

## 5. Demand (pass. personal vessels)

### Overview

#### Target

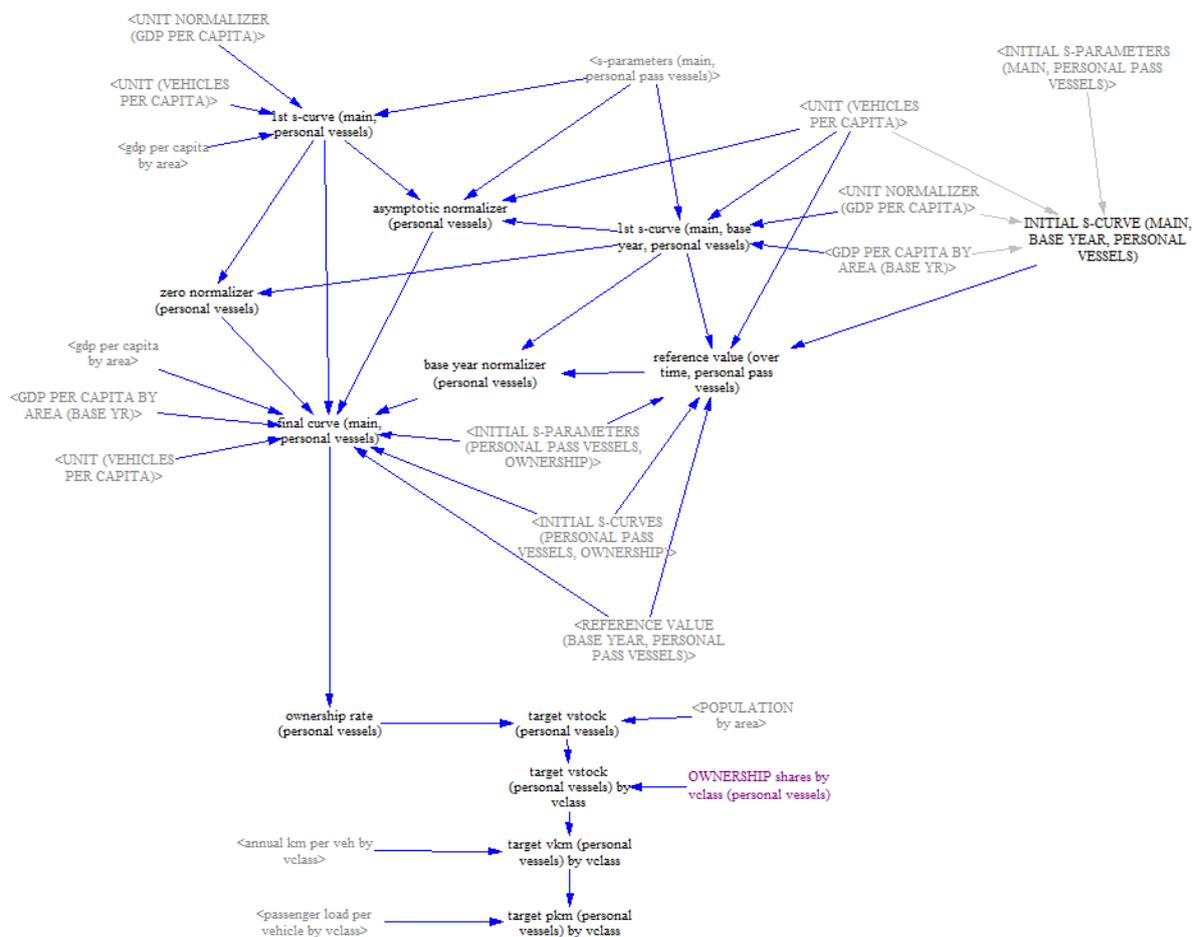
The view is aimed at evaluating the transport activity of passenger personal vessels (corresponding to vehicle classes from A to D of the VESSELS mode). The vehicle stock is estimated through the S-Curve on personal vessels ownership, while the vkm and pkm are subsequently calculated by means of the inputs on annual travel and load factors.

