road segment is the one for which the present value of costs over time is lower than for any other. From an agency perspective, costs include those for design, right-of-way, access, construction, maintenance, preservation, and reconstruction. From a user's perspective, costs include all of those (to the extent they are included in user fees) as well as user-borne costs such as delay and vehicle operating and maintenance costs. From society's perspective, costs include all of the above plus external costs borne by nonusers. The efficient fee approach prices the user delay and external costs separately, so for determining the wear-and-tear component of the efficient fee, the focus is on the agency-borne costs. The costs of the additional wear and tear on users' vehicles imposed by inadequate road maintenance are ignored, because those are already borne by users.

The optimal investment strategy depends greatly on the volume and composition of traffic. For a road that is expected to carry high volumes of heavy axle loads, building a solid, well-drained base with a thick, rigid (concrete) pavement makes the most sense. High initial construction costs are more than made up for by reduced maintenance and preservation costs over time. Heavy vehicles could be charged the amortized extra construction cost plus the (low) maintenance and preservation costs they impose on the durable pavement and still pay much less than if they were charged the (high) maintenance and preservation costs they impose on a thin, flexible (asphalt) pavement. On the other hand, if a road is not expected to carry many vehicles, particularly heavy vehicles, the savings in maintenance and preservation costs would never make up for the extra up-front construction cost of building a thick, durable road.

Units of Use

Because the amount of wear and tear imposed by a vehicle depends greatly on the weight on the vehicle's axles as it passes over the road, general measures of the number and travel of vehicles, such as average daily traffic (ADT) and vehicle miles of travel (VMT), are not good indicators of the wear and tear a particular traffic stream will impose. For this reason, engineers have developed alternative measures of traffic loads, such as equivalent single axle loads (ESALs) and load equivalence factors (LEFs).

Average Cost

Given some chosen investment strategy, the average cost per unit of use will be high at low-use levels, then fall as fixed construction costs are spread over more units of use until usage matches the level for which the investment strategy was optimized, and then rise again as maintenance and preservation costs per unit of use rise (because the facility was under-built for the usage it experienced). This is another way of looking at the investment-optimization process. The usage level for which an investment strategy is optimized determines the minimum-cost usage level for that strategy. For example, if heavy use is expected, it may be more economical to spend more on building a sturdier facility and spending less on maintenance, whereas if light use is expected, the additional cost of a sturdier facility might never be recovered through reduced maintenance costs.

Marginal Cost

The marginal wear-and-tear cost is the cost imposed by an additional unit of use. Like the average cost, it depends on the level of use, but unlike the average cost, it generally increases over the relevant range of use levels. This is mostly a result of shifting future maintenance and preservation activities closer to the present, increasing the present value of their cost. For example, if pavement must be overlaid after some number of vehicle miles of use, the undiscounted overlay cost per vehicle mile will be constant, but the discounted cost will be higher with higher use, because there will be fewer years of discounting.

Given some chosen investment strategy, the marginal cost will equal the average cost at the usage level where the average cost is minimized. As a result, average-cost pricing and marginal-cost pricing result in the same prices when engineers with perfect foresight are able to perfectly optimize the investment strategy. When usage exceeds the optimal level for a facility, marginal costs will exceed average costs and marginal-cost pricing will produce more collected fees than will average-cost pricing. When usage falls short of the optimal level, marginal costs will be lower than average costs.

Marginal-cost pricing produces the amount of fees necessary to optimize the system over time without requiring perfect foresight. Average-cost pricing "locks in" non-optimal investment levels that inevitably result from imperfect foresight. By incorporating a wear-and-tear fee based on marginal costs, and recalculating that fee periodically as system conditions and usage levels change, efficient fee pricing, combined with a policy of spending the collected fees on the facilities from which it was collected, pushes the system toward optimality over time.

The advantages of marginal-cost pricing derive from the effect such prices have on behavior. They guide users and agencies to make optimal use of and investments in facilities. Highway cost allocation by itself doesn't change behavior, so the advantages of marginal-cost pricing do not accrue from using marginal costs within highway cost allocation. The advantage of highway cost allocation is that the right level of costs is allocated to the vehicle classes. Getting the levels right is important because categories of costs are allocated differently and the dollar amount allocated in each category affects the overall results.

The Relationship between Marginal Cost and Average Cost

Small, Winston, and Evans[1] present a set of equations that relate the long-run marginal cost of pavement wear and tear to a simple version of average cost (cost of an overlay divided by the useful life of the overlay). The additional pieces of information needed are:

- The overlay interval in years
- The discount rate
- The traffic growth rate
- The environmental deterioration rate (determined by weather conditions)
- A measure of pavement thickness (structural number for flexible pavements or actual thickness for rigid pavements)
- The proportion of overlay cost that is pavement (and not labor or equipment)
- Whether the pavement is rigid (concrete) or flexible (asphalt)

The equation below combines the equations from Small, Winston, and Evans into one.

Given a set of parameters for this equation that represent a particular highway segment at a particular time, the relationship between long-run marginal cost and simple average cost is a constant proportion.

Estimating Pavement Wear-and-Tear Fees for Efficient Fee Highway Cost Allocation

The traditional approach to highway cost allocation in Oregon produces relative cost

$$\frac{MC}{AC} = \left[(rT)^2 \mathrm{e}^{rT} \Big/ \left(\mathrm{e}^{rT}-1\right)^2\right]\left[\left(\left(1-\mathrm{e}^{-fT}\right)\Big/ fT\right)\mathrm{e}^{mT} \Big/ \left(1+mT\left(1-\mathrm{e}^{-fT}\right)\Big/ fT\right)\right]\left[1+\frac{k_2}{k_m}(D+1)\left(\mathrm{e}^{fT/A_1}-1\right)\right]$$

where:

$MC =$ marginal cost

$AC =$ average cost

$T =$ overlay interval in years

$r =$ discount rate

$f =$ traffic growth rate

$m =$ environmental deterioration rate (ranges from 0.01 for dry, warm to 0.07 for wet, freezing; 0.04 is typical)

$\frac{k_2}{k_m} =$ proportion of overlay cost that is pavement (0.07 default)

$D =$ structural number (measures thickness; 0.44*pavement+0.14*base+0.11*sub-base)

$A_1 =$ coefficient on $\ln(D+1)$ in pavement life equation
5.04 for rigid or 7.76 for flexible

[1] Small, Kenneth A., Winston, Clifford, and Evans, Carol A. *Road Work: A new highway pricing and investment policy (*1969). The Brookings Institution.

factors for each combination of vehicle class and functional class. These are scaled so that when multiplied by the VMT for each vehicle class, they add up to one. Because the scaled factors sum to one, when they are multiplied by the expenditure amounts for the different functional classes, the product is the amount of expenditure for which that vehicle class is responsible. These pavement cost allocation factors are independent of the dollar amounts they are applied to and are equally valid for allocating marginal costs or average costs. The efficient fee method uses the same pavement cost allocation factors as the traditional method.

In the efficient fee method, the desire is to allocate marginal costs imposed, rather than expenditures. Marginal costs could be estimated by multiplying the annual cost of overlays and other preservation and maintenance activities by the appropriate ratios from the equation above. It is assumed that the budgeted maintenance and preservation expenditures used in the traditional study represent a lower bound on the simple average cost of providing steady-state maintenance and preservation for existing roads, because the agencies have stated that their existing maintenance and preservation budgets are inadequate to maintain the current state of the roads.

There is not sufficient information on parameter values to apply the marginal cost / average cost equation to every road in Oregon. Based on combinations of plausible value ranges for each parameter, marginal cost / average cost ratios are between 1.01 and 1.25. Because the budgeted expenditures are believed to represent a lower bound on the simple average cost of preservation and maintenance, a value from the high end of that range, 1.2, was used to scale up pavement costs from the traditional study.

The result is the same shares of cost responsibility as with the traditional method, but the dollar amounts allocated to each vehicle class are 20 percent higher.

Exhibit 3-1 displays the annual wear-and-tear fee for pavement for each summary weight class. Collections from the modeled fee totaled $453.0 million per year. Light vehicles would pay 34.2 percent of the fees, or $155.1 million per year. Vehicles weighing between 10,001 and 26,000 pounds (e.g., delivery trucks) would pay 6.6 percent of wear-and-tear fees for pavement, or $30.0 million per year. Heavy trucks would pay 59.1 percent of the fees, or $267.9 million per year. Heavy vehicles would have a predominant share of the responsibility for pavement wear-and-tear costs, and the cents-per-mile responsibilities would be significantly higher for heavy vehicles than for light vehicles.

Detailed results for the wear-and-tear fee for pavement can be found in Exhibits 7-4 and 7-5 of this report.

Exhibit 3-1: Annual Wear-and-Tear for Pavement Fees and Cents Per Mile, by Declared Weight Class

Declared Weight (pounds)			Annual Wear-and-Tear Fees	Share	Cents per Mile
1	to	10,000	155,074,838	34.2%	0.44
10,001	to	26,000	29,989,173	6.6%	4.82
26,001	to	78,000	29,107,058	6.4%	7.80
78,001	to	80,000	137,023,626	30.2%	11.71
80,001	to	104,000	39,133,692	8.6%	16.86
104,001	to	105,500	55,160,057	12.2%	20.72
105,501	and	up	7,521,108	1.7%	232.70
All			453,009,552	100.0%	1.19
10,001	and	up	297,934,714	65.8%	11.17
26,001	to	80,000	166,130,683	36.7%	10.77
80,001	to	105,500	94,293,749	20.8%	18.92
26,001	to	105,500	260,424,432	57.5%	12.76
26,001	and	up	267,945,540	59.1%	13.10

Chapter 4

Wear-and-Tear Fee for Structures

Under efficient pricing, the initial cost of a new structure (bridge) is paid from capacity fees, and the cost of future structures to replace the new structure when it wears out and the cost of routine maintenance are paid from a wear-and-tear fee.

As with pavements, the correct wear-and-tear fee for structures is the marginal cost, or the change in total cost imposed by the marginal user. Marginal cost per unit of use is determined by taking the first derivative of the total cost function with respect to use. The total cost function measures the present value of future expenditures, taking into account the effects of aging, the current amount of use, future growth in use, and the discount rate.

In traditional highway cost allocation studies, including Oregon's, all costs associated with structures are allocated using the incremental construction cost method. It costs a certain amount to build a bridge strong enough to carry a light vehicle and all vehicles share in that first increment of cost. It costs some additional amount to build a bridge strong enough to carry a heavier vehicle, and all heavier vehicles share in that increment of cost. In Oregon's traditional study, there are five increments. The heaviest trucks pay for all of the fifth increment, and for portions of the other four. This traditional, incremental method accounts for construction costs but does not address the effects of use by different vehicle classes on maintenance costs or replacement intervals.

The efficient fee approach seeks to determine the effects of use by vehicles of different weights on the full lifecycle costs of a structure. Even if it is never used, a structure will eventually deteriorate to the point where it could not safely be used and must be replaced. If a structure is used, it will wear out faster, and the more it is used, the faster it should wear out. Use by a heavy vehicle is likely to impose more stress and wear on a structure than use by a light vehicle. With appropriate engineering data, one could estimate the marginal cost imposed by a vehicle of a given weight. The study team sought such engineering data, but the necessary engineering studies have not yet been conducted. This chapter describes how one could develop a wear-and-tear fee for structures if the necessary engineering data existed, and also describes what was done for this study in the absence of such data.

The data needed for developing a wear-and-tear fee would not be used in the actual practice of bridge engineering or management. Safe operation requires periodic inspection and rating of every bridge, and maintenance and replacement activities are driven by the results of those inspections. The ability to predict when a bridge will wear out under varying levels of use is not useful to the agencies responsible for operating bridges because they care only about the actual condition of the bridge today and not what condition it might be in if past usage had been different.

The Effect of Aging on Consumption of Useful Life

Aging degrades a structure over time. The pure effects of environmental degradation have not been studied because no bridges are built to not be used and because such a study would take more than one human lifetime to complete. One plausible model of the effects of environmental degradation assumes exponential decay in the remaining life of a structure. This means that if engineers can estimate the half-life, or the number of years it would take for environmental degradation to consume half the useful life of the structure, assuming no use, one could calculate the rate of decay.

Without use, the fraction of total life that remains could be calculated as

$$remaining\,life = \mathrm{e}^{-mt}$$

where m is the rate of decay and t is the number of years that have passed.

If h is the estimated half-life in years, the corresponding value of m could be calculated as

$$m = \frac{-\ln(0.5)}{h}$$

For example, if a structure has a half-life of 100 years, the value of m would be 0.0069315.

