Scrapping for Clean Air: Emissions Savings from the BC SCRAP-IT Program

WERNER ANTWEILER
Sauder School of Business
University of British Columbia

SUMEET GULATI
Food and Resource Economics
University of British Columbia

September 4, 2014

TECHNICAL APPENDIX

Material in this Technical Appendix is intended for online-only publication.

It contains descriptions of data sources and additional tables and figures that accompany the main paper and may assist other researchers in replicating our work.

A Proof of the Emission Change Decomposition into Technique, Composition, and Scale Effects

The theoretical core of the paper is based on a decomposition of emission changes into contributions from a technique effect, composition effect, and scale effect:

$$E_t^* - E_t = \underbrace{(e_1^* - e_1)M_{1,t}^*}_{\text{technique effect}} + \underbrace{\sum_{i=1}^{n}(e_i - \bar{e})(M_{i,t}^* - M_{i,t})}_{\text{composition effect}} + \underbrace{\bar{e}(M_t^* - M_t)}_{\text{scale effect}} \tag{1}$$

where emissions E_t in period t are the sum of n emission streams i with emission intensity e_i and mileage $M_{i,t}$ where

$$E_t = \sum_{i=1}^{n} e_i M_{i,t} \quad \text{s.t.} \sum_{i=1}^{n} M_{i,t} = M_t \tag{2}$$

Emissions, emission intensities, and mileage after scrappage are denoted by asterisks. The average emission intensity $\bar{e}$ is defined as $\bar{e} = \sum_i e_i M_{i,t}/M_t$. The proof proceeds in seven steps as follows:

$$\begin{aligned}
E_t^* - E_t &= \sum_i e_i^* M_{i,t}^* - \sum_i e_i M_{i,t} \\
&= \sum_i e_i^* M_{i,t}^* - \sum_i e_i M_{i,t} + \sum_i e_i M_{i,t}^* - \sum_i e_i M_{i,t}^* \\
&= \sum_i (e_i^* - e_i) M_{i,t}^* + \sum_i e_i (M_{i,t}^* - M_{i,t}) \\
&= (e_1^* - e_1) M_{1,t}^* + \sum_i e_i (M_{i,t}^* - M_{i,t}) \\
&= (e_1^* - e_1) M_{1,t}^* + \sum_i (e_i - \bar{e})(M_{i,t}^* - M_{i,t}) + \sum_i \bar{e}(M_{i,t}^* - M_{i,t}) \\
&= (e_1^* - e_1) M_{1,t}^* + \sum_i (e_i - \bar{e})(M_{i,t}^* - M_{i,t}) + \bar{e}\sum_i M_{i,t}^* - \bar{e}\sum_i M_{i,t} \\
&= (e_1^* - e_1) M_{1,t}^* + \sum_i (e_i - \bar{e})(M_{i,t}^* - M_{i,t}) + \bar{e}(M_i^* - M_i)
\end{aligned} \tag{3}$$

The first line applies the definition of emission streams. The second line adds zero by adding and subtracting the same expression. The third line rearranges the previous line by collecting expressions within the summation sign. The fourth line applies the notion that only emission stream $i = 1$ is subject to a technique effect when a scrapped vehicle is replaced with a new vehicle or none at all. Only for $i = 1$ is $e_1^* \neq e_1$; for all other $i > 1$ it holds that $e_i^* = e_i$. The fifth line adds zero again by adding and subtracting the expressions with $\bar{e}$. The sixth line pulls $\bar{e}$ in front of the summation signs in the last two expressions. The seventh line applies the definition of mileage sums. This seventh line concludes the proof of (1).

B Data Definitions

B.1 BC Scrap-It Data

We have obtained data from the BC Scrap-It program through a nondisclosure agreement (NDA) with the BC Scrap-It Society. We have been given assurance that other researchers would be able to obtain access under similar favourable conditions. A copy of the NDA is available from the authors upon request.

Table TA-1 provides an inventory of the fields in our raw data set, along with an example. In addition to crucial information about the timing of the approval process, the data set contains information about very specific information about the vehicle (make, model, VIN) and its mileage (in klilometres). Where a vehicle has been replaced with a new vehicle, information about the type of new vehicle is also included. Where a transit pass option was chosen as an incentive, information about the nature of the transit pass is included instead. As far as individual participants are concerned, the daa set includes information about the gender, age, city, and postal code. The latter we use to link the BC Scrap-It data to census data through the three-letter forward sortation area (FSA) as described below.

Table TA-2 shows the manufacturers represented in our data set in descending order of number of participating vehicles in the BC Scrap-It program. In addition to the absolute number of vehicles, the table also shows the percentage share an the cumulative percentage share. The top ten manufacturers account for three quarters of all participating vehicles, with Ford, Toyota and Honda topping the list.

We have also obtained additional survey data from the BC Scrap-It program whose content we are not utilizing for this paper. It will be used to study participants' choice among incentives in a separate paper.

B.2 Translink/AirCare Data

The British Columbia *AirCare* program collects data on vehicle emissions as part of the mandatory inspections. Vehicle Identification Numbers (VINs) from the BC Scrap-It program participants were matched against the database of vehicles subjected to an *AirCare* inspection since 2001. The information from the latest inspection is used. This represents the most recent emission data available for each vehicle. From the original list of 17,993 vehicles in the program participation list we are thus able to obtain 12,449 data points with emission data (about 69% coverage). Some points are worth noting that pertain to the original data:

(1) If the vehicle is 1992 model year or newer, the ASM and idle test variables are either empty or of no meaning.
(2) If the vehicle is 1991 or older, the IM240 test variables are either empty or of no meaning
(3) The inspection source data does not store zero values—it leaves them empty instead in order to use less space—so an empty variable might mean a zero value. This mostly applies to readings for CO, HC and NOx.

Translink's AirCare program also provided us with data from a sample of scrapped vehicles and new vehicles that informs our calculation of emission savings for urban air pollutants (carbon monoxide, nitrogen oxides, and hydrocarbons).

We obtained further data that informed our analysis of the potential selection effect with respect to participating vehicles. We have odometer readings and AirCare inspection failure rates by vehicle make/model and age that allows us to compare participating and non-participating vehicles. We also use additional odometer reading data across all vehicles to estimate the way in which vehicle-kilometers traveled decrease with age. This is explained in detail below.

B.3 Census Data

Socio-demographic data were obtained from the 2006 Census of Population aggregated to geographic regions defined by postal Forward Sortation Area (FSA), i.e., the first three letters of a Canadian postal code. There are 185 forward sortation areas in British Columbia. However, we are only able to use 183 of them. We had to exclude two FSAs due to missing data, that is data suppressed by Statistics Canada due to aggregation and data integrity issues. Also, one FSA (V6Z) is a new FSA since 2007 and had to be matched backward to V0S; a rural area had changed to become an urban area. We have accessed census data through the EStat interface that can be found at http://estat.statcan.gc.ca/.

Our program participant data set contains a very small number of individuals living outside the province. They were eligible for program participation but have subsequently moved to other provinces.

- Household Income: census data provides varies income measures for individuals and for households. As car ownership is primarily a household decision, it appears appropriate to rely on household income as the key measure. Here, two aggregates are available: average (mean) income and median income. It is well known that income distributions can be highly skewed, leading to large gaps between mean and median income. In fact, the ratio of the two income measures is a measure of the skewness of the income distribution, and thus a proxy for unequal income distribution. We therefore employ two variables, the log of the median household income, and the log ratio of mean-to-median household income as a proxy for unequal income distributions and the prevalence of high-income households.

