22. Travel per vehicle by age

Overview

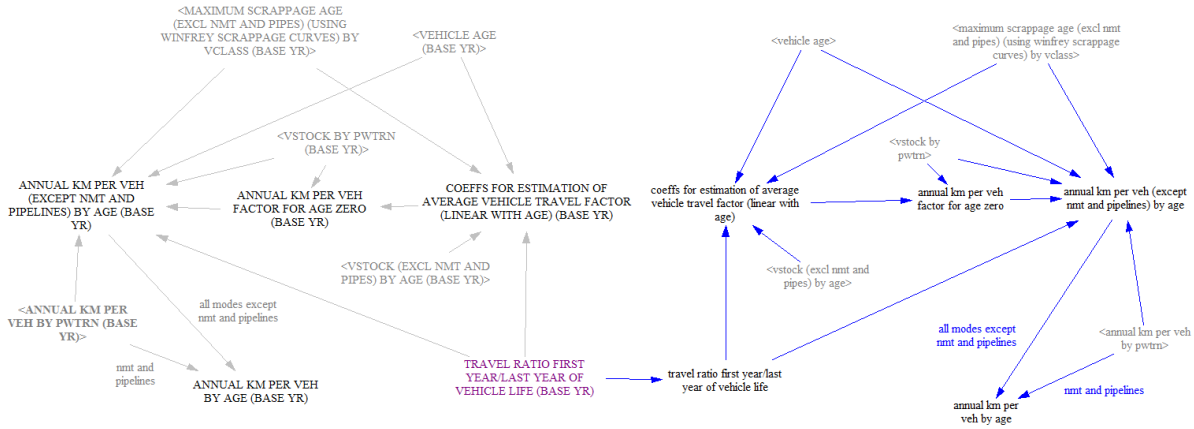
Target

This view is aimed to distribute the annual travel per vehicle across the different age subscripts, by means of assuming a linear distribution.

Structure

Figure 22.1 contains the Vensim sketch of the view. The calculations are divided in two main groups: base year (left side) and over time (right side). The variables for these two groups are displayed symmetrically.

Figure 22.1 Vensim sketch of the view



Detailed description of the view

Inputs

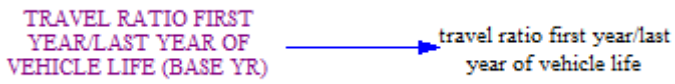
The main inputs are the variables "ANNUAL KM PER VEH BY PWTRN" and "ANNUAL KM PER VEH BY PWTRN (BASE YR)", containing information on the annual km per vehicle by area, service, mode, vehicle class and powertrain. Both are calculated in the view "travel per vehicle". These variables represent the average travel in the vehicle stock across all vehicle ages.

The maximum scrappage age of a vehicle (base year and over time) enters this view from the view "vehicles, new registrations (historical) ("MAXIMUM SCRAPPAGE AGE (EXCL NMT AND PIPES) BY VCLASS" and "MAXIMUM SCRAPPAGE AGE (EXCL NMT AND PIPES) BY VCLASS (BASE YR)" variables). This is used here to provide information on the upper limit assumed for the vehicle lifetime.

Other inputs taken from other model views are the vehicle stock, by vehicle age (i.e. the number of vehicles belonging to the stock in each age cohort) at the base year and over time ("VSTOCK (EXCL NMT AND PIPES) BY AGE" and " VSTOCK (EXCL NMT AND PIPES) BY AGE (BASE YR)"). These variables are calculated in the view "vehicle by age".

The only exogenous input coming in this view is the "TRAVEL RATIO FIRST YEAR/LAST YEAR OF VEHICLE LIFE (BASE YR)" (Figure 22.2). This is the ratio that gives the reduction between the annual travel of those vehicles at age zero and those at the maximum scrappage age. The model is currently assuming that the annual travel of the vehicles at the maximum scrappage age is half of the annual travel of newly registered vehicles. As a result, the factor is set to 2. The current assumptions are maintained constant over time: "TRAVEL RATIO FIRST YEAR/LAST YEAR OF VEHICLE LIFE" equals "TRAVEL RATIO FIRST YEAR/LAST YEAR OF VEHICLE LIFE (BASE YR)" (Figure 22.2).