The Effect of Use on Consumption of Useful Life

Given its durability, and ignoring the effects of aging for a moment, a structure will need to be replaced after some amount of use has degraded it to the point where it is no longer considered to be safe.

Use must be measured in units such that each unit of use degrades the structure by the same amount. Ignoring aging, the useful life of a structure may be defined in terms of some number of units of use,

$$L_0 = \frac{N}{Q}$$

where L_0 is the useful life in years (ignoring aging), N is the number of units of use composing the useful life of the structure, and Q is the number of units consumed each year.

Estimating Useful Life with Both Aging and Use

With both aging and use, the useful life of a structure is shorter than the calculation above would indicate. The useful life is used up when the portion consumed through use is equal to the portion remaining after aging.

$$L = t \text{ such that } \frac{tQ}{N} = \mathrm{e}^{-mt}$$

For example, if N/Q is 75 years and the half-life without use is 100 years, the useful life would be about 50 years.

Present Value of Costs Given Useful Life

The cost of the replacement structure to be built at the end of the initial structure's useful life, and the structure that will replace that one, and so on, may be discounted to present value and added to the cost of the initial structure to determine the present value of providing a serviceable structure forever. At any discount rate greater than zero, the present value into perpetuity is finite and calculable. The present value of the cost of all future replacement structures is

$$PV = \frac{C}{(1+r)^L - 1}$$

where C is the cost of the structure in today's dollars, r is the real annual discount rate, and L is the useful life.

Accounting for Growth in Use Over Time

If use grows over time, the present value of total cost will increase because either the intervals between replacements will shrink, or replacements will be built to be more durable, adding to the cost. Some combination of more-durable replacements and shorter replacement intervals will result in the minimum present value of total cost, given the rate of increase in use and taking into account the effects of aging, which are diminished by a shorter replacement interval.

We can find the replacement interval without aging from

$$L_0 = \frac{\ln\left(g\frac{N}{Q}+1\right)}{\ln(1+g)}$$

where L_0 is the useful life in years (ignoring aging), N is the number of units of use composing the useful life of the structure, Q is the number of units consumed in the first year, and g is the annual rate of growth in use.

For example, assume $N = 75$ million and $Q = 1$ million. L_0 would be 75 if Q did not grow. But if Q grows at one percent per year, L_0 becomes

$$L_0 = \frac{\ln\left(0.01\frac{75{,}000{,}000}{1{,}000{,}000}+1\right)}{\ln(1+0.01)} = 56.24 \text{ years}$$

The effect of aging may be incorporated in the same way by considering the replacement interval without any growth in the use of the structure, though with the shortened life from use, the effect of aging on the resulting useful life is less dramatic.

Present Value with Growth in Use

With even moderate growth in use over the life of a structure (typically 50 to 100 years), the capacity of the structure (mostly determined by the number of lanes) will limit the ability of the structure to carry more traffic. If there is non-trivial growth in use, it is likely that additional capacity will be added at the time the structure is replaced, either by adding a second structure or by adding width to a single replacement structure. The cost of increased capacity is assumed to be linear in capacity, that is, that either two two-lane bridges or one four-lane bridge will cost approximately twice as much as one two-lane bridge. In that case, the ratio of Q to N on the replacement structure(s) will be reset to approximately what it was on the initial structure and, if growth in use continues at the same rate, L for the replacement structure will be approximately the same as it was for the first structure. Because the additional capacity in the replacement structure(s) would be paid for from the capacity fee, rather than the wear-and-tear fee, C remains the same, and we may continue to use the simple formula for present value.

Marginal Cost

Marginal cost is the first derivative of total cost. If one takes the formula for the present value of total cost, substitutes in the formula for L with aging and growth in use, and then takes the first derivative, one has the formula for marginal cost. That formula is very complex and takes a full page to write out, but it is calculable if the necessary parameter values are available.

The derivative of present value with respect to Q incorporates the effect of the growth-in-traffic assumption, which is relevant but causes the derivative to overstate the marginal cost imposed by an additional vehicle because it also includes the marginal cost imposed by additional, fractional vehicles in subsequent years. This can be corrected for by scaling by the ratio of the present value of constant level traffic (i.e., no growth applied) to the present value of grown traffic over the life of the structure.

Estimating Structure Wear-and-Tear Fees for Efficient Fee Highway Cost Allocation

The formulas presented above describe a method for calculating efficient fees for structure wear and tear but require the following information in order to be applied:

- The rate of decay from environmental conditions (or the half-life of the structure without use)
- The development of units of use and the calculation of the number of units per vehicle for each vehicle class
- The number of units of use that would use up each structure's useful life, assuming no environmental degradation
- The number of units of use per year for each structure (from traffic counts by weight and configuration)
- The cost of each structure
- The rate of growth in use for each structure

The first two would come from bridge engineering research, but the necessary research has not been conducted. Some research has been conducted on the relationships between both environmental factors and repeated loads and the probability of failure, and a probabilistic approach is required given the nature of bridge failure (bridges fail suddenly; they don't slowly sink into the river). The useful life of a bridge ends just short of the point where the probability of failure becomes unacceptably high. However, that research has not been carried through to the point of being able to estimate either the half-life without use, or the useful life with different levels of use for a particular bridge, given its design and construction. We also don't have good information on the amount of use by vehicles of different weights and axle configurations for many bridges in Oregon.

Because the formulas developed for this chapter could not be applied, the results of the traditional study were used to develop wear-and-tear fees for structures (see Exhibit 4-1). The proportions of costs allocated to the different vehicle classes, as well as the dollar amounts, may be different from what would be obtained by applying the method described above. Collections from the fee as modeled totaled $163.3 million per year. Light vehicles would pay 44.8 percent of the fees, or $73.2 million per year. Vehicles weighing between 10,001 and 26,000 pounds (e.g., delivery trucks) would pay 6.6 percent of

Exhibit 4-1: Annual Wear-and-Tear for Structures Fees and Cents Per Mile, by Declared Weight Class

Declared Weight (pounds)			Annual Wear-and-Tear Fees for Structures	Share	Cents per Mile
1	to	10,000	73,174,737	44.8%	0.21
10,001	to	26,000	10,812,875	6.6%	1.74
26,001	to	78,000	7,648,970	4.7%	2.05
78,001	to	80,000	25,543,554	15.6%	2.18
80,001	to	104,000	20,618,738	12.6%	8.88
104,001	to	105,500	25,214,789	15.4%	9.47
105,501	and	up	325,068	0.2%	10.06
All			163,338,731	100.0%	0.43
10,001	and	up	90,163,995	55.2%	3.38
26,001	to	80,000	33,192,524	20.3%	2.15
80,001	to	105,500	45,833,527	28.1%	9.20
26,001	to	105,500	79,026,051	48.4%	3.87
26,001	and	up	79,351,120	48.6%	3.88

wear-and-tear fees for structures, or $10.8 million per year. Heavy trucks would pay 48.6 percent of the fees, or $79.4 million per year. Cents-per-mile responsibilities would be higher for heavy vehicles than for light vehicles.

Detailed results for the wear-and-tear fee for structures can be found in Exhibits 7-4 and 7-5 of this report.

Chapter 5

Fee to Recover Administrative and Other Costs

The cost of administering Oregon's roads includes significant expenditures not recovered by congestion charges or wear and tear fees. These may be combined together as "administrative and other costs" and include:

- Preliminary engineering
- Right-of-way acquisition and property management
- Safety-related projects
- Pedestrian/bike projects
- Railroad safety projects
- Fish- and wildlife-enabling projects (e.g., salmon culverts)
- Transportation demand management and transportation system management projects (e.g., Traffic Operations Centers)
- Multi-modal projects
- Transportation project development and delivery
- Transportation planning, research, and analysis
- Maintenance activities not related to pavements or bridges (e.g., maintenance of roadside, traffic service, and safety items)
- General administrative activities

For the 2011-13 biennium, these expenditures sum to nearly $1.5 billion, or almost 49 percent of total expenditures.

Collections from the emissions fee may be used to offset these administrative costs. Since the purpose of the emissions fee is to incorporate the external costs of emissions into the price faced by those who undertake the activities that produce the emissions, the collection of the emissions fee is sufficient to achieve its goal.

Once the emissions fees are collected, the expenditure of those funds should be guided by the level of net benefits the expenditure produces for those who paid them. In this case, the emissions fees are paid by highway users, and so may be used to provide cost-effective administrative and other support for highway programs. The emissions fee would produce $987 million in collections in the 2011-13 biennium, which would cover more than two thirds of the administrative costs, leaving $479 million to be collected from an administrative fee.

The administrative fee is implemented for the purpose of this study as a simple, per-vehicle-mile-traveled charge, which is how almost all of these expenditures are allocated under the traditional method of highway cost allocation. Issue Paper 7 in Appendix B of the separate technical appendices document addresses the issues surrounding the allocation of costs that are not directly imposed by the use of highways and describes the rationale for allocating those costs on the basis of vehicle miles traveled. That charge comes out to a flat

0.63 cents per mile and applies equally to all vehicle classes (see Exhibit 5-1). As modeled, light vehicles would pay a large majority ($222.6 million, or 93.0 percent) of the annual administrative fees because they account for that share of total vehicle miles traveled.

Detailed results for the administrative fee can be found in Exhibits 7-4 and 7-5 of this report.

Exhibit 5-1: Annual Administrative Fees and Cents Per Mile, by Declared Weight Class

Declared Weight (pounds)			Annual Administrative Fees	Share	Cents per Mile
1	to	10,000	222,587,300	93.0%	0.63
10,001	to	26,000	3,909,236	1.6%	0.63
26,001	to	78,000	2,346,283	1.0%	0.63
78,001	to	80,000	7,351,826	3.1%	0.63
80,001	to	104,000	1,458,771	0.6%	0.63
104,001	to	105,500	1,672,864	0.7%	0.63
105,501	and	up	20,313	0.0%	0.63
All			239,346,592	100.0%	0.63
10,001	and	up	16,759,292	7.0%	0.63
26,001	to	80,000	9,698,108	4.1%	0.63
80,001	to	105,500	3,131,635	1.3%	0.63
26,001	to	105,500	12,829,743	5.4%	0.63
26,001	and	up	12,850,056	5.4%	0.63

Chapter 6

Emissions Fee

The operation of motor vehicles produces air emissions from fuel combustion (exhaust emissions) and evaporation, and also from particulates produced by brake and tire wear. Air emissions are themselves air pollutants, or precursors, reacting with other gases and particles in the air to form secondary air pollutants. Air emissions impose costs because of their adverse effects on human health, agricultural yields and plants, animals, and property. In addition to emitting air pollutants, motor vehicles are a significant source of greenhouse gas emissions (carbon dioxide [CO2] being the primary greenhouse gas). Greenhouse gases may contribute to global climate change, the costs of which may be borne many decades in the future.

In the efficient fee approach to highway cost allocation, prices are charged for highway use based on the actual costs imposed by each vehicle class, as opposed to the highway expenditures associated with each class. Efficient pricing includes charging fees based on a vehicle's contribution to roadway wear-and-tear and fixed costs, as well as the vehicle's contribution to roadway congestion and other external costs imposed by the operation of the vehicle. The costs related to air emissions are external costs because road users do not bear these costs in relation to their road use.

A number of factors influence emissions rates, ambient air pollution levels, and the incremental cost of an additional unit of air pollutant. Emissions rates vary by vehicle class, primarily because of vehicle size and weight, and are also influenced by numerous other vehicle and operational characteristics (e.g., engine type, fuel type, age, operating speeds, number of starts and stops, and rates of deceleration and acceleration). The incremental (additional unit) cost of emissions also varies by location because of ambient emissions levels (which are influenced by atmospheric conditions, topography, chemical reactions to other pollutants, seasonal variations in ambient conditions, etc.), exposure levels, and the types and amount of local resources exposed.

The purpose of this chapter is to describe some existing methods used to quantify and value vehicle emissions, and to present the method used to estimate the efficient emissions fees in this study. The basic approach used to calculate the emissions fees for criteria pollutants (e.g., volatile organic compounds [VOC], particulate matter, sulfur dioxide) was to first determine the per-mile emissions rates by vehicle class and speed. These emissions rates reflect the current vehicle fleet and assume there are no behavioral responses in terms of the fleet or vehicle usage in response to the emissions fees. Next, the cost per additional unit emitted for each pollutant was applied to its corresponding emissions rate to determine the appropriate emissions fee. This method produced emissions fees that reflect the incremental cost imposed per unit of emissions per vehicle mile.