- Immigrant share is the percentage share of foreign-born individuals in the population.

- Married share is the percentage share of married individuals in the population.

- Migration share is the percentage share of individuals who have moved within the last five years; this includes all moves, within the city, across the province, across the country, and immigration.

- Renting share is the percentage share of renters in the population (as opposed to home owners).

- Labour force variables include the participation rate (percentage share of individuals gainfully employed) and the unemployment rate (percentage share). The participation rate includes both employed and unemployed individuals and is strongly influenced by female labour force participation.

- Age is the average age of the population. The census records brackets of age (0-4, 5-9, 10-14, and so on, through 80-84, and 85 and over). Average age is the weighted mean by using bracket midpoints (2.5, 7.5, 12.5, etc.). Using midpoints is not be entirely accurate (especially for the 85+ category), but it provides a good approximation.

Table TA-3 provides basic correlation statistics for our socio-demographic data by FSAs in British Columbia. The upper half of the table shows the highest positive correlations, and the lower half of the table shows the highest negative correlations. The purpose of this table is to demonstrate how some of the key variables we use may be related to other socio-demographic characteristics. In particular, in our paper related to emission savings we employ both the log of the median household income and a measure of income dispersion, the log of the mean-to-median ratio of household income. The table shows that the two measures are distinct; their correlation coefficient is only about 0.4. Another key variable in our analysis is the proxy for population density, the inverse of which is captured by the log distance to the nearest FSA. Urban density is thus positively correlated with a higher proportion of immigrants and foreign-born residents. Urban density is also positively correlated (albeit weaker) with higher income dispersion and a higher proportion of renters.

B.4 Geographic Data

Our geographic unit of analysis is the postal Forward Sortation Area (FSA). The forward sortation area (FSA) is identified by the first three characters of the postal code. FSAs are associated with a postal facility from which mail delivery originates. The average number of households served by an FSA is approximately 8,000, but the number can range from zero to more than 60,000 households. This wide range of households occurs because some FSAs contain only businesses (zero households) and some FSAs serve very large geographic areas. The Census FSA boundary files are available through the Data Liberation Initiative and were access through the UBC Data Library.

First, we are interested in describing geographic properties of FSAs. We obtained the digital boundary file from the 2006 Census (gfsa0000a06a_e). This allows us to compute the distances between the FSA centroids. The distance to the nearest FSA is an inverse proxy for the population density and thus indicates whether an area is urban or rural.

It is also possible to construct a 'rural' indicator variable by checking whether the second character in an FSA is '0'. However, this information turns out to be less useful than the proxy for population density.

Second, it is necessary to be able to identify geographic data points. We have used data from Translink to identify the availability of public transit. Here it is necessary whether points are inside or outside specific FSAs. The digital boundary file allows us to carry out such geo-computations.

Table TA-1: Scrap-It Data Catalogue and Sample Data

Variable	**Example**
Approval Num	7575
App Recv'd Date	6-Jul-09
App Status	Complete
Approval Sent Date	20-Jul-09
Claim Status	Complete
Claim Apprv'd Date	14-Sep-09
Gender	Male
Age	63
City	Victoria
Postal Code	V8Y 2E6
VIN	2B4GH2534SR358083
Year	1995
Make	Dodge
Model	Caravan
Fuel Type	Gas
Transmission	Automatic
Engine Size	3.0
Engine Size Units	litres
Colour	Brown
Mileage (KM)	203660
Incentive Program	P2
Incentive Type	VEHICLE
Incentive Value	
Incentive Cost	2,000.00
Transit Region	
Transit Months	
Transit Zone	
Transit Start Date	
Transit End Date	
Share Type	
Forfeit Transit	
Forfeit Bike	
Replacement Year	2008
Replacement Make	TOYOTA
Replacement Model	PRIUS 5DR HB
Replacement Fuel Type	Gas
Replacement Transmission	Automatic
Replacement Engine Size	1.5
Replacement Colour	Grey
Replacement Mileage (KM)	20781
Scrap Supplier Name	Steel Pacific Recycling
Scrap Paid Date	21-Jul-09

Table TA-2: Scrapped Vehicles by Make

	Manufacturer	[#]	[%]	[Σ%]
1.	Ford	2,431	14.06	14.1
2.	Toyota	2,307	13.34	27.4
3.	Honda	1,419	8.20	35.6
4.	Chevrolet	1,392	8.05	43.6
5.	Mazda	1,304	7.54	51.2
6.	Dodge	1,072	6.20	57.4
7.	Nissan	946	5.47	62.9
8.	Pontiac	752	4.35	67.2
9.	Plymouth	715	4.13	71.3
10.	Oldsmobile	580	3.35	74.7
11.	Volkswagen	546	3.16	77.8
12.	Mercury	488	2.82	80.7
13.	GMC	474	2.74	83.4
14.	Volvo	455	2.63	86.0
15.	Buick	393	2.27	88.3
16.	Chrysler	393	2.27	90.6
17.	Jeep	296	1.71	92.3
18.	Acura	222	1.28	93.6
19.	Subaru	211	1.22	94.8
20.	Hyundai	128	0.74	95.5
21.	Saturn	124	0.72	96.3
22.	Suzuki	94	0.54	96.8
23.	BMW	91	0.53	97.3
24.	Isuzu	80	0.46	97.8
25.	Mercedes-Benz	79	0.46	98.2
26.	Cadillac	63	0.36	98.6
27.	Eagle	58	0.34	98.9
28.	Lincoln	51	0.29	99.2
29.	Saab	41	0.24	99.5
30.	Audi	30	0.17	99.7
31.	Lexus	17	0.10	99.8
32.	Infiniti	14	0.08	99.8
	All other makes	29	0.17	100.0

Note: Vehicles are identified by their World Manufacturer Identifier (WMI), the first three letters of the 17-character Vehicle Identification Number (VIN). Vehicles built prior to 1981 do not have standardized VINs and were excluded from this tabulation. 17,295 vehicles were identified through this method, and 698 pre-1981 vehicles were excluded.

Table TA-3: Socio-demographic Correlations by Postal FSA, 2006 Census

1st Variable	2nd Variable	Corr.
ln(mean HH income)	ln(median HH income)	0.891
Foreigners	Immigrants	0.876
ln(median HH income)	Married	0.706
Migration (last 5 years)	Renting	0.645
ln(mean HH income)	Married	0.574
Foreigners	Renting	0.534
Foreigners	Migration (last 5 years)	0.463
Foreigners	ln(mean/median income)	0.442
Immigrants	Renting	0.396
ln(mean HH income)	ln(mean/median income)	0.390
ln(mean/median income)	Renting	0.327
Immigrants	ln(mean/median income)	0.312
Average Age	ln(mean/median income)	0.306
Immigrants	Migration (last 5 years)	0.274
ln(mean HH income)	ln(distance nearest FSA)	−0.247
ln(distance nearest FSA)	Migration (last 5 years)	−0.263
Average Age	ln(median HH income)	−0.264
ln(mean/median income)	ln(distance nearest FSA)	−0.315
ln(mean HH income)	Migration (last 5 years)	−0.328
ln(distance nearest FSA)	Renting	−0.418
ln(median HH income)	Migration (last 5 years)	−0.450
ln(mean HH income)	Renting	−0.459
Married	Migration (last 5 years)	−0.496
Foreigners	ln(distance nearest FSA)	−0.639
ln(median HH income)	Renting	−0.659
Immigrants	ln(distance nearest FSA)	−0.690
Married	Renting	−0.873

Note: The table shows Pearson correlation coefficients of variables derived from the 2006 Canadian census. Unit of analysis are postal Forward Sortation Areas (FSAs) in British Columbia. The correlation coefficients are shown in descending order of magnitude, suppressing all correlations that are not significant at the 99.9% confidence level.