Figure 22.2 **Ratio that gives the reduction between the annual travel of those vehicles at age zero and those at the maximum scrappage age**

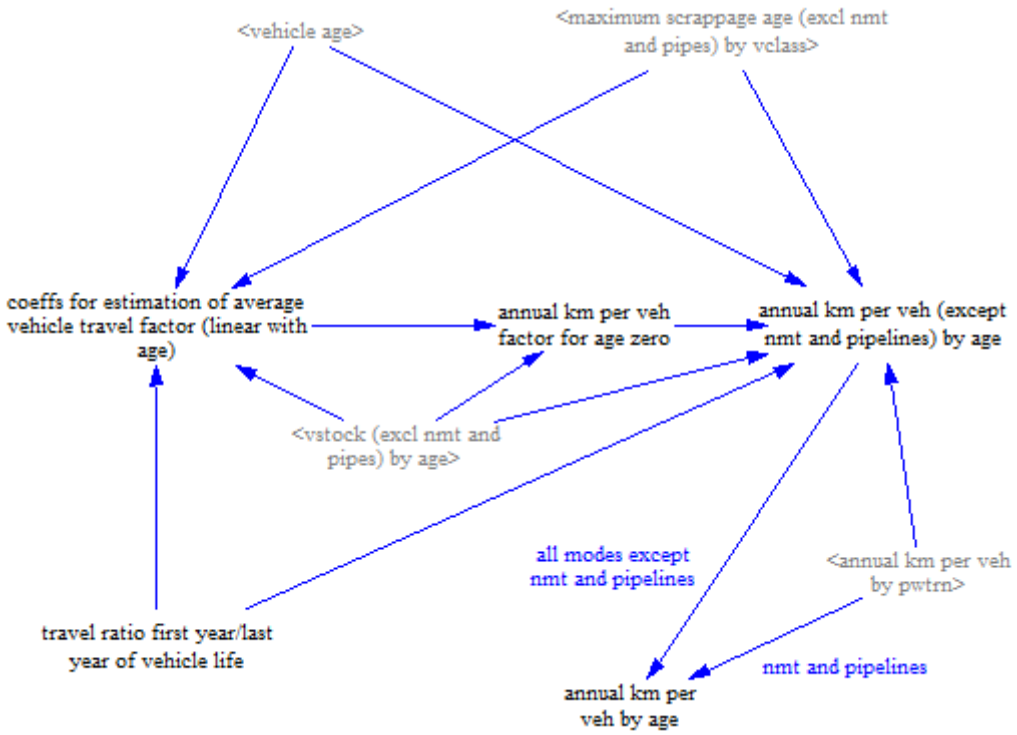


Outputs

The above mentioned inputs are used in this view to define the linear distribution that enables to allocate a value on annual travel per vehicle at each age subscript.

For simplicity, the following description focuses only on variables changing over time (Figure 22.3, right side of the sketch).

Figure 22.3 **Calculations for variables changing over time**



The vehicle activity (vkm) in each age cohort is the result of the product between the number of vehicles by age in the vehicle stock and the respective annual travel (see equation below).

$$vkm\ by\ age = vehicle\ stock\ by\ age \times annual\ travel\ per\ vehicle\ by\ age$$

The total vkm is obtained summing up the vkm of each age cohort.

$$vkm = \sum_{ages} vehicle\ stock_{age\ i} \times annual\ travel\ per\ vehicle_{age\ i}$$

The annual travel per vehicle by age can be expressed ad the product of an average value ($Annual\ travel\ (stock)$) multiplied by a function that depends on the variable age: ($\delta(age)$). The equation written earlier becomes, then:

$$vkm = \sum_{ages} vehicle\ stock_{age\ i} \times Annual\ travel\ (stock) \times \delta_{age\ i}$$

By definition of vkm, the $vehicle\ stock$ can be calculated as the ratio of vkm and the average annual travel ($Annual\ travel\ (stock)$). This is expressed in the equation below, which equals the equation above, divided by $Annual\ travel\ (stock)$

$$vehicle\ stock = \frac{vkm}{Annual\ travel\ (stock)} = \sum_{ages} vehicle\ stock_{age\ i} \times \delta_{age\ i}$$

Assuming that $\delta(age)$ is a linear function with a value of δ_0 at age zero, and a value of $\delta_0/2$ at the $maximmum\ scrappage\ age$ (this is consistent with the reduction factor of 2 between the average travel of vehicle at age zero and at the maximum scrappage age), the same equation can be re-written as follows:

$$vehicle\ stock = \sum_{ages} vehicle\ stock_{age\ i} \times \left(\delta_0 - \frac{\delta_0}{2 \times maximmum\ scrappage\ age} \times age\ i\right)$$

Finally, from the inputs on vehicle stock, vehicle stock by age and maximum scrappage age, the value δ_0 can be calculated:

$$\delta_0 = \frac{vehicle\ stock}{\sum_{ages} vehicle\ stock_{age\ i} \times \left(1 - \frac{age\ i}{2 \times maximmum\ scrappage\ age}\right)}$$

The term $vehicle\ stock_{age\ i} \times \left(1 - \frac{age\ i}{2 \times maximmum\ scrappage\ age}\right)$ is equivalent to the variable "COEFFS FOR ESTIMATION OF AVERAGE VEHICLE TRAVEL FACTOR (LINEAR WITH AGE)" of the Vensim sketch, and δ_0 is the annual km per vehicle of newly registered vehicles ("ANNUAL KM PER VEH FACTOR FOR AGE ZERO" variable) (Figure 22.4).