The emissions fee for CO_2 was estimated by first calculating the total amount of CO_2 emissions by estimating total fuel consumption from vehicle miles traveled (VMT) and miles per-gallon (MPG) assumptions, then converting fuel consumption into CO_2 emissions. The social cost of carbon was then applied to the CO_2 emissions to determine the total CO_2 efficient fees.

Because efficient emissions fees will not be charged during the study period, behavior will not change, so the efficient emissions fees approach estimates user responsibility for external emissions costs under current law revenue instruments, which is the goal of the highway cost allocation study. For implemented efficient emissions fees to have the desired behavioral response, the fees should be as close as possible to the actual, context-specific cost of a vehicle's emissions. In practice, it would be difficult to levy differentiated emissions fees for every individual vehicle, by time and location. However, the "flatter" or more averaged the emissions charge becomes, the weaker its rationale. As the results of the efficient emissions fee method demonstrate, CO_2 emissions constitute the majority of the emissions measured. Because CO_2 emissions are directly related to fuel consumption, and the equivalent per-gallon emissions fees are similar to existing fuel use tax rates, one would expect behavioral responses similar to those for existing fuel taxes.

The remainder of this chapter provides some background on vehicle emissions and describes approaches and the actual implemented methodology for determining the efficient emissions fees.

Background

The U.S. Environmental Protection Agency (EPA) regulates air pollutants that are harmful to humans and the environment. Carbon monoxide, nitrogen oxides, and VOC are regulated under the Clean Air Act, with grams-per-mile standards for automobiles. Vehicle manufacturers meet these per-mile standards through emissions control systems and vehicle fuel economy. Assuming proper maintenance of emissions control systems, tailpipe emissions of criteria pollutants do not vary much with vehicle fuel economy, but are mostly a function of vehicle miles traveled and vehicle age, because emissions control systems deteriorate with both vehicle age and use.

Toxic air pollutants are another category of air pollutants regulated by the EPA. Air toxins are pollutants that cause, or may cause, cancer or other serious reproductive and neurological health effects, or have other serious environmental and ecological effects. The EPA is required to regulate 187 air toxins. Benzene, formaldehyde, acetaldehyde, 1,3-butadiene, and diesel particulate are all air toxins emitted by motor vehicles.

As with criteria air pollutants, damages imposed by air toxins are local in nature, but in general, less is known about the effects and cost of toxic air pollutants. The exact relationship between concentrations of air toxins and health responses (called the dose-response) is difficult to define because much of the research on the carcinogenic effects of air toxins relies on laboratory experiments in which animals are given toxin doses that are much higher than the concentrations of air toxins people are exposed to in typical ambient air conditions. Thus, the effects at lower concentration levels have been harder to quantify and isolate from other factors.

Carbon dioxide is the primary greenhouse gas produced by motor vehicles and is now regulated explicitly by the EPA, although the National Highway Traffic Safety Administration (NHTSA) has also regulated average fuel economy, which affects CO_2 emission levels, since the first Corporate Average Fuel Economy (CAFE) Standard legislation was passed by

Congress in 1975. Unlike criteria pollutants and air toxins, whose effects are local, greenhouse gas emissions contribute to global climate change. Thus, a ton of CO_2 emitted anywhere in the world has the same contribution toward climate change and the same global marginal cost.

Implementing the Efficient Pricing Approach

Implementing truly efficient emissions fees, that is, fees that capture actual differences in emissions levels and the marginal costs associated with the emissions, would require the following:

1. Calculation of the emissions rate (measured in grams per mile) for different vehicle types, speeds, locations, and/or roadway functional classes for each pollutant. Truly efficient emissions fees would calculate the fees using actual emissions levels, determined for each individual vehicle, by location and time of day.
2. Determination of the marginal cost per unit emitted for each type of pollutant, by location, day, and time. The marginal cost of each pollutant is the cost, in dollars per gram or ton, associated with the damage to human health, property, and the environment caused by the pollutant, which is highly dependent on ambient conditions and the size of the exposed population.
3. Multiplication of the emissions rate (grams per mile) by the marginal cost (dollars per gram) for each pollutant to determine the efficient emissions fee per mile for that pollutant for each vehicle, location, and time.
4. Application of the emissions fees to the corresponding VMT, again specific to vehicle, time, and location and summation for each vehicle class to determine the total amount of fees that would be collected from efficient emissions fees.

In this chapter, we address air emissions and the costs of those emissions related to vehicle operation. A lifecycle analysis of air emissions related to motor vehicles would account for tailpipe emissions, the upstream emissions associated with refinement and transportation of fuels, and the carbon emissions related to vehicle production.

Emissions fees could be charged per mile, but some emissions, particularly those of CO_2, are highly correlated with fuel consumption, which suggests that fuel-based (per gallon) fees may be more logical. Emissions associated with electric vehicles are upstream, and not at the tailpipe. Ideally, efficient emissions fees would be levied at the point of electricity distribution. In that case, operators of electric vehicles would pay equivalent efficient emissions fees as a per-kilowatt-hour charge on their electric bill. Otherwise, emissions fees based on electricity generation would need to be assessed as a per-mile fee on the operation of electric vehicles.

Determining the Per-Mile Emissions Rates for Criteria Pollutants

Emissions rates express the grams per mile of pollutants emitted by motor vehicles. Mobile source emissions models have been developed by the EPA, U.S. Department of Energy, and U.S. Department of Transportation for determining the total amount of mobile source emissions for use in state implementation plans and air quality conformity modeling required under the Clean Air Act. These mobile source emissions models are based on emissions rates that are sensitive to the fleet composition and utilization, vehicle operational characteristics, and regional atmospheric conditions (e.g., temperatures, relative humidity).

MOVES2010 is the new mobile source emissions model developed by the EPA for state implementation plans (SIPs) and transportation conformity analysis. MOVES2010 is capable of calculating emissions rates for 13 vehicle classes and 16 average speeds. While emissions rates vary across vehicle types, vehicle weight is not an explicit parameter in MOVES2010.

MOVES2010 was developed from the EPA's prior mobile source emissions model, MOBILE, with enhancements and updates based on millions of additional vehicle emissions measurements from vehicle inspection and maintenance (I/M) programs, remote sensing device (RSD) testing, certification testing, and portable emissions measurement systems. MOVES2010 also includes updated models of dispersion and a state-of-the-practice understanding of the relationship between atmospheric chemistry related to exposure and the formation of secondary pollutants.

Because emissions rates are sensitive to fleet characteristics, especially fleet composition and vehicle age, mobile source emissions models typically contain some type of simplified fleet model. Fleet models contain information on the fleet composition (vehicle and fuel types), initial age distributions, and future model-year vehicle sales forecasts, vehicle survival rates, utilization by vehicle age, and speed distributions. For example, in MOVES2010, information from the fleet model is used to adjust emissions rates to reflect the effect of the deterioration of emissions control systems as a function of vehicle age and accumulated mileage. Default national fleet distribution and vehicle activity data are used with county-specific meteorological data (average temperatures and humidity) to calculate emissions rates when local fleet information is not available.

Carbon dioxide emissions are directly related to fuel consumption. The Intergovernmental Panel on Climate Change (IPCC) has issued guidance on the calculation of CO2 emissions based on the average fleet fuel economy and carbon content of fuels, a very straightforward calculation if average fleet fuel economy is known.

Determining the Cost Per Additional Unit Emitted

Efficient emissions fees could be assessed on a per-mile basis, determined by the per-mile emissions rate and the per-unit (e.g., per gram or ton) cost associated with the emission of an additional unit of pollutant. With the per-mile emissions rates tabulated for each vehicle class and functional class, based on output from mobile source emissions models, the remaining parameter needed for the calculation is the per-unit cost of an additional unit of pollutant.

Estimates of the per-unit cost of air pollution are traditionally calculated using a "multi-step, damage-function" approach. The first step in this method is to determine the change in the ambient air concentration of pollutants attributable to vehicle emissions. Next, the physical effects (damages) associated with exposure to pollutants are determined based on the published epidemiological and scientific literature. In the final step, the dollar estimate of the cost of an additional unit of pollutant is determined through the monetization of the physical effects associated with exposure to air pollutants.

The major damage (cost) categories associated with air emissions from motor vehicle use are listed below. The first five categories apply to criteria or toxic air pollutants. Global climate change, the final category, is associated with greenhouse gases and encompasses both human and environmental costs that may occur in the future.

Human-Health Effects: Human-health effects comprise the largest category of damages associated with air emissions. Numerous human-health conditions, such as eye irritation and coughing, respiratory problems, cardiovascular disease, neurological diseases, and premature death, are associated with exposure to air pollutants. Human-health effects are typically divided for valuation purposes into premature deaths and increased rates of illness.

Reduced Agricultural and Forest (Timber) Yields: Air emissions can negatively affect agricultural yields and timber harvests. Ozone, a secondary pollutant formed by the reaction of VOCs and nitrogen oxides (NOx) in sunlight, can reduce the efficiency of photosynthesis, thereby reducing agricultural and timber harvest yields.

Visibility Costs: Costs associated with visibility are generally aesthetic, although poor visibility can also hinder traffic safety.

Ecosystem/Environmental Costs: Environmental damage to plant life and species, not related to agriculture, is due primarily to the interference of ozone with photosynthesis, leaving plant life more susceptible to diseases, insects, and other damage. Reduction in forest growth and plant life can affect species diversity in ecosystems.

Other Damages: Other damages associated with air emissions include damage to buildings, paint, and other infrastructure, requiring increased maintenance due to corrosion or other physical damage from air emissions.

Global Climate Change: The primary impacts of climate change are believed to include higher temperatures, rising sea levels, and increased weather variability. The net damages, or costs, associated with climate change are due to changes in agricultural yields, human health (including the spread of tropical diseases), property damage due to flooding, and damage to ecosystems. Future costs associated from global climate change are estimated separately from health and other damages caused contemporaneously with criteria pollutant emissions.

The damage-function approach used to calculate the cost of emissions is implemented in integrated assessment models. Integrated assessment models contain both the physical models of the emissions and damages and the economic models for valuation. The physical models of dispersion, meteorology, and atmospheric chemistry determine the changes in ambient air concentrations from the emission of an additional unit of pollutant. Epidemiological, clinical, or animal laboratory studies of the physical effects of exposure to air pollution are used to develop exposure-response functions, which describe the relationship between exposure to an airborne pollutant and a particular health (or other) effect.

Once the physical effects associated with air pollution exposure are quantified, they are assigned a dollar value. The cost of illness associated with air emissions includes the valuation for chronic asthma, chronic bronchitis, and other costs of illness (medical expenses plus lost wages). Estimates of the value of a statistical life for the valuation of the mortality effects of emissions have been developed from revealed preference studies of purchases of products that reduce safety risks (e.g., bike helmets) and from hedonic wage models of the wage premium in dangerous occupations.

Determining the (Social) Cost of Carbon

In the case of greenhouse gas emissions, estimates of the cost of an additional ton of CO_2 are also typically produced using integrated assessment models. These models combine the geophysical modeling of climate change (e.g., climate models) with models of economic growth and the future cost of the damage associated with the physical effects of climate change. Climate models determine the relationship between additional output of CO_2 and the concentration of CO_2 over time. These models also illustrate relationships between CO_2 emissions rates and levels (inventories) with changes in temperatures and sea levels. Economic growth models estimate the optimal, least-cost emissions reduction path, balancing current expenditures for CO_2 reduction with the future expected costs associated with the effects of climate change.

In March 2010, the federal government published guidance on the social cost of carbon to be be used in federal regulatory impact assessments. A U.S. federal interagency working group selected four estimates for the social cost of CO2 ($/tCO2, 2007 dollars): $5, $21, $35, and $65. The first three estimates are based on the mean estimates from integrated assessment models, using discount rates of 5 percent, 3 percent, and 2.5 percent, respectively. The value of $65/tCO2 is based on the 95th percentile cost, using a discount rate of 3 percent. This higher value is intended to reflect higher-than-expected costs from climate change and the fact that there is a long right tail in the distribution of CO2 cost estimates. Exhibit 6-1, taken from the federal guidance, displays the per-metric-ton cost of CO2 for the years 2010 through 2050 for the four different selected estimates.

In the discussion of the current and future value of the cost of carbon, there is often mention of the "climate-policy ramp" or the increase in the cost of carbon over time. The current cost of carbon is relatively modest, compared to the cost of carbon projected in future years. By the middle of this century, the cost per ton of CO2 is expected to be more than double the current value, growing at a rate of 2 percent to 4 percent per year.