C Hazard Rate Functions and Vehicle Lifetime Estimation

When we estimate remaining vehicle life parametrically, we employ three different distributional functions that are summarized in table TA-4. For each of the three distributions (Weibull, log-logistics, and complementary log-log), the table shows the survival rate function $S(t)$, the corresponding hazard rate function $h(t)$, and the median of the distribution. In each case, parameters α and β are estimated through suitable numerical techniques (non-linear least squares). All three parametric functions have been used in the past for estimating vehicle lifetime, and thus for us the question is primarily focused on which distribution fits the conditions of the British Columbia data best. We are cognizant of the fact that the distributions imply rather different behaviour in the tail of the distribution, and we observe that the British Columbia vehicle data appears to indicate that the hazard rate peaks at a certain age and trails off for higher vehicle ages.

Table TA-4: Vehicle Inventory Distribution Functions

	Weibull	**log-logistic**	**compl. log-log**
Survival Rate	$\exp\left[-(t/\alpha)^{\beta}\right]$	$\dfrac{1}{1+(t/\alpha)^{\beta}}$	$1-e^{-e^{\alpha-\beta t}}$
Hazard Rate	$\dfrac{\beta}{t}\left[\dfrac{t}{\alpha}\right]^{\beta}$	$\left[\dfrac{\beta}{\alpha}\right]\dfrac{(t/\alpha)^{\beta-1}}{1+(t/\alpha)^{\beta}}$	$\dfrac{\beta e^{\alpha-\beta t-e^{\alpha-\beta t}}}{1-e^{-e^{\alpha-\beta t}}}$
Median	$\alpha(\ln(2))^{1/\beta}$	α	$\dfrac{\alpha-\ln(\ln(2))}{\beta}$

Each distribution is characterized by its cumulative distribution function $F(t;\alpha,\beta)$, where α and β are the scale and shape parameter respectively. The survival function is given by $S(t) = 1 - F(t)$. In continuous-time notation, the hazard function is $h(t) = -S'(t)/S(t)$. Table TA-4 provides closed form expressions for the survival and hazard functions. It should be noted that the scale parameter α equals the median in the log-logistic survival function. The median is also closely related to α in the Weibull function. As we observe interval-censored annual data of changes in the vehicle fleet, the observed discrete hazard rate can be used to approximate the continuous-time equivalent. The parameters α and β are estimated directly from the observed hazard rates through iterative OLS or maximum likelihood. We list these estimated parameters by manufacturer in Table TA-7 for British Columbia and Table TA-8 for Canada.

D Emission Reductions

D.1 Canada-Wide Hazard Rates

We provide several additional tables and figures that we did not include in the main body of our paper for space considerations. Table TA-6 provides estimates of hazard rates, survival rates, and estimated residual lifetimes for vehicles in all of Canada. It corresponds to the table TA-5 that only shows the results for British Columbia. This table highlights the fact that vehicles in British Columbia have a higher residual lifetime than in the rest of Canada. There are a variety of reasons for this effect. A key contributing factor is weather, which is much milder in British Columbia than in other provinces. The information in the table contains estimates based on the empirical distribution (subscript e), the log-logistic distribution (subscript l), the Weibull distribution (subscript w), and the complementary log-log distribution (subscript c).

Table TA-8 shows the estimated parameters α and β for each of the three parametric distributions. It should be noted that in the case of the log-logistic distribution, the median α_l is readily interpreted as the median age of the distribution. For easier interpretation of the table, the rows in this table have been arranged in descending order of α_l. It reveals that Mercedes-Benz an BMW vehicles tended to have the highest median age, whereas Suzuki and Hyundai vehicles thad the shortest median age. The four figures in TA-2 correspond to the results in table TA-8 and visualize the estimated distributions for four vehicle manufacturers. Panels A through D in TA-2 depict the three estimated hazard rate curves along with the empirically-observed hazard rate for the manufacturers Toyota, Honda, Ford, and Chrysler, respectively. These tables and figures complement the tables and charts in the paper that are solely based on the data for British Columbia, which in turn inform our discussion of the emission savings specific to the BC Scrap-It program.

D.2 Mileage Adjustment Factors

In our paper we use an adjustment to the mileage driven by aging vehicles. That is, we deflate the actual mileage driven in the immediate period before a vehicle is scrapped for each hypothetical year of the residual lifetime of the vehicle had it not been scrapped. In other words, we assume that vehicles would have been driven less and less had they been operated rather than scrapped.

Table TA-9 shows the results of our estimation of adjustment factors. The upper half of the table shows the expected residual mileage (in thousand kilometers) for a vehicle at a given starting age in years (row entry) and an expected residual lifetime in years (column entry). These are the predicted values $\hat{m}$ of a regression of the log kilometrage on the log age of a vehicle and its square. The estimated values for each year are then summed to obtain a cumulative value for the assumed (estimated) survival period. For example, a sixteen-year old vehicle is driven an estimated 12.96 thousand kilometers (km), and this is expected to decline in the following year to 12.2. In the year afterwards, the car is expected to be driven another 11.5 thousand km, for a total of 23.7 thousand km.

The lower half of the table shows the corresponding adjustment factor that we apply in our analysis. The adjustment factor is normalized so that estimated kilometrage is divided by the predicted kilometrage at the starting age (the number in the second column) and the number of remaining years $\hat{m}$ (the numbers in the column header). Adjustment factors are in most instances smaller than one. For example, a vehicle that is 16 years old would be expected to be driven 94.2% in the next year, 91.3% in the second year, and 80.5% in the tenth year afterwards (the vehicle's 27th year in total).