Once the annual km per vehicle of newly registered vehicles are calculated, it is possible to evaluate the annual travel per vehicle by age, using the assumption of a linear distribution across the ages. This is expressed in the following equation. It corresponds in Vensim to the calculation shown in Figure 22.5.

$$Annual\ travel\ age_i = Annual\ travel\ (stock) \times \delta_0 \times \left(1 - \frac{age\ i}{2 \times Maximmum\ scrappage\ age}\right)$$

Figure 22.4 **Calculation of the factor between the average annual km per vehicle and the annual km per vehicle of newly registered vehicles**

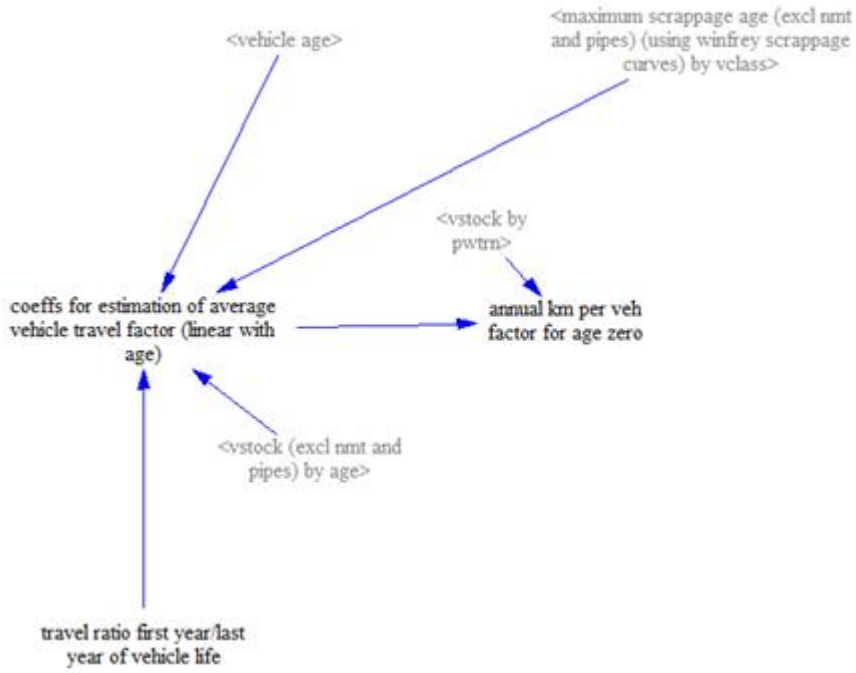
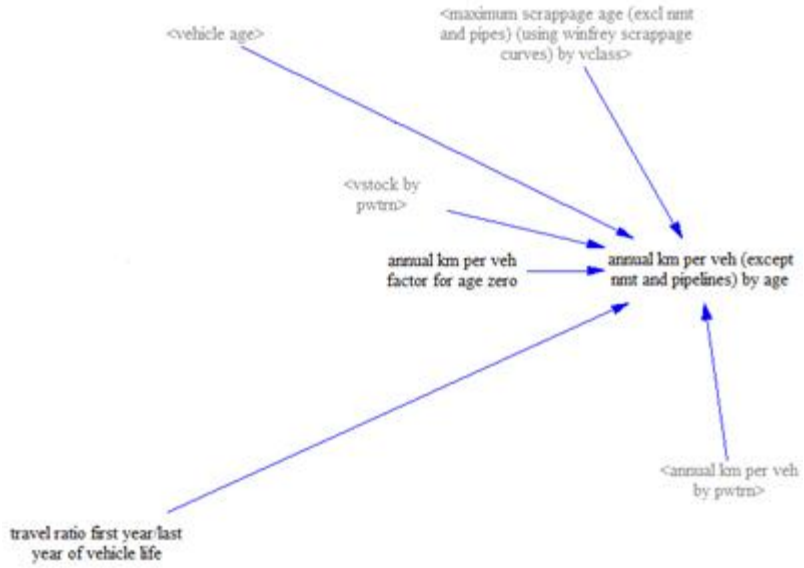
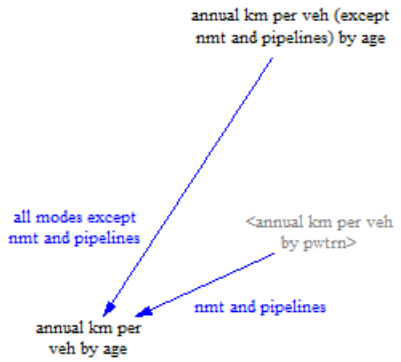


Figure 22.5 **Calculation of the annual travel per vehicle by age**



Since non-motorised transport and pipelines are out of the aging system of the model, all data concerning these modes are placed in the age subscript ZERO. In these cases, the average annual travel per vehicle is not distributed across the ages (**Error! Not a valid bookmark self-reference.**).

Figure 22.6 NMT and pipelines



Base year calculations (Figure 22.7, left side of the sketch) mirror exactly the ones described for time-dependent parameters, in this view.

Figure 22.7 Base year calculations