Exhibit 6-1: Social Cost of Carbon Dioxide, 2010-2050 ($/metric ton, in 2007 dollars)

	Discount Rate and Estimate			
	5%	3%	2.5%	3%
Year	Average	Average	Average	95th percentile
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

Source: Table 15A.1 Social Cost of CO2, 2010-2050, (in 2007 dollars), Appendix 15A. Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.

Determining the Efficient Fees Collected from Each Vehicle Class

To estimate the amount of collections under efficient emissions fees, one would multiply the per-mile fee for each vehicle, location, time, and speed by the corresponding VMT for each vehicle, by location, time, speed, and other operating conditions. The efficient fees that would be collected from each vehicle class under a system of efficient emissions fees are then equal to the amount of emissions damage costs that would be allocated to that class in an efficient fee-based highway cost allocation study. The total efficient emissions fee collections from each vehicle class is the sum of the efficient emissions fees that would be collected from all the individual vehicles in that class.

Method for this Study

Given the data limitations listed above, a practical approach based on available data was used to calculate emissions fees for the purpose of the present efficient fee study. When feasible, Oregon-specific and vehicle class-specific information was used to determine emissions rates and the associated costs required to calculate the efficient emissions fees.

Criteria emissions rates (grams per mile) were produced using the MOVES2010 model. To address variation in the emissions rates, which are affected by ambient conditions, particularly with respect to time of day and day of year, the MOVES2010 model allows for time aggregation, applying default VMT distributions by hour of the day and day of the year. Similarly, the default distributions for vehicle model year and utilization by model year capture variation in emissions rates due to characteristics and operation of the fleet. After reviewing the MOVES emissions rates assumptions and source data for different vehicle types, the most appropriate vehicle types were matched to the HCAS weight classes.

Two MOVES model runs were produced, each run producing emissions rates by vehicle type and roadway functional class, but with the different runs corresponding to different geographic scales. Oregon counties were categorized as either urban or rural, with the geographic scale of the two MOVES runs corresponding to this rural/urban classification.[1] The decision to develop emissions rates by vehicle class and roadway functional system for the rural/urban classification stemmed from the availability of marginal cost data at the county level and the lack of vehicle class-specific VMT at the county level. The use of the rural/urban emissions rates with the values of the marginal cost for each pollutant and the HCAS VMT is discussed in more detail below.

Carbon dioxide emissions were directly estimated using the HCAS model year VMT and MPG and diesel-gasoline split assumptions. The assumed, average MPG for each weight class was applied to the weight class model year VMT to determine the number of gallons of fuel consumed by that class. Fuel consumption was split into gallons of gasoline or diesel using the light and heavy vehicle "percent of gallons that are diesel" assumptions. Gallons of gasoline (diesel) consumed by each weight class were then converted to tons of CO2 emissions using the CO2 emissions formula recommended by the EPA and the IPCC. This formula takes the carbon content per gallon of fuel, applies an oxidation factor of 0.99, which represents the amount of carbon in the fuel that is oxidized into emissions, and then multiplies by the ratio of the molecular weight of CO2 to carbon to determine the CO2 emissions produced from vehicle fuel consumption. To convert total CO2 emissions back to CO2 grams per mile, the CO2 emissions of each weight class are divided by the corresponding VMT of that class.

With the emissions rates measured in physical quantities (grams, or converted to tons), the next step in the calculation of the efficient emissions fees is to apply the marginal cost to those rates.

A recently published paper by Muller and Mendelsohn[2] estimates source-specific damage estimates for point sources and mobile (ground) sources for every U.S. county in the 48 contiguous states, based on county-specific emissions inventories and population data. Their model contains a simple dispersion model for estimating the effects of atmospheric chemistry on ambient air pollution concentration levels. County-specific resources, such as population and agriculture, are used with damage functions to determine the costs associated with one additional ton of pollutant generated in each county. This methodology includes attributing the cost of damages from secondary pollutants back to the primary emission. Thus, when applying these marginal cost estimates it is appropriate to only account for primary emissions, because including secondary pollutants will double count the costs.

Muller and Mendelsohn's county-level marginal cost estimates were used with estimates of 2009 county-level VMT for state-owned highways[3] to determine the average marginal cost for rural and urban parts of the state. Exhibit 6-2 displays these rural and urban county VMT-weighted average marginal costs. While VMT estimates by county exist for state-

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[1] For this study, urban counties were defined as Clackamas, Deschutes, Jackson, Lane, Marion, Multnomah, and Washington. It is recognized that county boundaries imperfectly capture distinctions between rural and urban areas.

[2] Muller and Mendelsohn (2009). Efficient Pollution Regulation: Getting the Prices Right. *American Economic Review* 99:55, 1714-1739.

[3] ODOT. Oregon Vehicle Miles of Travel on state-owned highways within each county (2009). Available online: http://www.oregon.gov/ODOT/TD/TDATA/tsm/vmtpage.shtml#Oregon_VMT_by_County

Exhibit 6-2: Marginal Cost of Emissions for Rural and Urban Areas, VMT-Weighted State Averages ($ per ton, in 2012 dollars)

County	Ammonia (NH3)	Particulate Matter (2.5)	Nitrogen Oxides (NOx)	Sulfur Dioxide (SO2)	Volatile Organic Compounds (VOC)
Rural	757	1,244	193	722	145
Urban	3,541	3,263	306	1,370	366

owned highways, these estimates are not broken down by vehicle type or weight class.

Given that the three pieces of information (i.e., emissions rates, marginal costs, and VMT) needed to calculate the emissions fees were available in slightly different dimensions, the rural/urban approach was taken to allow for county differences in the MOVES model and in the marginal cost estimates from Muller and Mendelsohn, while allowing for aggregation with HCAS VMT. Thus the MOVES emissions rates, aggregated across rural and urban counties, have some county variation, as do the county VMT-weighted marginal costs applied to the emissions rates.

The last step to calculate the criteria emissions fees by vehicle class is to multiply and sum the rates and costs by VMT by functional class for each vehicle class. For this calculation, the rural emissions rates and marginal costs are applied to rural functional class VMT, and similarly the urban emissions rates and marginal costs are applied to the urban functional class VMT.

Based on the guidance from the Federal Interagency Working Group on the Cost of Carbon, the social cost of carbon used for the efficient CO2 emissions fee is $24.10 per (metric) ton. This is the cost for the year 2012, determined using a 3 percent discount rate and applying the US Gross Domestic Product implicit price deflator to convert the estimate of $22.40 in 2007 dollars to 2012 dollars. Total CO2 emissions for each weight class are multiplied by the social cost of carbon to determine the total collections from each class under a CO2 emissions fee.

Findings

The emissions fees, as calculated for this study, represent 31.7 percent of the total hypothetical collections under the efficient fee approach. Pavement wear-and-tear fees, the second largest source, represent 29.1 percent of total efficient fees. Emissions fee collections are also significantly larger than those from congestion fees, which account for only 13.4 percent of the total efficient fees.

Collections from the modeled emissions fees total $493.6 million per year. Light (up to 10,000-pound) vehicles would pay 78.1 percent of the emissions fees, or $385.6 million per year. Vehicles weighing between 10,001 and 26,000 pounds would pay 3.3 percent of the emissions fees, or $16.3 million. Heavy trucks weighing 26,001 pounds and up would pay $91.7 million, or 18.6 percent of the total emissions fees.

The CO2 component of the modeled emissions fees account for $480.2 million, or 97.3 percent, of the total emissions fees (see Exhibit 6-3). Since CO2 emissions are essentially proportionate to fuel consumption, implementing CO2 emissions fees on a per-gallon basis may be appropriate. The CO2 emissions fee calculated in this study is roughly equivalent to a gasoline tax of $0.23 per gallon and a diesel tax of $0.27 per gallon.

Despite much higher marginal costs per ton emitted, criteria pollutants impose a relatively small proportion of cost responsibility in the efficient fee approach.

Exhibit 6-3: Efficient Emissions Fees by Pollutant and Vehicle Summary Weight Class

Criteria Pollutants

Declared Weight (pounds)			CO2 Fee	NH3 Fee	SO2 Fee	NoX Fee	VOC Fee	Particulate Matter Fee	Criteria Emissions Fee	Total Efficient Emissions Fee
1	to	10,000	378,832,130	2,580,826	209,915	2,942,427	427,579	611,825	6,772,572	385,604,702
10,001	to	26,000	15,687,595	20,574	2,999	359,362	47,175	150,565	580,675	16,268,270
26,001	to	78,000	13,537,015	10,799	2,746	537,109	32,287	186,132	769,073	14,306,089
78,001	to	80,000	49,539,028	32,811	10,854	2,693,362	89,446	805,552	3,632,024	53,171,052
80,001	to	104,000	10,263,828	6,431	2,144	534,850	18,338	167,592	729,355	10,993,183
104,001	to	105,500	12,222,300	7,771	2,505	624,116	22,313	206,113	862,819	13,085,118
105,501	and	up	165,134	100	31	7,879	305	2,864	11,180	176,313
		Total	480,247,030	2,659,312	231,195	7,699,104	637,444	2,130,644	13,357,698	493,604,728
		Percent of Total	97.3%	0.5%	0.1%	1.6%	0.1%	0.4%	2.7%	100.0%
10,001	and	up	101,414,900	78,486	21,279	4,756,677	209,865	1,518,818	6,585,126	108,000,025
26,001	to	80,000	63,076,044	43,610	13,600	3,230,471	121,733	991,684	4,401,097	67,477,141
80,001	to	105,500	22,486,127	14,202	4,650	1,158,966	40,651	373,705	1,592,174	24,078,301
26,001	to	105,500	85,562,171	57,812	18,250	4,389,436	162,384	1,365,389	5,993,271	91,555,442
26,001	and	up	85,727,304	57,912	18,281	4,397,315	162,689	1,368,253	6,004,451	91,731,755

Criteria Pollutants

Declared Weight (pounds)			CO2 Fee Share	NH3 Fee Share	SO2 Fee Share	NoX Fee Share	VOC Fee Share	Particulate Matter Fee Share	Share of Total Criteria Pollutants Fee	Share of Total Emissions Fee
1	to	10,000	78.9%	97.0%	90.8%	38.2%	67.1%	28.7%	50.7%	78.1%
10,001	to	26,000	3.3%	0.8%	1.3%	4.7%	7.4%	7.1%	4.3%	3.3%
26,001	to	78,000	2.8%	0.4%	1.2%	7.0%	5.1%	8.7%	5.8%	2.9%
78,001	to	80,000	10.3%	1.2%	4.7%	35.0%	14.0%	37.8%	27.2%	10.8%
80,001	to	104,000	2.1%	0.2%	0.9%	6.9%	2.9%	7.9%	5.5%	2.2%
104,001	to	105,500	2.5%	0.3%	1.1%	8.1%	3.5%	9.7%	6.5%	2.7%
105,501	and	up	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.1%	0.0%
10,001	and	up	21.1%	3.0%	9.2%	61.8%	32.9%	71.3%	49.3%	21.9%
26,001	to	80,000	13.1%	1.6%	5.9%	42.0%	19.1%	46.5%	32.9%	13.7%
80,001	to	105,500	4.7%	0.5%	2.0%	15.1%	6.4%	17.5%	11.9%	4.9%
26,001	to	105,500	17.8%	2.2%	7.9%	57.0%	25.5%	64.1%	44.9%	18.5%
26,001	and	up	17.9%	2.2%	7.9%	57.1%	25.5%	64.2%	45.0%	18.6%

The reason is that vehicle technologies have improved to the point that the per-mile output of these pollutants is quite low, although emissions rates vary on a vehicle-by-vehicle basis. Heavy vehicles, those with operating weights greater than 10,000 pounds, contribute a relatively higher proportion of the total criteria pollutant emissions fees due to their higher emissions rates per mile. Heavy vehicles would pay only 21.1 percent of the total CO_2 emissions fee collections, but 49.3 percent of the total criteria pollutant emissions fee collections.

The inability to estimate precise emissions fees specific to individual vehicles by time and location reduces incentives for behavioral responses to the fees. Therefore, no behavioral response nor emissions impact can be estimated from these hypothetical fees. Only highly differentiated fees, transparent to the users, would be expected to lead to emissions-reducing actions.

For future studies, emissions rates by vehicle weight class would be preferred for the purposes of identifying weight class-specific emissions responsibilities.

Exhibit 6-4 displays the modeled annual emissions fees for each summary weight class. Collections would total $493.6 million per year. Light vehicles would pay 78.1 percent of the emissions fees, or $385.6 million per year. Vehicles weighing between 10,001 and 26,000 pounds (e.g., delivery trucks) would pay 3.3 percent of emissions fees, or $16.3 million per year. Heavy trucks would pay 18.6 percent of emissions fees, or $91.7 million per year. Fees per mile are higher for heavier vehicles than for light vehicles.