Table TA-5: British Columbia Vehicle Fleet

Year	Age	2008	2009	Δ	$h(t)$	$S(t)$	$\hat{F}_e(t)$	$\hat{h}_l(t)$	$\hat{S}_l(t)$	$\hat{F}_l(t)$	$\hat{h}_w(t)$	$\hat{S}_w(t)$	$\hat{F}_w(t)$	$\hat{h}_c(t)$	$\hat{S}_c(t)$	$\hat{F}_c(t)$
2009	1	36,794	145,862	109,068		100.0	22.7	0.0	100.0	23.1	0.0	100.0	21.3	0.0	100.0	23.2
2008	2	189,331	195,553	6,222		100.0	21.7	0.0	100.0	22.1	0.2	99.9	20.3	0.0	100.0	22.2
2007	3	218,028	217,869	-159	0.1	99.9	20.7	0.0	100.0	21.1	0.3	99.6	19.4	0.0	100.0	21.2
2006	4	192,810	191,431	-1,379	0.7	99.2	19.9	0.0	100.0	20.1	0.5	99.2	18.4	0.0	100.0	20.2
2005	5	190,622	192,340	1,718		99.2	18.9	0.1	99.9	19.1	0.7	98.6	17.5	0.0	100.0	19.2
2004	6	166,713	169,407	2,694		99.2	17.9	0.2	99.8	18.2	1.0	97.8	16.7	0.0	100.0	18.2
2003	7	183,936	184,901	965		99.2	16.9	0.3	99.5	17.2	1.3	96.6	15.9	0.1	99.9	17.2
2002	8	174,457	174,318	-139	0.1	99.1	15.9	0.5	99.2	16.3	1.7	95.2	15.1	0.2	99.8	16.2
2001	9	144,349	144,244	-105	0.1	99.1	14.9	0.8	98.5	15.4	2.0	93.5	14.4	0.4	99.5	15.2
2000	10	142,220	141,451	-769	0.5	98.5	14.0	1.1	97.6	14.5	2.4	91.4	13.7	0.8	98.9	14.3
1999	11	121,665	120,659	-1,006	0.8	97.7	13.1	1.6	96.3	13.7	2.8	89.1	13.0	1.3	97.9	13.5
1998	12	130,182	128,102	-2,080	1.6	96.1	12.3	2.1	94.5	12.9	3.3	86.4	12.4	1.9	96.3	12.7
1997	13	128,182	125,429	-2,753	2.1	94.1	11.5	2.8	92.2	12.2	3.8	83.4	11.8	2.7	94.2	11.9
1996	14	96,945	94,063	-2,882	3.0	91.3	10.8	3.6	89.4	11.6	4.3	80.1	11.2	3.5	91.3	11.3
1995	15	117,696	112,335	-5,361	4.6	87.1	10.3	4.4	85.8	11.0	4.8	76.6	10.7	4.5	87.7	10.7
1994	16	109,909	104,191	-5,718	5.2	82.6	9.8	5.4	81.7	10.5	5.3	72.8	10.2	5.4	83.5	10.2
1993	17	108,178	101,278	-6,900	6.4	77.3	9.4	6.3	77.1	10.1	5.9	68.8	9.7	6.4	78.7	9.7
1992	18	110,703	102,663	-8,040	7.3	71.7	9.1	7.3	72.0	9.7	6.5	64.7	9.3	7.3	73.5	9.4
1991	19	101,768	93,402	-8,366	8.2	65.8	8.8	8.3	66.6	9.5	7.1	60.4	8.9	8.2	68.0	9.0
1990	20	97,450	88,495	-8,955	9.2	59.8	8.6	9.2	61.0	9.2	7.8	56.1	8.5	9.0	62.4	8.8
1989	21	78,772	70,480	-8,292	10.5	53.5	8.5	10.0	55.4	9.1	8.5	51.7	8.1	9.7	56.9	8.5
1988	22	64,384	56,947	-7,437	11.6	47.3	8.5	10.7	50.0	8.9	9.1	47.3	7.8	10.4	51.4	8.3
1987	23	48,072	42,251	-5,821	12.1	41.6	8.5	11.3	44.8	8.9	9.9	43.0	7.4	11.0	46.2	8.1
1986	24	42,337	37,021	-5,316	12.6	36.4	8.6	11.8	39.9	8.8	10.6	38.9	7.1	11.5	41.3	8.0
1985	25	27,521	23,845	-3,676	13.4	31.5	8.7	12.2	35.4	8.8	11.4	34.8	6.8	12.0	36.7	7.9
1984	26	20,925	18,349	-2,576	12.3	27.6	8.8	12.4	31.3	8.9	12.1	31.0	6.6	12.4	32.5	7.7
1983	27	11,883	10,502	-1,381	11.6	24.4	8.8	12.6	27.6	8.9	12.9	27.3	6.3	12.8	28.6	7.6
1982	28	9,949	8,820	-1,129	11.3	21.6	8.8	12.7	24.3	9.0	13.8	23.9	6.1	13.1	25.2	7.6
1981	29	16,095	14,275	-1,820	11.3	19.2	8.8	12.8	21.4	9.1	14.6	20.7	5.8	13.4	22.0	7.5

Note: Subscript l refers to the log-logistic function, subscript w refers to the Weibull function, and subscript c refers to the complementary log-log function. Hazard rates and survival rates are expressed in percent. Expected future lifetime is expressed in years.

Table TA-6: Canada Vehicle Fleet

Year	Age	2008	2009	Δ	$h(t)$	$S(t)$	$\hat{F}_e(t)$	$\hat{h}_l(t)$	$\hat{S}_l(t)$	$\hat{F}_l(t)$	$\hat{h}_w(t)$	$\hat{S}_w(t)$	$\hat{F}_w(t)$	$\hat{h}_c(t)$	$\hat{S}_c(t)$	$\hat{F}_c(t)$
2009	1	398,339	1,392,352	994,013		100.0	15.4	0.0	100.0	16.6	1.3	99.2	14.1	0.1	99.9	16.0
2008	2	1,662,237	1,680,556	18,319		100.0	14.4	0.0	100.0	15.6	2.2	97.5	13.3	0.2	99.8	15.1
2007	3	1,794,016	1,761,062	-32,954	1.8	98.2	13.6	0.1	99.9	14.6	3.0	95.0	12.6	0.4	99.5	14.1
2006	4	1,586,578	1,533,764	-52,814	3.3	94.9	13.1	0.3	99.7	13.7	3.8	91.8	12.0	0.8	98.9	13.2
2005	5	1,584,484	1,552,450	-32,034	2.0	93.0	12.3	0.7	99.2	12.7	4.4	88.1	11.5	1.4	97.8	12.3
2004	6	1,388,300	1,392,156	3,856		93.0	11.3	1.2	98.3	11.9	5.1	84.0	11.0	2.2	96.0	11.5
2003	7	1,605,537	1,572,191	-33,346	2.1	91.0	10.5	2.0	96.7	11.0	5.7	79.5	10.6	3.2	93.5	10.8
2002	8	1,505,770	1,467,547	-38,223	2.5	88.7	9.8	3.0	94.4	10.3	6.3	74.9	10.2	4.2	90.1	10.2
2001	9	1,281,327	1,237,991	-43,336	3.4	85.7	9.1	4.2	91.1	9.6	6.9	70.1	9.8	5.3	85.9	9.6
2000	10	1,346,753	1,290,743	-56,010	4.2	82.2	8.4	5.6	86.8	9.0	7.5	65.2	9.4	6.5	81.0	9.2
1999	11	1,102,077	1,039,163	-62,914	5.7	77.5	7.9	7.1	81.5	8.6	8.1	60.3	9.1	7.6	75.5	8.8
1998	12	1,120,342	1,043,267	-77,075	6.9	72.1	7.4	8.7	75.3	8.2	8.6	55.5	8.8	8.6	69.6	8.4
1997	13	988,232	899,165	-89,067	9.0	65.6	7.0	10.2	68.5	7.9	9.1	50.8	8.6	9.6	63.5	8.1
1996	14	710,836	631,372	-79,464	11.2	58.3	6.8	11.6	61.4	7.7	9.7	46.2	8.3	10.5	57.5	7.9
1995	15	773,652	661,748	-111,904	14.5	49.9	6.8	12.8	54.4	7.6	10.2	41.9	8.1	11.3	51.5	7.7
1994	16	649,571	554,634	-94,937	14.6	42.6	6.7	13.8	47.6	7.5	10.7	37.7	7.8	12.0	45.9	7.5
1993	17	556,526	461,080	-95,446	17.2	35.3	6.9	14.5	41.3	7.5	11.2	33.8	7.6	12.6	40.5	7.3
1992	18	523,410	439,350	-84,060	16.1	29.6	7.1	15.1	35.6	7.5	11.7	30.2	7.4	13.2	35.6	7.2
1991	19	424,317	351,500	-72,817	17.2	24.5	7.3	15.4	30.6	7.6	12.2	26.8	7.2	13.7	31.2	7.1
1990	20	371,588	314,327	-57,261	15.4	20.8	7.5	15.5	26.2	7.7	12.6	23.6	7.1	14.1	27.1	7.0
1989	21	300,780	250,379	-50,401	16.8	17.3	7.8	15.6	22.4	7.8	13.1	20.8	6.9	14.5	23.5	7.0
1988	22	252,960	213,704	-39,256	15.5	14.6	8.0	15.5	19.2	8.0	13.6	18.2	6.7	14.8	20.3	6.9
1987	23	179,365	152,154	-27,211	15.2	12.4	8.3	15.3	16.4	8.2	14.0	15.8	6.6	15.0	17.5	6.8
1986	24	162,165	138,755	-23,410	14.4	10.6	8.5	15.1	14.1	8.3	14.5	13.7	6.5	15.3	15.0	6.8
1985	25	115,753	99,174	-16,579	14.3	9.1	8.8	14.8	12.2	8.5	15.0	11.9	6.3	15.5	12.9	6.8
1984	26	89,571	77,588	-11,983	13.4	7.9	9.0	14.5	10.5	8.7	15.4	10.2	6.2	15.6	11.0	6.7
1983	27	50,356	43,832	-6,524	13.0	6.8	9.2	14.2	9.1	8.9	15.8	8.7	6.1	15.8	9.4	6.7
1982	28	43,783	38,563	-5,220	11.9	6.0	9.3	13.8	7.9	9.1	16.3	7.4	6.0	15.9	8.1	6.7
1981	29	64,019	57,133	-6,886	10.8	5.4	9.3	13.5	6.9	9.3	16.7	6.3	5.8	16.0	6.9	6.7

Note: Subscript l refers to the log-logistic function, subscript w refers to the Weibull function, and subscript c refers to the complementary log-log function. Hazard rates and survival rates are expressed in percent. Expected future lifetime is expressed in years.

Table TA-7: British Columbia Vehicle Fleet Hazard Rate Estimates

Make	Log-Logistic Distribution				Weibull Distribution				Comp. Log-Log Distribution			
	$\hat{\alpha}_l$		$\hat{\beta}_l$		$\hat{\alpha}_w$		$\hat{\beta}_w$		$\hat{\alpha}_c$		$\hat{\beta}_c$	
Mercedes-Benz	30.186^c	(23.0)	3.744^c	(6.22)	33.706^c	(27.5)	2.701^c	(5.33)	2.189^c	(5.56)	0.086^c	(7.75)
BMW	26.692^c	(58.4)	8.506^c	(13.3)	28.011^c	(71.7)	5.224^c	(12.3)	5.811^c	(11.6)	0.230^c	(13.7)
Suzuki	25.895^c	(14.5)	2.849^c	(5.79)	30.675^c	(15.4)	2.042^c	(4.22)	1.774^b	(3.93)	0.083^c	(6.09)
Navistar	25.362^c	(13.8)	3.417^c	(6.12)	27.785^c	(12.4)	1.920^c	(4.93)	1.419^b	(3.03)	0.081^c	(6.73)
Volvo	25.060^c	(53.4)	6.058^c	(18.0)	27.069^c	(49.5)	3.713^c	(12.4)	3.964^c	(15.8)	0.173^c	(20.6)
White	24.553^c	(20.8)	7.863^c	(6.04)	24.447^c	(14.7)	3.530^c	(5.01)	5.483^c	(5.52)	0.236^c	(6.57)
Toyota	23.584^c	(79.1)	5.322^c	(33.0)	25.782^c	(36.2)	3.090^c	(11.7)	3.524^c	(26.4)	0.163^c	(36.5)
Honda	23.290^c	(116.)	7.537^c	(43.8)	24.474^c	(55.7)	3.862^c	(18.5)	5.251^c	(31.7)	0.239^c	(41.0)
Volkswagen	23.125^c	(33.7)	4.024^c	(16.5)	25.972^c	(22.8)	2.400^c	(8.52)	2.574^c	(11.5)	0.125^c	(18.0)
Nissan	22.276^c	(76.6)	5.928^c	(34.5)	23.754^c	(28.7)	3.061^c	(11.4)	3.935^c	(26.0)	0.192^c	(36.6)
Subaru	22.023^c	(31.0)	6.963^c	(13.5)	23.030^c	(16.2)	3.302^c	(6.64)	4.778^c	(11.2)	0.231^c	(15.2)
All Manuf.	21.996^c	(89.7)	4.708^c	(45.1)	24.507^c	(33.3)	2.690^c	(13.2)	3.021^c	(29.6)	0.152^c	(44.4)
Ford	21.806^c	(78.1)	4.706^c	(39.8)	24.053^c	(37.7)	2.637^c	(15.7)	2.996^c	(30.0)	0.153^c	(45.7)
Freightliner	21.792^c	(28.1)	4.762^c	(11.8)	23.885^c	(21.2)	2.681^c	(7.92)	3.030^c	(9.69)	0.155^c	(13.6)
GM	21.555^c	(71.5)	4.455^c	(38.0)	24.119^c	(28.2)	2.517^c	(12.0)	2.828^c	(22.7)	0.146^c	(35.1)
Mazda	21.327^c	(23.9)	4.912^c	(12.5)	23.148^c	(14.3)	2.518^c	(6.61)	3.171^c	(8.87)	0.163^c	(13.5)
Paccar	20.879^c	(13.3)	4.241^c	(6.77)	22.524^c	(14.8)	2.473^c	(6.40)	1.888^c	(4.54)	0.125^c	(8.66)
Chrysler	20.666^c	(40.8)	4.799^c	(22.5)	22.222^c	(18.5)	2.406^c	(9.38)	3.040^c	(14.7)	0.163^c	(23.0)
Hyundai	18.207^c	(44.0)	6.241^c	(22.8)	19.148^c	(27.3)	2.926^c	(13.7)	4.048^c	(18.9)	0.243^c	(27.9)

Note: The table is sorted in descending order of the estimated parameter α, which is equal to the median of the survival rate function in the case of the log-logistic distribution. Subscript l refers to the log-logistic function, subscript w refers to the Weibull function, and subscript c refers to the complementary log-log function. Statistical significance at the 95%, 99%, and 99.9% confidence levels is indicated by the superscripts ^{a}, ^{b}, and ^{c}, respectively.

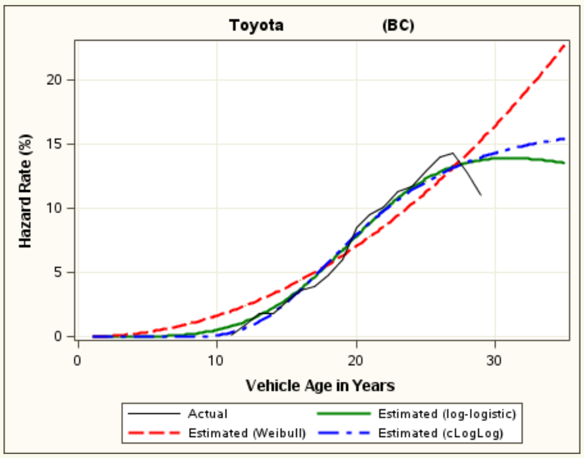
Table TA-8: Canada Vehicle Fleet Hazard Rate Estimates