Detailed results for the emissions fee can be found in Exhibits 7-4 and 7-5 of this report.

Exhibit 6-4: Annual Emissions Fees and Cents Per Mile, by Declared Weight Class

Declared Weight (pounds)			Annual Emissions Fees	Share	Cents per Mile
1	to	10,000	385,604,702	78.1%	1.09
10,001	to	26,000	16,268,270	3.3%	2.62
26,001	to	78,000	14,306,089	2.9%	3.83
78,001	to	80,000	53,171,052	10.8%	4.55
80,001	to	104,000	10,993,183	2.2%	4.74
104,001	to	105,500	13,085,118	2.7%	4.92
105,501	and	up	176,313	0.0%	5.46
All			493,604,728	100.0%	1.30
10,001	and	up	108,000,025	21.9%	4.05
26,001	to	80,000	67,477,141	13.7%	4.37
80,001	to	105,500	24,078,301	4.9%	4.83
26,001	to	105,500	91,555,442	18.5%	4.48
26,001	and	up	91,731,755	18.6%	4.49

Chapter 7

Efficient Fee Results and Equity Ratios

In this chapter, all the efficient fee components are brought together and summed to produce the total average efficient fee for each vehicle class. This chapter compares the projected revenue shares attributed to vehicle classes under current law revenue instruments and rates with the total efficient fee shares. These results are discussed for broader groups of vehicles (e.g., all heavy vehicles combined) and also presented for each of the individual 2,000-pound weight classes at the end of the chapter.

The comparison of current fee revenue shares to efficient fee shares is facilitated by the calculation of equity ratios, the ratio of the share of current law revenues contributed by a class of vehicles to the share of efficient fees that would be collected from that class. An equity ratio greater than one indicates that the vehicles in that class are projected to pay more under the existing revenue instrument rates than their fair share of costs as estimated by the efficient fee method. Conversely, an equity ratio less than one indicates that the vehicles in that class are projected to pay less under the existing revenue instrument rates than their fair share of costs as estimated by the efficient fee method.

The above-mentioned projected revenue shares are those for a vehicle class under the current revenue instruments (e.g., fuel and use taxes, weight mile taxes, registration fees, etc.). Exhibit 7-1 displays the average annual revenue by existing (tax) revenue instrument, projected for the 2011-13 biennium. Full-fee revenues are the revenues collected from vehicles that pay the standard full rates applicable to their vehicle class. Some vehicles are exempt from certain fees and others pay according to alternative fee schedules; fees paid by these vehicles are not included in full-fee revenues.

Under current law revenue instruments and rates, equity ratios are determined by comparing each vehicle class's share of full-fee revenues paid to their share of cost responsibility (as estimated by allocating projected expenditures), and the equity ratios are for full-fee-paying vehicles only.

Exhibit 7-1: Average Annual User-Fee Revenue by Current Law Tax Instrument, Projected for 2011-13 Biennium

Current Law Tax Instrument	Average Annual User-Fee Revenue
Fuel Tax	535,887,535
Registration and Title Fees	305,254,999
Weight-Mile Tax	268,066,672
Other Motor Carrier	5,437,018
Flat Fee	9,209,300
RUAF	2,376,713
Total	1,126,232,238
Full-Fee Revenues	1,116,858,658

The equity ratios presented in this chapter are calculated in the same way, except that the shares of cost responsibility are estimated using the efficient fee method.

Presentation of Equity Ratios

Exhibit 7-2 presents the estimated annual efficient fee collections for each efficient fee component for the summary-level vehicle weight groups. The second part of the exhibit displays the share of efficient fees for each summary-level weight group by efficient fee component, followed by each summary-level group's share of the total efficient fees, the full-fee-paying vehicle shares of revenue payments under existing, current law revenue instruments, and the overall equity ratios for the summary-level weight groups. Exhibit 7-5, at the end of this chapter, shows the equity ratios for each individual, 2,000-pound weight class.

As shown in Exhibit 7-2, estimated average annual efficient fee collections total $1.56 billion, 66.6 percent from light (1-10,000 pound) vehicles and 33.4 percent from heavy (over 10,000 pound) vehicles. This study finds overall equity ratios of 0.9874 for light vehicles and 1.0251 for heavy vehicles as a group. This means that, for the 2011-13 biennium, light and heavy vehicles are each expected to pay close to the same share of revenues as they would under an efficient fee system.

Exhibit 7-2 also shows the overall equity ratios for vehicles under and over 26,000 pounds, as well as for the summary-level weight groups. Vehicles with weights between 10,001 pounds and 26,000 pounds have an equity ratio of 0.9320 and are projected to underpay, relative to their efficient fee share of total fees, by 6.8 percent. Those with declared weights between 26,001 and 78,000 pounds underpay relative to their efficient fee share by 27.1 percent (an equity ratio of 0.7294).

Vehicles between 78,001 and 80,000 pounds have an equity ratio of 1.3304, indicating they would overpay relative to their share of total efficient fees by 33.0 percent. These vehicles alone account for 48.0 percent of the overall vehicle miles traveled (VMT) by full-fee-paying heavy vehicles and 60.1 percent of the VMT by over-26,000-pound vehicles. These vehicles also account for 56.3 percent (19.3 percent / 34.3 percent) of the user fees paid by full-fee-paying heavy vehicles.

The large difference in the equity ratio between the vehicles between 78,001 and 80,000 pounds and the weight groups above and below it is due to the fact that most truckers who are capable of operating at 80,000 pounds and do not know in advance how much their loads will weigh, choose to declare at 80,000 pounds. As a result, the average operating weights of vehicles declared at 80,000 pounds are a smaller fraction of their declared weight than are those for most other declared weight classes, and the wear-related costs they impose per mile are correspondingly lower.

As a group, vehicles between 80,001 and 104,000 pounds (Schedule B vehicles) pay 19.6 percent less than their fair share of total efficient fees. Those in the 104,001 to 105,500-pound class alone underpay their fair share by 24.6 percent.

Vehicles over 105,500 pounds all pay the road use assessment fee, as do some vehicles between 98,001 and 105,500 pounds, under the existing highway revenue taxation system. Those over 105,500 pounds, as a group, are projected to underpay by 57.3 percent, relative to their shares under efficient fees.

Looking at the individual components of the total efficient fees in Exhibit 7-2, the congestion charge would generate $209.5 million in annual fees, 13.4 percent of the total, with light vehicles paying 96 percent of the congestion fees. The annual pavement fees would generate $453.0 million and the annual bridge fees would generate $163.3 million, the majority of which would be paid by heavy vehicles. The emissions charges would result in $493.6 million annually, 31.7 percent of the total efficient fees generated. The administrative fee would result in $239.3 million, with

93.0 percent of the common charge paid by light vehicles.

The third section of Exhibit 7-2 presents the efficient fees in cents per mile for each of the summary-level vehicle classes. The average efficient fee for light vehicles is 2.93 cents per mile, while the overall average fee for heavy vehicles is 19.54 cents per mile. The per mile efficient fees for heavy vehicles range from 10.19 cents per mile for vehicles with gross weights between 10,001 and 26,000 pounds up to 249.49 cents per mile for vehicles operated at permit gross weights over 105,500 pounds.

The last section of Exhibit 7-2 shows the relative contribution of each of the summary-level vehicle classes to the total efficient fee, by efficient fee component. The emissions fee, administrative fee, and congestion fee are the largest components of the light vehicle efficient fee, comprising 37.2 percent, 21.5 percent, and 19.4 percent, respectively. The pavement fee is by far the largest component of the heavy vehicle efficient fee, comprising 57.2 percent of the average efficient fee for vehicles with weights greater than 10,000 pounds. The emissions and bridge fees are the next largest components for heavy vehicles, with congestion and administrative fees making up a very small percentage of the efficient fee for these vehicles.

Comparison with the Traditional Highway Cost Allocation Study Revenues and Equity Ratios

As shown in Exhibit 7-3, the overall light and heavy vehicle equity ratios found by this efficient fee study are quite similar to those determined by the 2011 traditional highway cost allocation study. While the equity ratios are similar, the total amount of user fees that would be collected under an efficient fee system are different than the projected annual revenues under current law revenue instruments, just as the total allocated costs are different in the traditional study.

Exhibit 7-3 compares full-fee-paying user fee revenues, the revenue shares for full-fee-paying vehicles, and the traditional study's full-fee subsidy-adjusted equity ratios to the efficient fees, efficient fee shares, and efficient fee equity ratios. The traditional method allocated costs column is the sum of two columns from Exhibit 6-1 of the traditional report: the full-fee annual cost responsibility column and the allocated alternative-fee difference column. Again, the efficient fee equity ratio is calculated as the ratio of the share of current law, full-fee revenues to the share of costs as estimated by the efficient fee method, and the traditional study's equity ratio is the share of current law, full-fee revenues to the share of allocated expenditures for that vehicle class.

Exhibit 7-2: Annual Efficient Fees, Shares by Vehicle Weight Class, Equity Ratios, Cents Per Mile, and Shares by Efficient Fee Component

Annual Efficient Fees

Declared Weight (pounds)			Annual Congestion Fee	Annual Pavement Fee	Annual Bridge Fee	Annual Administrative Fee	Annual Emissions Fee	Total Efficient Fees
1	to	10,000	201,183,857	155,074,838	73,174,737	222,587,300	385,604,702	1,037,625,434
10,001	to	26,000	2,422,408	29,989,173	10,812,875	3,909,236	16,268,270	63,401,962
26,001	to	78,000	1,321,276	29,107,058	7,648,970	2,346,283	14,306,089	54,729,675
78,001	to	80,000	3,038,427	137,023,626	25,543,554	7,351,826	53,171,052	226,128,485
80,001	to	104,000	659,452	39,133,692	20,618,738	1,458,771	10,993,183	72,863,836
104,001	to	105,500	836,472	55,160,057	25,214,789	1,672,864	13,085,118	95,969,300
105,501	and	up	21,026	7,521,108	325,068	20,313	176,313	8,063,829
		Total	209,482,918	453,009,552	163,338,731	239,346,592	493,604,728	1,558,782,521
Fee Share of Total			13.4%	29.1%	10.5%	15.4%	31.7%	100%
10,001	and	up	8,299,061	297,934,714	90,163,995	16,759,292	108,000,025	521,157,087
26,001	to	80,000	4,359,704	166,130,683	33,192,524	9,698,108	67,477,141	280,858,160
80,001	to	105,500	1,495,924	94,293,749	45,833,527	3,131,635	24,078,301	168,833,136
26,001	to	105,500	5,855,627	260,424,432	79,026,051	12,829,743	91,555,442	449,691,296
26,001	and	up	5,876,654	267,945,540	79,351,120	12,850,056	91,731,755	457,755,125

Shares for Efficient Fee Components by Vehicle Weight Class | **Equity Ratio**

Declared Weight (pounds)			Share of Congestion Fee	Share of Pavement Fee	Share of Bridge Fee	Share of Admin-istrative Fee	Share of Emissions Fee	Share of Total Efficient Fees	Share of Current Law Revenues for Full-Fee-Paying Vehicle	Equity Ratio
1	to	10,000	96.0%	34.2%	44.8%	93.0%	78.1%	66.6%	65.7%	0.9874
10,001	to	26,000	1.2%	6.6%	6.6%	1.6%	3.3%	4.1%	3.8%	0.9320
26,001	to	78,000	0.6%	6.4%	4.7%	1.0%	2.9%	3.5%	2.6%	0.7294
78,001	to	80,000	1.5%	30.2%	15.6%	3.1%	10.8%	14.5%	19.3%	1.3304
80,001	to	104,000	0.3%	8.6%	12.6%	0.6%	2.2%	4.7%	3.8%	0.8039
104,001	to	105,500	0.4%	12.2%	15.4%	0.7%	2.7%	6.2%	4.6%	0.7542
105,501	and	up	0.0%	1.7%	0.2%	0.0%	0.0%	0.5%	0.2%	0.4267
			100%	100%	100%	100%	100%	100%	100%	
10,001	and	up	4.0%	65.8%	55.2%	7.0%	21.9%	33.4%	34.3%	1.0251
26,001	to	80,000	2.1%	36.7%	20.3%	4.1%	13.7%	18.0%	21.9%	1.2132
80,001	to	105,500	0.7%	20.8%	28.1%	1.3%	4.9%	10.8%	8.4%	0.7757
26,001	to	105,500	2.8%	57.5%	48.4%	5.4%	18.5%	28.8%	30.3%	1.0490
26,001	and	up	2.8%	59.1%	48.6%	5.4%	18.6%	29.4%	30.5%	1.0380