	Log-Logistic Distribution		Weibull Distribution		Comp. Log-Log Distribution	
Make	$\hat{\alpha}_l$	$\hat{\beta}_l$	$\hat{\alpha}_w$	$\hat{\beta}_w$	$\hat{\alpha}_c$	$\hat{\beta}_c$
Mercedes-Benz	25.710^c (23.3)	3.496^c (10.0)	29.299^c (24.6)	2.284^c (7.74)	2.054^c (7.59)	0.095^c (11.6)
BMW	23.028^c (48.0)	5.558^c (20.7)	25.089^c (44.5)	3.230^c (15.1)	3.535^c (17.8)	0.171^c (25.2)
Paccar	21.059^c (41.9)	2.914^c (27.4)	25.221^c (46.1)	1.901^c (22.1)	1.595^c (16.8)	0.095^c (33.3)
Volvo	20.646^c (36.8)	5.137^c (19.9)	22.117^c (23.5)	2.589^c (11.6)	3.246^c (14.9)	0.174^c (23.0)
Honda	18.682^c (86.8)	6.043^c (50.3)	18.958^c (25.4)	2.498^c (16.3)	3.814^c (34.1)	0.224^c (53.1)
Subaru	18.108^c (43.8)	5.983^c (26.3)	18.546^c (19.8)	2.482^c (13.2)	3.713^c (20.4)	0.227^c (32.6)
Toyota	17.513^c (53.3)	4.559^c (36.5)	18.434^c (17.0)	2.018^c (12.2)	2.595^c (15.3)	0.170^c (27.9)
Freightliner	17.248^c (23.8)	3.001^c (19.0)	20.449^c (20.1)	1.707^c (13.5)	1.479^c (8.39)	0.111^c (20.4)
Nissan	16.255^c (30.9)	4.648^c (22.4)	16.754^c (9.76)	1.877^c (7.99)	2.610^c (9.27)	0.182^c (17.5)
Navistar	15.863^c (23.9)	2.892^c (20.7)	18.866^c (14.5)	1.542^c (11.2)	1.298^c (5.87)	0.110^c (16.8)
All Manuf.	15.636^c (48.2)	4.211^c (37.2)	16.232^c (12.7)	1.753^c (11.0)	2.164^c (10.9)	0.166^c (23.6)
Volkswagen	15.621^c (21.4)	4.016^c (16.8)	16.770^c (8.27)	1.699^c (6.99)	2.094^c (6.15)	0.156^c (13.2)
Ford	15.554^c (48.8)	4.133^c (38.1)	16.360^c (13.8)	1.761^c (11.8)	2.138^c (11.9)	0.164^c (25.5)
Chrysler	15.181^c (51.7)	4.574^c (39.6)	15.326^c (11.0)	1.772^c (10.1)	2.420^c (11.2)	0.186^c (23.0)
GM	15.168^c (46.2)	4.197^c (36.5)	15.478^c (13.2)	1.700^c (12.1)	2.026^c (10.6)	0.166^c (24.4)
Mazda	14.773^c (28.8)	4.352^c (22.9)	14.728^c (9.19)	1.664^c (8.89)	2.139^c (7.64)	0.176^c (17.3)
White	14.540^c (27.9)	2.854^c (25.8)	17.125^c (17.6)	1.487^c (15.1)	1.178^c (6.71)	0.116^c (22.7)
Suzuki	13.146^c (13.4)	3.195^c (12.4)	14.862^c (6.21)	1.400^c (6.04)	1.287^b (2.86)	0.133^c (9.22)
Hyundai	12.994^c (45.3)	6.206^c (31.5)	11.497^c (9.60)	1.854^c (10.3)	3.380^c (12.8)	0.296^c (23.3)

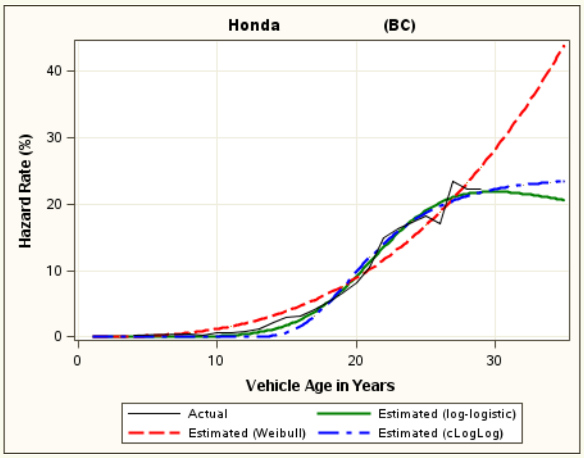
Note: The table is sorted in descending order of the estimated parameter α, which is equal to the median of the survival rate function in the case of the log-logistic distribution. Subscript l refers to the log-logistic function, subscript w refers to the Weibull function, and subscript c refers to the complementary log-log function. Statistical significance at the 95%, 99%, and 99.9% confidence levels is indicated by the superscripts ^{a}, ^{b}, and ^{c}, respectively.

Figure TA-1: British Columbia Vehicle Fleet Hazard Rate Estimates

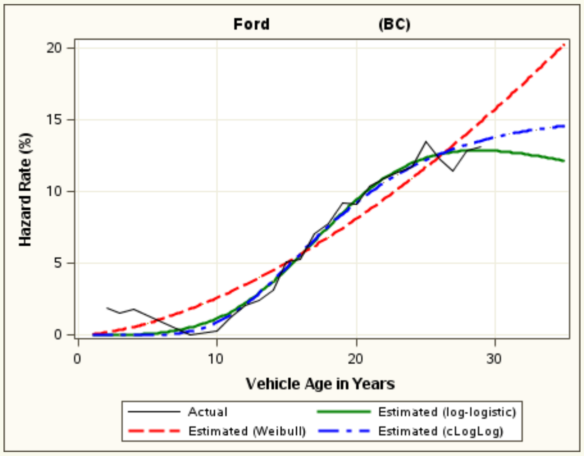
PANEL A



PANEL B



PANEL C



PANEL D

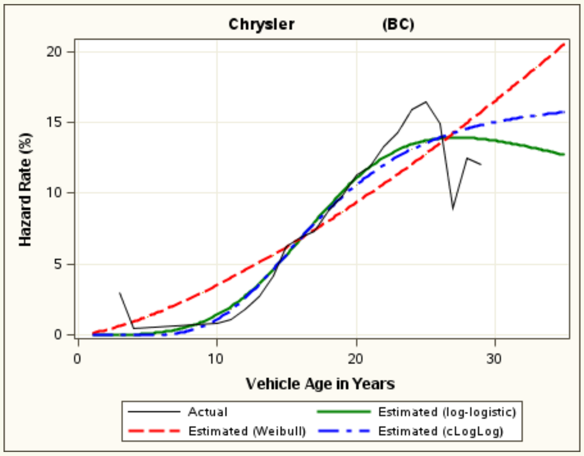
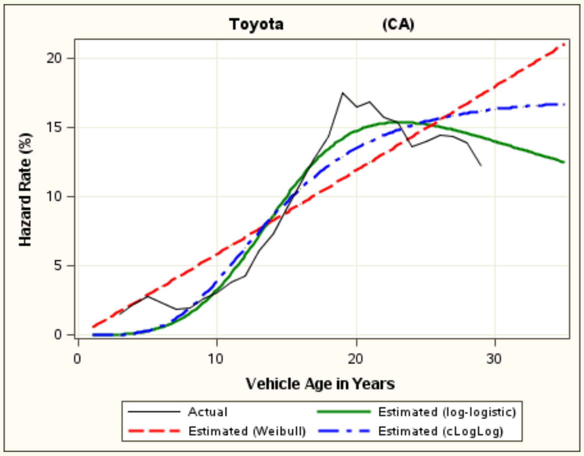
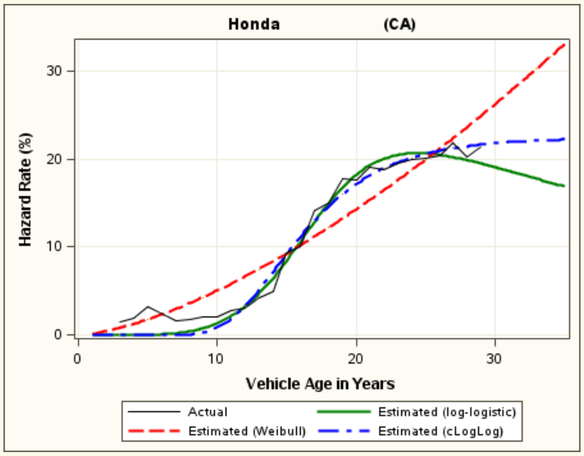