Exhibit 7-2 (continued)

Cents Per Mile

Declared Weight (pounds)			Average Congestion Fee	Average Pavement Fee	Average Bridge Fee	Average Administrative Fee	Average Emissions Fee	Average Total Efficient Fee
1	to	10,000	0.57	0.44	0.21	0.63	1.09	2.93
10,001	to	26,000	0.39	4.82	1.74	0.63	2.62	10.19
26,001	to	78,000	0.35	7.80	2.05	0.63	3.83	14.66
78,001	to	80,000	0.26	11.71	2.18	0.63	4.55	19.33
80,001	to	104,000	0.28	16.86	8.88	0.63	4.74	31.39
104,001	to	105,500	0.31	20.72	9.47	0.63	4.92	36.05
105,501	and	up	0.65	232.70	10.06	0.63	5.46	249.49
	All		0.55	1.19	0.43	0.63	1.30	4.09
10,001	and	up	0.31	11.17	3.38	0.63	4.05	19.54
26,001	to	80,000	0.28	10.77	2.15	0.63	4.37	18.20
80,001	to	105,500	0.30	18.92	9.20	0.63	4.83	33.88
26,001	to	105,500	0.29	12.76	3.87	0.63	4.48	22.03
26,001	and	up	0.29	13.10	3.88	0.63	4.49	22.39

Shares for Vehicle Class by Efficient Fee Component

Declared Weight (pounds)			Average Congestion Fee	Average Pavement Fee	Average Bridge Fee	Average Administrative Fee	Average Emissions Fee	Average Total Efficient Fee
1	to	10,000	19.4%	14.9%	7.1%	21.5%	37.2%	100%
10,001	to	26,000	3.8%	47.3%	17.1%	6.2%	25.7%	100%
26,001	to	78,000	2.4%	53.2%	14.0%	4.3%	26.1%	100%
78,001	to	80,000	1.3%	60.6%	11.3%	3.3%	23.5%	100%
80,001	to	104,000	0.9%	53.7%	28.3%	2.0%	15.1%	100%
104,001	to	105,500	0.9%	57.5%	26.3%	1.7%	13.6%	100%
105,501	and	up	0.3%	93.3%	4.0%	0.3%	2.2%	100%
	All		13.4%	29.1%	10.5%	15.4%	31.7%	100%
10,001	and	up	1.6%	57.2%	17.3%	3.2%	20.7%	100%
26,001	to	80,000	1.6%	59.2%	11.8%	3.5%	24.0%	100%
80,001	to	105,500	0.9%	55.9%	27.1%	1.9%	14.3%	100%
26,001	to	105,500	1.3%	57.9%	17.6%	2.9%	20.4%	100%
26,001	and	up	1.3%	58.5%	17.3%	2.8%	20.0%	100%

Exhibit 7-3: Comparison of Revenues and Equity Ratios from the 2011 Traditional and Efficient Fee Highway Cost Allocation Studies

Declared Weight (pounds)			Total Current Law Full-Fee-Paying Vehicle Revenues	Total Efficient Fees	Traditional Method Allocated Costs	Share of Current Law Full-Fee-Paying Vehicle Revenues	Share of Efficient Fees	Share of Allocated Costs	Traditional Study Full-Fee Equity Ratio	Efficient Fee Study Equity Ratio
1	to	10,000	734,078,259	1,037,625,434	1,077,717,047	65.7%	66.6%	66.0%	0.9954	0.9874
10,001	to	26,000	42,339,113	63,401,962	49,743,306	3.8%	4.1%	3.0%	1.2439	0.9320
26,001	to	78,000	28,601,158	54,729,675	50,352,770	2.6%	3.5%	3.1%	0.8301	0.7294
78,001	to	80,000	215,543,485	226,128,485	249,404,937	19.3%	14.5%	15.3%	1.2630	1.3304
80,001	to	104,000	41,971,100	72,863,836	86,215,827	3.8%	4.7%	5.3%	0.7114	0.8039
104,001	to	105,500	51,860,017	95,969,300	111,235,334	4.6%	6.2%	6.8%	0.6813	0.7542
105,501	and	up	2,465,528	8,063,829	7,544,302	0.2%	0.5%	0.5%	0.4776	0.4267
Total			1,116,858,658	1,558,782,521	1,632,213,523	100.0%	100.0%	100.0%	1.0000	1.0000
10,001	and	up	382,780,399	521,157,087	554,496,475	34.3%	33.4%	34.0%	1.0089	1.0251
26,001	to	80,000	244,144,642	280,858,160	299,757,706	21.9%	18.0%	18.4%	1.1903	1.2132
80,001	to	105,500	93,831,117	168,833,136	197,451,161	8.4%	10.8%	12.1%	0.6945	0.7757
26,001	to	105,500	337,975,759	449,691,296	497,208,868	30.3%	28.8%	30.5%	0.9934	1.0490
26,001	and	up	340,441,287	457,755,125	504,753,170	30.5%	29.4%	30.9%	0.9857	1.0380

Recommendations

This report describes an application of the efficient fee approach to highway cost allocation in Oregon, given available data. It provides valuable insights into the potential for more stable highway funding and more efficient provision of transportation infrastructure, which would benefit travelers, shippers, truckers, and taxpayers. It also makes clear the need for more and better data about the amount of travel, congestion levels, and the condition of highway infrastructure. The study team does not recommend the Oregon Legislature fund another efficient fee highway cost allocation study for the 2013-15 biennium. It instead recommends funding a research program that would support a cost-efficient transition to efficient pricing in Oregon. Such a research program might consist of the following tasks.

Task 1: Technical Research Plan

- Introduce the basis for efficient pricing in a benefit-cost context, including the benefits of travel time reductions and increased reliability of travel times, operating cost savings, and other cost savings.

- Develop a plan for collecting the data necessary for the analysis, including recommendations for instrumentation (e.g., permanent loop detectors, portable traffic counters) and deployment. Data should include maintenance and preservation costs and their relationship to use of the state's road system by vehicles of various weights and configurations.

- Describe procedures for determining efficient congestion fees and efficient wear-and-tear fees. Also describe procedures for simplifying efficient fees and determining efficient fees under partial implementation (e.g., freeway-only congestion charges) that minimize the loss of efficiency.

- Describe procedures for setting efficient fee levels.

- Estimate, at the sketch-planning level, revenues and benefits under current and expected future conditions, with ubiquitous efficient fees and with partial implementation.

Task 2: Technical Implementation Plan

- Develop a long-range plan for implementing efficient pricing. Goals of the plan should include:
    - Cost-effective investment in facilities and technology
    - Flexible design to accommodate future technologies
    - Incremental approach that does not impede progress toward full efficiency

- Describe the advantages, disadvantages, and availability of technology options and recommend appropriate technologies for each stage of the implementation plan.

- Describe the expected initial and ongoing costs for construction, equipment, data transmission, maintenance, transaction processing, and enforcement under the recommended plan.

- Discuss financing options for the introduction of efficient pricing.

- Discuss the relationship between pricing and investment and the uses of revenue.

- Describe cost and schedule risks associated with the recommended plan.

Task 3: Organizational Implementation Plan

- Identify affected state and local government agencies and describe their roles in planning and implementation.

- Identify federal agencies with funding, policy, or regulatory authority and describe their potential contributions.

- Describe costs and benefits that would accrue to travelers and to the trucking industry and businesses that ship by truck. Describe how travelers from outside Oregon and Oregonians without bank accounts would participate.

- Describe appropriate outreach efforts for stakeholders, including the general public, and fully describe how user privacy would be safeguarded.

- Describe the role in cost-effective planning of information gathered as a part of implementing efficient fees and how that information could improve state and local asset management programs and help guide capital investment, project selection, and maintenance decisions.

- Describe the effects of efficient pricing on energy use and greenhouse-gas production and the role of efficient pricing in statewide energy policy.

Exhibit 7-4: Detailed Comparison of Fees Paid by Vehicles Under an Efficient Fee System

Weight Class (pounds)	Axles	Annual Congestion Fee	Annual Pavement Fee	Annual Bridge Fee	Annual Administrative Fee	Annual Emissions Fee	Total Efficient Fees
1	0	201,183,857	155,074,838	73,174,737	222,587,300	385,604,702	1,037,625,434
10,001	0	316,006	1,249,912	1,808,778	664,790	2,312,992	6,352,477
12,001	0	179,024	1,160,586	1,056,354	386,527	1,467,443	4,249,935
14,001	0	583,683	3,561,006	2,484,076	901,913	3,590,948	11,121,627
16,001	0	272,548	2,296,703	1,199,158	434,241	1,806,666	6,009,315
18,001	0	262,845	2,944,345	1,142,851	414,562	1,797,028	6,561,631
20,001	0	52,773	825,638	224,031	80,884	364,416	1,547,741
22,001	0	137,370	3,066,697	626,676	225,372	1,052,928	5,109,044
24,001	0	618,160	14,884,286	2,270,951	800,947	3,875,849	22,450,192
26,001	0	58,026	1,207,574	368,894	122,078	660,416	2,416,987
28,001	0	74,262	1,809,033	449,065	152,922	839,104	3,324,386
30,001	0	140,762	4,963,879	888,298	296,783	1,652,274	7,941,996
32,001	0	119,530	2,529,351	648,215	218,883	1,233,916	4,749,895
34,001	0	35,798	757,441	217,139	69,213	395,612	1,475,203
36,001	0	22,383	587,757	131,845	42,788	247,744	1,032,517
38,001	0	100,616	1,935,991	748,226	247,582	1,444,880	4,477,296
40,001	0	19,621	396,501	110,658	37,048	218,672	782,501
42,001	0	25,717	434,901	103,096	36,936	220,310	820,960
44,001	0	134,730	1,652,802	518,133	183,502	1,106,045	3,595,212
46,001	0	56,422	1,115,422	224,361	79,640	511,522	1,987,366
48,001	0	76,592	1,688,618	333,845	114,442	743,139	2,956,637
50,001	0	64,775	1,170,007	375,733	98,088	642,743	2,351,345
52,001	0	75,847	1,834,520	546,483	139,921	924,692	3,521,463
54,001	0	102,170	2,038,896	612,289	154,499	1,026,380	3,934,235
56,001	0	41,408	792,557	218,328	54,164	364,698	1,471,155
58,001	0	25,687	716,266	201,108	49,485	335,599	1,328,145
60,001	0	5,054	150,112	26,988	6,811	46,556	235,522
62,001	0	8,029	142,152	47,999	11,782	81,148	291,110
64,001	0	47,323	1,180,698	347,910	85,962	596,708	2,258,601
66,001	0	12,258	321,709	73,089	18,871	131,165	557,092
68,001	0	43,317	788,118	226,523	59,593	417,935	1,535,486
70,001	0	7,899	215,439	54,773	15,482	109,161	402,753
72,001	0	4,668	84,248	32,850	9,420	66,859	198,045
74,001	0	15,617	495,802	119,887	33,622	240,229	905,158
76,001	0	2,766	97,263	23,236	6,767	48,579	178,610
78,001	0	3,038,427	137,023,626	25,543,554	7,351,826	53,171,052	226,128,485
80,001	5	45,641	2,747,293	1,431,400	106,554	776,331	5,107,220
80,001	6	1,809	55,928	40,703	2,833	20,634	121,906
80,001	7	2,260	78,594	77,492	5,355	39,022	202,722
80,001	8	366	9,904	12,571	869	6,330	30,040
80,001	9	141	2,811	2,465	147	1,081	6,645
82,001	5	23,261	1,576,668	886,248	65,118	477,837	3,029,132