Figure TA-2: Canada Vehicle Fleet Hazard Rate Estimates

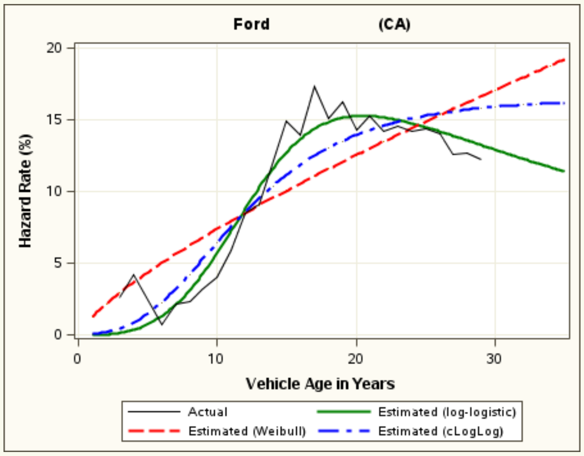
PANEL A



PANEL B



PANEL C



PANEL D

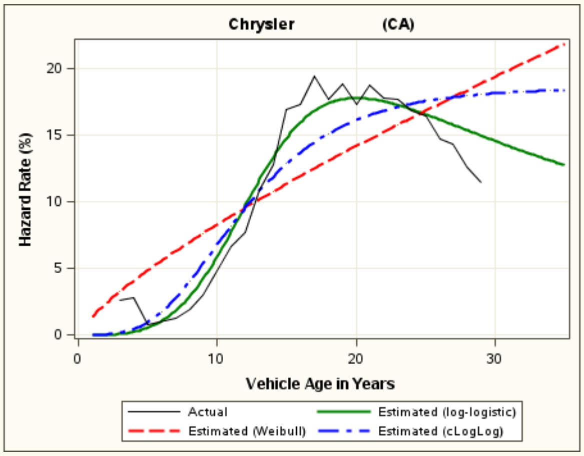


Table TA-9: Vehicle Age Adjustment Factors for Mileage Driven

Age	$\hat{m}$	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7	14.38	15.5	31.5	47.7	63.7	79.3	94.4	108.8	122.5	135.5	147.7	159.2	169.9	179.9	189.3	198.1
8	15.47	16.0	32.2	48.2	63.9	78.9	93.3	107.1	120.0	132.2	143.7	154.4	164.5	173.8	182.6	190.7
9	16.03	16.2	32.2	47.8	62.9	77.3	91.0	104.0	116.2	127.7	138.4	148.4	157.8	166.6	174.7	182.3
10	16.18	16.0	31.6	46.7	61.1	74.8	87.8	100.0	111.5	122.2	132.3	141.6	150.4	158.5	166.1	173.2
11	16.01	15.6	30.7	45.1	58.8	71.8	84.0	95.5	106.2	116.2	125.6	134.4	142.5	150.1	157.2	163.7
12	15.62	15.1	29.5	43.2	56.2	68.4	79.8	90.6	100.6	110.0	118.7	126.9	134.5	141.5	148.1	154.2
13	15.07	14.4	28.1	41.1	53.3	64.8	75.5	85.5	94.9	103.7	111.8	119.4	126.5	133.0	139.1	144.8
14	14.42	13.7	26.7	38.9	50.3	61.1	71.1	80.5	89.2	97.4	105.0	112.0	118.6	124.7	130.4	135.7
15	13.71	13.0	25.2	36.6	47.4	57.4	66.8	75.5	83.7	91.3	98.3	104.9	111.0	116.7	122.0	126.9
16	12.96	12.2	23.7	34.4	44.5	53.8	62.6	70.7	78.3	85.4	91.9	98.1	103.7	109.0	114.0	118.6
17	12.21	11.5	22.2	32.2	41.6	50.4	58.5	66.1	73.2	79.7	85.8	91.5	96.8	101.8	106.3	110.6
18	11.47	10.7	20.8	30.2	38.9	47.0	54.6	61.7	68.3	74.4	80.1	85.4	90.3	94.9	99.2	103.1
19	10.74	10.0	19.4	28.2	36.3	43.9	51.0	57.5	63.6	69.3	74.6	79.6	84.1	88.4	92.4	96.1
20	10.04	9.4	18.1	26.3	33.8	40.9	47.5	53.6	59.3	64.6	69.5	74.1	78.4	82.4	86.1	89.5
21	9.37	8.7	16.9	24.5	31.5	38.1	44.2	49.9	55.2	60.1	64.7	69.0	73.0	76.7	80.1	83.4
22	8.74	8.1	15.7	22.8	29.4	35.5	41.2	46.5	51.4	56.0	60.3	64.2	67.9	71.4	74.6	77.6
23	8.15	7.6	14.6	21.2	27.3	33.0	38.3	43.2	47.8	52.1	56.1	59.8	63.3	66.5	69.5	72.3
24	7.59	7.1	13.6	19.7	25.4	30.7	35.7	40.3	44.5	48.5	52.2	55.7	58.9	61.9	64.7	67.3
25	7.06	6.6	12.7	18.4	23.7	28.6	33.2	37.5	41.4	45.2	48.6	51.8	54.9	57.7	60.3	62.7
26	6.57	6.1	11.8	17.1	22.0	26.6	30.9	34.9	38.6	42.0	45.3	48.3	51.1	53.7	56.2	58.5
27	6.12	5.7	11.0	15.9	20.5	24.8	28.8	32.5	35.9	39.2	42.2	45.0	47.6	50.0	52.3	54.5
28	5.69	5.3	10.2	14.8	19.1	23.1	26.8	30.2	33.5	36.5	39.3	41.9	44.4	46.7	48.8	50.8
29	5.30	4.9	9.5	13.8	17.8	21.5	24.9	28.2	31.2	34.0	36.6	39.1	41.4	43.5	45.5	47.4
30	4.93	4.6	8.9	12.8	16.6	20.0	23.2	26.2	29.1	31.7	34.1	36.4	38.6	40.6	42.5	44.2
7	14.38	1.076	1.095	1.105	1.107	1.103	1.094	1.081	1.065	1.047	1.027	1.006	0.985	0.963	0.940	0.918
8	15.47	1.036	1.041	1.039	1.032	1.020	1.006	0.989	0.970	0.950	0.929	0.908	0.886	0.864	0.843	0.822
9	16.03	1.009	1.004	0.994	0.981	0.964	0.946	0.927	0.906	0.885	0.863	0.842	0.820	0.799	0.778	0.758
10	16.18	0.990	0.978	0.962	0.945	0.925	0.904	0.883	0.861	0.839	0.817	0.796	0.774	0.754	0.733	0.713
11	16.01	0.976	0.958	0.939	0.918	0.897	0.874	0.852	0.829	0.807	0.784	0.763	0.742	0.721	0.701	0.682
12	15.62	0.965	0.944	0.922	0.899	0.875	0.852	0.828	0.805	0.782	0.760	0.738	0.717	0.697	0.677	0.658
13	15.07	0.957	0.933	0.909	0.884	0.859	0.835	0.811	0.787	0.764	0.742	0.720	0.699	0.679	0.659	0.641
14	14.42	0.951	0.925	0.899	0.873	0.847	0.822	0.797	0.774	0.750	0.728	0.706	0.685	0.665	0.646	0.627
15	13.71	0.946	0.918	0.891	0.864	0.838	0.812	0.787	0.763	0.740	0.717	0.696	0.675	0.655	0.636	0.617
16	12.96	0.942	0.913	0.885	0.857	0.831	0.805	0.779	0.755	0.732	0.709	0.688	0.667	0.647	0.628	0.610
17	12.21	0.939	0.909	0.880	0.852	0.825	0.799	0.773	0.749	0.725	0.703	0.681	0.661	0.641	0.622	0.604
18	11.47	0.937	0.906	0.877	0.848	0.821	0.794	0.769	0.744	0.721	0.698	0.677	0.656	0.637	0.618	0.600
19	10.74	0.935	0.904	0.874	0.845	0.817	0.791	0.765	0.741	0.717	0.695	0.673	0.653	0.633	0.615	0.597
20	10.04	0.934	0.902	0.872	0.843	0.815	0.788	0.763	0.738	0.715	0.692	0.671	0.650	0.631	0.612	0.594
21	9.37	0.933	0.901	0.870	0.841	0.813	0.786	0.761	0.736	0.713	0.690	0.669	0.649	0.629	0.611	0.593
22	8.74	0.932	0.900	0.869	0.840	0.812	0.785	0.759	0.735	0.712	0.689	0.668	0.648	0.628	0.610	0.592
23	8.15	0.931	0.899	0.868	0.839	0.811	0.784	0.758	0.734	0.711	0.689	0.667	0.647	0.628	0.609	0.592
24	7.59	0.931	0.899	0.868	0.838	0.810	0.784	0.758	0.734	0.711	0.688	0.667	0.647	0.628	0.609	0.592
25	7.06	0.931	0.898	0.868	0.838	0.810	0.783	0.758	0.734	0.711	0.688	0.667	0.647	0.628	0.610	0.592
26	6.57	0.931	0.898	0.867	0.838	0.810	0.784	0.758	0.734	0.711	0.689	0.668	0.648	0.629	0.610	0.593
27	6.12	0.931	0.898	0.868	0.838	0.810	0.784	0.759	0.734	0.711	0.690	0.669	0.649	0.630	0.611	0.594
28	5.69	0.931	0.898	0.868	0.839	0.811	0.784	0.759	0.735	0.712	0.690	0.670	0.650	0.631	0.612	0.595
29	5.30	0.931	0.899	0.868	0.839	0.811	0.785	0.760	0.736	0.713	0.691	0.671	0.651	0.632	0.614	0.596
30	4.93	0.931	0.899	0.869	0.840	0.812	0.786	0.761	0.737	0.714	0.692	0.672	0.652	0.633	0.615	0.598