Weight Class (pounds)	Axles	Annual Congestion Fee	Annual Pavement Fee	Annual Bridge Fee	Annual Administrative Fee	Annual Emissions Fee	Total Efficient Fees
82,001	6	5,396	138,393	135,393	9,715	71,128	360,026
82,001	7	189	6,670	6,499	449	3,292	17,099
82,001	8	107	2,955	3,665	253	1,857	8,837
82,001	9	82	1,719	1,444	86	637	3,968
84,001	5	24,157	2,034,861	904,640	60,612	449,489	3,473,760
84,001	6	14,207	671,479	418,487	30,824	227,002	1,361,999
84,001	7	1,035	50,658	35,484	2,452	18,093	107,721
84,001	8	299	11,181	10,253	708	5,227	27,668
84,001	9	183	5,058	3,200	191	1,421	10,052
86,001	5	10,115	780,035	304,581	21,709	161,427	1,277,867
86,001	6	72,060	2,896,480	1,834,648	133,567	989,452	5,926,207
86,001	7	2,217	90,908	76,035	5,255	39,006	213,421
86,001	8	733	23,081	25,152	1,738	12,902	63,608
86,001	9	259	5,767	4,526	270	2,022	12,843
88,001	5	6,875	389,124	167,619	11,632	86,973	662,223
88,001	6	110,917	5,219,317	2,996,738	217,802	1,623,438	10,168,212
88,001	7	1,696	107,859	56,181	3,819	28,539	198,094
88,001	8	176	8,573	6,048	418	3,120	18,335
88,001	9	32	1,340	1,107	76	571	3,127
90,001	5	929	83,157	23,038	1,676	12,602	121,402
90,001	6	14,494	746,157	327,387	23,327	175,106	1,286,471
90,001	7	3,421	184,616	117,461	8,106	60,890	374,495
90,001	8	65	2,670	2,239	154	1,160	6,288
90,001	9	74	1,625	988	59	444	3,189
92,001	5	299	15,726	7,445	565	4,267	28,303
92,001	6	6,740	468,567	183,418	13,450	101,481	773,656
92,001	7	2,392	161,536	75,478	4,997	37,811	282,214
92,001	8	81	4,211	2,767	191	1,442	8,692
92,001	9	158	2,879	1,419	84	639	5,178
94,001	5	4,319	235,790	97,536	7,451	56,544	401,640
94,001	6	13,785	464,415	316,797	23,101	175,074	993,172
94,001	7	61,083	4,927,624	2,272,112	158,625	1,204,757	8,624,201
94,001	8	2,497	135,089	80,338	5,374	40,876	264,173
94,001	9	202	3,932	3,045	205	1,559	8,943
96,001	5	7,113	394,306	165,599	13,006	99,146	679,172
96,001	6	10,110	355,334	238,826	17,545	133,818	755,633
96,001	7	51,367	4,835,227	2,291,855	159,331	1,217,449	8,555,230
96,001	8	2,435	156,523	82,824	5,692	43,501	290,976
96,001	9	418	9,424	6,290	424	3,238	19,794
98,001	6	5,075	170,709	89,666	6,357	48,816	320,623
98,001	7	32,754	1,940,083	1,029,335	72,005	552,536	3,626,713
98,001	8	2,733	150,267	93,834	6,476	49,760	303,070
98,001	9	45	1,577	735	44	338	2,738
100,001	7	31,221	1,728,097	1,097,352	76,727	593,063	3,526,460
100,001	8	21,025	1,287,181	721,780	49,816	384,846	2,464,649

Weight Class (pounds)	Axles	Annual Congestion Fee	Annual Pavement Fee	Annual Bridge Fee	Annual Administrative Fee	Annual Emissions Fee	Total Efficient Fees
100,001	9	21	835	353	21	163	1,394
102,001	7	13,411	793,031	404,347	27,414	212,720	1,450,923
102,001	8	46,960	2,956,004	1,441,608	94,075	732,158	5,270,804
102,001	9	9	441	285	20	152	906
104,001	7	297,217	19,334,999	8,932,503	611,361	4,779,488	33,955,567
104,001	8	518,657	34,898,591	15,943,860	1,041,398	8,147,128	60,549,634
104,001	9	20,599	926,467	338,426	20,105	158,502	1,464,099
106,001	6	230	42,835	3,043	181	2,696	48,984
106,001	7	153	19,866	2,675	159	2,372	25,223
106,001	8	10	985	185	11	163	1,355
106,001	9	14	950	245	14	216	1,439
108,001	6	343	74,962	6,684	481	2,466	84,935
108,001	7	799	86,235	10,531	625	3,261	101,451
108,001	8	51	3,844	671	40	207	4,812
108,001	9	142	8,087	1,877	111	581	10,799
110,001	6	213	51,639	4,141	298	1,720	58,011
110,001	7	192	22,974	2,538	151	882	26,736
110,001	8	14	1,142	189	11	65	1,421
110,001	9	61	3,690	813	48	282	4,894
112,001	6	237	63,961	4,616	332	5,547	74,693
112,001	7	240	32,295	3,162	188	3,149	39,033
112,001	8	40	3,471	532	31	528	4,602
112,001	9	28	1,758	369	22	367	2,544
114,001	6	191	51,110	2,514	149	774	54,737
114,001	7	227	45,421	5,866	404	2,064	53,982
114,001	8	43	3,953	569	34	175	4,773
114,001	9	297	19,322	3,913	232	1,205	24,970
116,001	6	182	53,403	2,400	143	1,623	57,751
116,001	7	127	28,749	3,289	226	2,561	34,953
116,001	8	22	2,164	290	17	195	2,688
116,001	9	13	914	170	10	114	1,221
118,001	6	166	61,307	3,240	233	1,536	66,483
118,001	7	870	166,066	11,459	680	4,547	183,622
118,001	8	36	4,583	929	64	422	6,034
118,001	9	39	3,010	523	31	207	3,811
120,001	6	90	31,691	1,195	71	634	33,681
120,001	7	143	40,267	3,697	254	2,260	46,621
120,001	8	32	3,653	425	25	225	4,361
120,001	9	9	682	117	7	62	876
122,001	6	99	37,882	1,307	77	1,594	40,959
122,001	7	152	48,297	3,929	270	5,541	58,189
122,001	8	41	5,034	546	32	664	6,317
122,001	9	3	278	47	3	57	389
124,001	6	24	9,962	316	19	73	10,394
124,001	7	338	118,178	8,756	602	2,316	130,190

Weight Class (pounds)	Axles	Annual Congestion Fee	Annual Pavement Fee	Annual Bridge Fee	Annual Administrative Fee	Annual Emissions Fee	Total Efficient Fees
124,001	8	137	17,451	1,803	107	419	19,917
124,001	9	112	10,002	1,484	88	345	12,032
126,001	6	22	10,112	294	17	115	10,561
126,001	7	238	91,325	6,157	424	2,764	100,907
126,001	8	52	6,950	688	41	269	7,999
126,001	9	8	685	102	6	40	841
128,001	6	11	5,313	142	8	65	5,539
128,001	7	832	255,704	10,961	650	5,040	273,187
128,001	8	196	29,065	2,587	153	1,189	33,191
128,001	9	83	8,061	1,096	65	503	9,808
130,001	7	150	70,251	3,897	268	3,076	77,643
130,001	8	72	11,432	958	57	655	13,174
130,001	9	25	2,578	333	20	227	3,182
132,001	7	643	224,821	8,471	503	5,443	239,880
132,001	8	80	16,194	2,079	143	1,537	20,033
132,001	9	26	2,855	347	21	222	3,471
134,001	6	0	81	3	0	1	84
134,001	7	559	213,776	7,373	438	1,850	223,997
134,001	8	99	21,244	2,580	177	737	24,838
134,001	9	157	18,095	2,077	123	521	20,974
136,001	6	0	82	3	0	1	85
136,001	7	256	104,994	3,370	200	1,703	110,522
136,001	8	117	21,918	1,538	91	777	24,442
136,001	9	45	5,510	600	36	303	6,494
138,001	7	371	170,235	4,896	290	2,484	178,277
138,001	8	154	37,066	4,003	275	2,334	43,832
138,001	9	112	14,365	1,481	88	751	16,797
140,001	7	67	48,407	1,721	118	1,008	51,321
140,001	8	54	11,131	708	42	361	12,296
140,001	9	40	5,372	527	31	268	6,238
142,001	7	106	54,242	1,393	83	713	56,536
142,001	8	125	26,992	1,645	98	842	29,701
142,001	9	63	8,986	835	49	427	10,360
144,001	7	182	101,703	2,402	142	1,234	105,665
144,001	8	94	27,543	2,410	166	1,423	31,635
144,001	9	45	8,122	1,160	80	685	10,092
146,001	7	77	46,595	1,014	60	523	48,269
146,001	8	228	58,426	3,010	179	1,554	63,397
146,001	9	31	5,976	812	56	481	7,357
148,001	7	35	23,345	469	28	242	24,119
148,001	8	275	76,245	3,618	215	1,875	82,228
148,001	9	220	36,572	2,894	172	1,499	41,357
150,001	7	1	1,061	21	1	10	1,094
150,001	8	27	10,066	687	47	411	11,238
150,001	9	25	5,533	665	46	398	6,666

Weight Class (pounds)	Axles	Annual Congestion Fee	Annual Pavement Fee	Annual Bridge Fee	Annual Administrative Fee	Annual Emissions Fee	Total Efficient Fees
152,001	7	0	186	4	0	2	192
152,001	8	108	35,158	1,422	84	743	37,515
152,001	9	51	9,527	676	40	353	10,647
154,001	7	1	703	12	1	6	723
154,001	8	104	46,530	2,679	184	1,615	51,112
154,001	9	257	50,472	3,381	201	1,774	56,084
156,001	7	0	71	2	0	1	73
156,001	8	119	45,484	1,564	93	824	48,083
156,001	9	132	27,496	1,745	103	919	30,396
158,001	7	0	180	3	0	1	185
158,001	8	272	113,171	3,589	213	1,898	119,144
158,001	9	158	43,449	4,068	280	2,473	50,428
160,001	8	43	24,583	1,102	76	672	26,476
160,001	9	45	13,265	1,172	81	715	15,277
162,001	8	62	38,952	1,607	110	985	41,717
162,001	9	81	19,811	1,070	63	570	21,596
164,001	7	0	85	2	0	0	87
164,001	8	100	52,766	1,326	79	709	54,980
164,001	9	365	93,890	4,800	285	2,569	101,908
166,001	8	11	6,079	143	8	76	6,317
166,001	9	115	31,391	1,524	90	819	33,939
168,001	8	40	24,678	534	32	287	25,571
168,001	9	355	101,567	4,672	277	2,519	109,391
170,001	8	5	3,216	66	4	35	3,326
170,001	9	127	38,482	1,681	100	910	41,300
172,001	9	216	68,564	2,841	169	1,543	73,333
174,001	8	0	97	3	0	1	101
174,001	9	168	74,150	4,308	296	2,702	81,624
176,001	9	273	96,351	3,600	214	1,970	102,408
178,001	8	0	65	2	0	1	68
178,001	9	189	94,116	4,865	335	3,074	102,579
180,001	9	117	45,852	1,548	92	853	48,463
182,001	9	121	67,842	3,124	215	1,988	73,289
184,001	9	492	212,571	6,478	384	3,597	223,523
186,001	9	179	81,267	2,356	140	1,313	85,255
188,001	9	141	93,353	3,618	249	2,327	99,688
190,001	9	160	80,061	2,100	125	1,179	83,623
192,001	9	137	72,563	1,812	107	1,021	75,641
194,001	8	1	1,402	13	1	7	1,424
194,001	9	183	143,990	4,705	324	3,060	152,262
196,001	9	355	206,777	4,673	277	2,651	214,734
198,001	9	625	382,172	8,223	488	4,680	396,188
200,001	9	2,953	1,897,617	38,871	2,307	22,202	1,963,951
Total		$209,482,918	$453,009,552	$163,338,731	$239,346,592	$493,604,728	$1,558,782,521

Exhibit 7-5: Detailed Comparison of Equity Shares for Vehicles Under an Efficient Fee System

Weight Class (pounds)	Axles	Congestion Fee Shares	Pavement Fee Shares	Bridge Fee Shares	Common Shares	Emissions Fee Shares	Share of Total Efficient Fees	Share of Current Law Revenues by Full-Fee-Paying Vehicles	Equity Ratio
1	0	0.9604	0.3423	0.4480	0.9300	0.7812	0.6657	0.6573	0.9874
10,001	0	0.0015	0.0028	0.0111	0.0028	0.0047	0.0041	0.0055	1.3541
12,001	0	0.0009	0.0026	0.0065	0.0016	0.0030	0.0027	0.0031	1.1285
14,001	0	0.0028	0.0079	0.0152	0.0038	0.0073	0.0071	0.0076	1.0679
16,001	0	0.0013	0.0051	0.0073	0.0018	0.0037	0.0039	0.0049	1.2628
18,001	0	0.0013	0.0065	0.0070	0.0017	0.0036	0.0042	0.0049	1.1664
20,001	0	0.0003	0.0018	0.0014	0.0003	0.0007	0.0010	0.0007	0.6664
22,001	0	0.0007	0.0068	0.0038	0.0009	0.0021	0.0033	0.0027	0.8179
24,001	0	0.0030	0.0329	0.0139	0.0033	0.0079	0.0144	0.0086	0.5953
26,001	0	0.0003	0.0027	0.0023	0.0005	0.0013	0.0016	0.0007	0.4337
28,001	0	0.0004	0.0040	0.0027	0.0006	0.0017	0.0021	0.0010	0.4569
30,001	0	0.0007	0.0110	0.0054	0.0012	0.0033	0.0051	0.0022	0.4402
32,001	0	0.0006	0.0056	0.0040	0.0009	0.0025	0.0030	0.0020	0.6643
34,001	0	0.0002	0.0017	0.0013	0.0003	0.0008	0.0009	0.0004	0.3745
36,001	0	0.0001	0.0013	0.0008	0.0002	0.0005	0.0007	0.0003	0.3919
38,001	0	0.0005	0.0043	0.0046	0.0010	0.0029	0.0029	0.0006	0.1918
40,001	0	0.0001	0.0009	0.0007	0.0002	0.0004	0.0005	0.0003	0.6747
42,001	0	0.0001	0.0010	0.0006	0.0002	0.0004	0.0005	0.0004	0.7013
44,001	0	0.0006	0.0036	0.0032	0.0008	0.0022	0.0023	0.0026	1.1089
46,001	0	0.0003	0.0025	0.0014	0.0003	0.0010	0.0013	0.0011	0.8627
48,001	0	0.0004	0.0037	0.0020	0.0005	0.0015	0.0019	0.0016	0.8562
50,001	0	0.0003	0.0026	0.0023	0.0004	0.0013	0.0015	0.0014	0.9381
52,001	0	0.0004	0.0040	0.0033	0.0006	0.0019	0.0023	0.0021	0.9256
54,001	0	0.0005	0.0045	0.0037	0.0006	0.0021	0.0025	0.0024	0.9527
56,001	0	0.0002	0.0017	0.0013	0.0002	0.0007	0.0009	0.0009	0.9064
58,001	0	0.0001	0.0016	0.0012	0.0002	0.0007	0.0009	0.0008	0.9546
60,001	0	0.0000	0.0003	0.0002	0.0000	0.0001	0.0002	0.0001	0.7623
62,001	0	0.0000	0.0003	0.0003	0.0000	0.0002	0.0002	0.0002	1.1096
64,001	0	0.0002	0.0026	0.0021	0.0004	0.0012	0.0014	0.0016	1.0738
66,001	0	0.0001	0.0007	0.0004	0.0001	0.0003	0.0004	0.0004	0.9885
68,001	0	0.0002	0.0017	0.0014	0.0002	0.0008	0.0010	0.0012	1.2329
70,001	0	0.0000	0.0005	0.0003	0.0001	0.0002	0.0003	0.0003	1.2908
72,001	0	0.0000	0.0002	0.0002	0.0000	0.0001	0.0001	0.0002	1.6865
74,001	0	0.0001	0.0011	0.0007	0.0001	0.0005	0.0006	0.0008	1.3752
76,001	0	0.0000	0.0002	0.0001	0.0000	0.0001	0.0001	0.0002	1.4677
78,001	0	0.0145	0.3025	0.1564	0.0307	0.1077	0.1451	0.1930	1.3304
80,001	5	0.0002	0.0061	0.0088	0.0004	0.0016	0.0033	0.0027	0.8184
80,001	6	0.0000	0.0001	0.0002	0.0000	0.0000	0.0001	0.0001	0.7272
80,001	7	0.0000	0.0002	0.0005	0.0000	0.0001	0.0001	0.0001	0.7815
80,001	8	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.8198

Weight Class (pounds)	Axles	Congestion Fee Shares	Pavement Fee Shares	Bridge Fee Shares	Common Shares	Emissions Fee Shares	Share of Total Efficient Fees	Share of Current Law Revenues by Full-Fee-Paying Vehicles	Equity Ratio
80,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5976
82,001	5	0.0001	0.0035	0.0054	0.0003	0.0010	0.0019	0.0018	0.9074
82,001	6	0.0000	0.0003	0.0008	0.0000	0.0001	0.0002	0.0002	1.0658
82,001	7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9450
82,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9854
82,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7105
84,001	5	0.0001	0.0045	0.0055	0.0003	0.0009	0.0022	0.0017	0.7443
84,001	6	0.0001	0.0015	0.0026	0.0001	0.0005	0.0009	0.0008	0.8809
84,001	7	0.0000	0.0001	0.0002	0.0000	0.0000	0.0001	0.0001	0.7796
84,001	8	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.8257
84,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5652
86,001	5	0.0000	0.0017	0.0019	0.0001	0.0003	0.0008	0.0006	0.6734
86,001	6	0.0003	0.0064	0.0112	0.0006	0.0020	0.0038	0.0032	0.8397
86,001	7	0.0000	0.0002	0.0005	0.0000	0.0001	0.0001	0.0001	0.7020
86,001	8	0.0000	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000	0.7256
86,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4926
88,001	5	0.0000	0.0009	0.0010	0.0000	0.0002	0.0004	0.0004	0.8332
88,001	6	0.0005	0.0115	0.0183	0.0009	0.0033	0.0065	0.0053	0.8190
88,001	7	0.0000	0.0002	0.0003	0.0000	0.0001	0.0001	0.0001	0.6863
88,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7696
88,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6859
90,001	5	0.0000	0.0002	0.0001	0.0000	0.0000	0.0001	0.0000	0.5863
90,001	6	0.0001	0.0016	0.0020	0.0001	0.0004	0.0008	0.0006	0.7275
90,001	7	0.0000	0.0004	0.0007	0.0000	0.0001	0.0002	0.0002	0.9105
90,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.8058
90,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5748
92,001	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9307
92,001	6	0.0000	0.0010	0.0011	0.0001	0.0002	0.0005	0.0004	0.7634
92,001	7	0.0000	0.0004	0.0005	0.0000	0.0001	0.0002	0.0001	0.5922
92,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6989
92,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4904
94,001	5	0.0000	0.0005	0.0006	0.0000	0.0001	0.0003	0.0002	0.9110
94,001	6	0.0001	0.0010	0.0019	0.0001	0.0004	0.0006	0.0009	1.3459
94,001	7	0.0003	0.0109	0.0139	0.0007	0.0024	0.0055	0.0039	0.7097
94,001	8	0.0000	0.0003	0.0005	0.0000	0.0001	0.0002	0.0001	0.8032
94,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7791
96,001	5	0.0000	0.0009	0.0010	0.0001	0.0002	0.0004	0.0004	1.0201
96,001	6	0.0000	0.0008	0.0015	0.0001	0.0003	0.0005	0.0006	1.2107
96,001	7	0.0002	0.0107	0.0140	0.0007	0.0025	0.0055	0.0041	0.7455
96,001	8	0.0000	0.0003	0.0005	0.0000	0.0001	0.0002	0.0001	0.6944
96,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1903
98,001	6	0.0000	0.0004	0.0005	0.0000	0.0001	0.0002	0.0002	1.0381
98,001	7	0.0002	0.0043	0.0063	0.0003	0.0011	0.0023	0.0018	0.7889

Weight Class (pounds)	Axles	Congestion Fee Shares	Pavement Fee Shares	Bridge Fee Shares	Common Shares	Emissions Fee Shares	Share of Total Efficient Fees	Share of Current Law Revenues by Full-Fee-Paying Vehicles	Equity Ratio
98,001	8	0.0000	0.0003	0.0006	0.0000	0.0001	0.0002	0.0001	0.7016
98,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4897
100,001	7	0.0001	0.0038	0.0067	0.0003	0.0012	0.0023	0.0021	0.9150
100,001	8	0.0001	0.0028	0.0044	0.0002	0.0008	0.0016	0.0012	0.7851
100,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5299
102,001	7	0.0001	0.0018	0.0025	0.0001	0.0004	0.0009	0.0008	0.8266
102,001	8	0.0002	0.0065	0.0088	0.0004	0.0015	0.0034	0.0025	0.7291
102,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.8249
104,001	7	0.0014	0.0427	0.0547	0.0026	0.0097	0.0218	0.0176	0.8072
104,001	8	0.0025	0.0770	0.0976	0.0044	0.0165	0.0388	0.0284	0.7299
104,001	9	0.0001	0.0020	0.0021	0.0001	0.0003	0.0009	0.0005	0.5284
106,001	6	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3832
106,001	7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4170
106,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3574
106,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3771
108,001	6	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.6262
108,001	7	0.0000	0.0002	0.0001	0.0000	0.0000	0.0001	0.0000	0.4351
108,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3822
108,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3849
110,001	6	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.6480
110,001	7	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4228
110,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3812
110,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4114
112,001	6	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.5806
112,001	7	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3822
112,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3623
112,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3786
114,001	6	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3685
114,001	7	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.6285
114,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4214
114,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4095
116,001	6	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3609
116,001	7	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.5730
116,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4103
116,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3818
118,001	6	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.5513
118,001	7	0.0000	0.0004	0.0001	0.0000	0.0000	0.0001	0.0000	0.3440
118,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7257
118,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3950
120,001	6	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3497
120,001	7	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.5308
120,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4086
120,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4200

Weight Class (pounds)	Axles	Congestion Fee Shares	Pavement Fee Shares	Bridge Fee Shares	Common Shares	Emissions Fee Shares	Share of Total Efficient Fees	Share of Current Law Revenues by Full-Fee-Paying Vehicles	Equity Ratio
122,001	6	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3356
122,001	7	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4727
122,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3963
122,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4312
124,001	6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3480
124,001	7	0.0000	0.0003	0.0001	0.0000	0.0000	0.0001	0.0000	0.5016
124,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4271
124,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4683
126,001	6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3335
126,001	7	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.4830
126,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4171
126,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4788
128,001	6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3376
128,001	7	0.0000	0.0006	0.0001	0.0000	0.0000	0.0002	0.0001	0.2951
128,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4192
128,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4538
130,001	7	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.4588
130,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4198
130,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4382
132,001	7	0.0000	0.0005	0.0001	0.0000	0.0000	0.0002	0.0000	0.2970
132,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7105
132,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4195
134,001	6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6055
134,001	7	0.0000	0.0005	0.0000	0.0000	0.0000	0.0001	0.0000	0.2942
134,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7429
134,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4543
136,001	6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5395
136,001	7	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.2886
136,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4132
136,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4363
138,001	6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	19.0865
138,001	7	0.0000	0.0004	0.0000	0.0000	0.0000	0.0001	0.0000	0.2744
138,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.7230
138,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4277
140,001	7	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4139
140,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4313
140,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4321
142,001	7	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.2819
142,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4438
142,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4438
144,001	7	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.2721
144,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.7426
144,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7695

Weight Class (pounds)	Axles	Congestion Fee Shares	Pavement Fee Shares	Bridge Fee Shares	Common Shares	Emissions Fee Shares	Share of Total Efficient Fees	Share of Current Law Revenues by Full-Fee-Paying Vehicles	Equity Ratio
146,001	7	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.2708
146,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4055
146,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7557
148,001	7	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.2633
148,001	8	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.4106
148,001	9	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4224
150,001	7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2676
150,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6894
150,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7435
152,001	7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3279
152,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3837
152,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4168
154,001	7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2683
154,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.6390
154,001	9	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4116
156,001	7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4852
156,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3678
156,001	9	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4448
158,001	7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3029
158,001	8	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.3486
158,001	9	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.7494
160,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.5839
160,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7477
162,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.5876
162,001	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4297
164,001	7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4328
164,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3267
164,001	9	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.4395
166,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3182
166,001	9	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4426
168,001	8	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3105
168,001	9	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.4380
170,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3058
170,001	9	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4334
172,001	9	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.4433
174,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5029
174,001	9	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.7243
176,001	9	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.4300
178,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6308
178,001	9	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.7233
180,001	9	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.4328
182,001	9	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.6956
184,001	9	0.0000	0.0005	0.0000	0.0000	0.0000	0.0001	0.0001	0.4309

Weight Class (pounds)	Axles	Congestion Fee Shares	Pavement Fee Shares	Bridge Fee Shares	Common Shares	Emissions Fee Shares	Share of Total Efficient Fees	Share of Current Law Revenues by Full-Fee-Paying Vehicles	Equity Ratio
186,001	9	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.4218
188,001	9	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.6700
190,001	9	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.4197
192,001	9	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.4161
194,001	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2441
194,001	9	0.0000	0.0003	0.0000	0.0000	0.0000	0.0001	0.0001	0.6413
196,001	9	0.0000	0.0005	0.0000	0.0000	0.0000	0.0001	0.0001	0.4067
198,001	9	0.0000	0.0008	0.0001	0.0000	0.0000	0.0003	0.0001	0.3988
200,001	9	0.0000	0.0042	0.0002	0.0000	0.0000	0.0013	0.0005	0.3934