Note: The upper half of the table shows the expected residual mileage (in thousand kilometers) for a vehicle at a given starting age in years (row entry) and an expected residual lifetime in years (column entry). Rows indicate originating age, and columns indicate expected remaining lifetime in years. The lower half of the table shows the corresponding adjustment factor that we apply in our analysis.

Table TA-10: Net Emission Reductions from Scrapping (by mileage imputation, by fuel economy imputation, and by replacement type)

Variable	Mean	S.V.	Q1	Q2	Q3
All Vehicles [N=17866]					
CO Reduction [kg]	229.	631.	68.9	131.	215.
CO_2 Reduction [tonnes]	5.18	6.71	1.49	3.59	6.99
HC Reduction [kg]	16.1	57.2	3.90	7.77	14.4
NO_x Reduction [kg]	43.9	64.2	19.3	30.1	46.1
Vehicles replaced with new vehicles [N=8493]					
CO Reduction [kg]	250.	561.	122.	175.	242.
CO_2 Reduction [tonnes]	4.17	5.31	1.01	3.12	6.25
HC Reduction [kg]	17.0	66.3	6.48	10.7	15.5
NO_x Reduction [kg]	45.4	55.2	24.5	34.5	48.0
Vehicles scrapped for altern. transp. [N=9373]					
CO Reduction [kg]	210.	687.	41.8	83.3	158.
CO_2 Reduction [tonnes]	6.10	7.64	1.93	4.04	7.82
HC Reduction [kg]	15.4	47.5	2.18	5.35	10.6
NO_x Reduction [kg]	42.6	71.3	15.9	24.7	42.8
Vehicles with fuel consumption estimated [N=9173]					
CO Reduction [kg]	261.	748.	86.0	151.	232.
CO_2 Reduction [tonnes]	5.95	7.72	1.80	4.19	8.00
HC Reduction [kg]	18.5	66.6	4.87	9.26	15.5
NO_x Reduction [kg]	47.6	70.9	21.1	32.1	48.7
Vehicles with fuel consumption matched [N=8669]					
CO Reduction [kg]	195.	475.	55.9	107.	194.
CO_2 Reduction [tonnes]	4.37	5.32	1.25	3.08	5.93
HC Reduction [kg]	13.6	45.2	3.05	6.35	12.9
NO_x Reduction [kg]	40.0	56.0	17.7	27.5	43.4

Table TA-11: Net Emission Reductions from Scrapping with Different Distributional Assumptions about the Remaining Vehicle Lifetime

Variable	Mean	S.V.	Q1	Q2	Q3
All Vehicles [N=17866]					
CO Reduction [kg] (compl-loglog)	220.	588.	66.4	126.	209.
CO Reduction [kg] (empirical)	219.	603.	65.3	125.	207.
CO Reduction [kg] (log-logistic)	229.	631.	68.9	131.	215.
CO Reduction [kg] (weibull)	212.	549.	64.1	123.	205.
CO_2 Reduction [tonnes] (compl-loglog)	5.00	6.39	1.44	3.47	6.75
CO_2 Reduction [tonnes] (empirical)	4.99	6.45	1.41	3.46	6.75
CO_2 Reduction [tonnes] (log-logistic)	5.18	6.71	1.49	3.59	6.99
CO_2 Reduction [tonnes] (weibull)	4.86	6.16	1.38	3.36	6.60
HC Reduction [kg] (compl-loglog)	15.4	52.2	3.75	7.46	13.9
HC Reduction [kg] (empirical)	15.5	54.3	3.70	7.42	13.7
HC Reduction [kg] (log-logistic)	16.1	57.2	3.90	7.77	14.4
HC Reduction [kg] (weibull)	14.7	47.6	3.63	7.23	13.6
NO_x Reduction [kg] (compl-loglog)	42.3	60.0	18.5	29.1	44.7
NO_x Reduction [kg] (empirical)	42.1	61.7	18.4	28.8	44.1
NO_x Reduction [kg] (log-logistic)	43.9	64.2	19.3	30.1	46.1
NO_x Reduction [kg] (weibull)	40.9	56.4	17.9	28.4	43.8