#### Structure

The top section of the view (which is shown entirely in Figure 5.1) contains variables defining S-curves that link GDP per capita to the ownership of personal vessels.

The central variable is the target vehicle stock. The vertical line of variables located in the bottom part of the view contains the flow of calculations allowing the estimation of vkm and pkm associated with the vehicle stock.

Figure 5.1



## Detailed description of the view

### Inputs

The GDP per capita determines the ownership of personal vessels by means of S-shaped functions (S-curves). Ownership is converted into vehicle stocks after a multiplication by the population. Both GDP and population are exogenously entered by the user in the "Socio-economic data" tab of the ForFITS Excel file (more details on this are available in the explanation of the view "economic parameters").

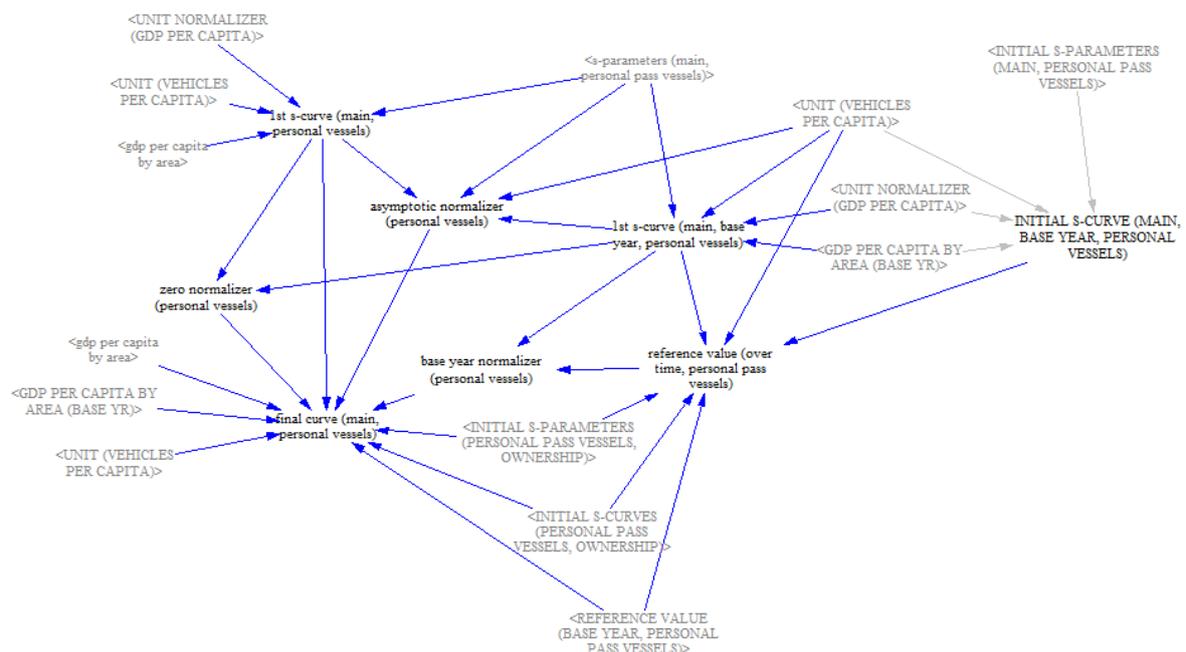
The data on the vehicle stock, combined with information on the average travel (from the view "travel per vehicle") and the average loads (from the "load (passenger)" view), are used here to calculate vkm and pkm.

Exogenous inputs from the user are necessary to disaggregate the information by vehicle class (see the headings "VEHICLE CLASSES (EXOGENOUS PROJECTIONS)" and "Personal passenger vessels" in the "Table of contents" tab of the ForFITS Excel file, as well as the related tables in the "User inputs (over time)" tab).

### Calculation flow and outputs

Figure 5.2 contains the Vensim sketch of the sections allowing the definition of the "final S-curves" of personal vessels ownership.

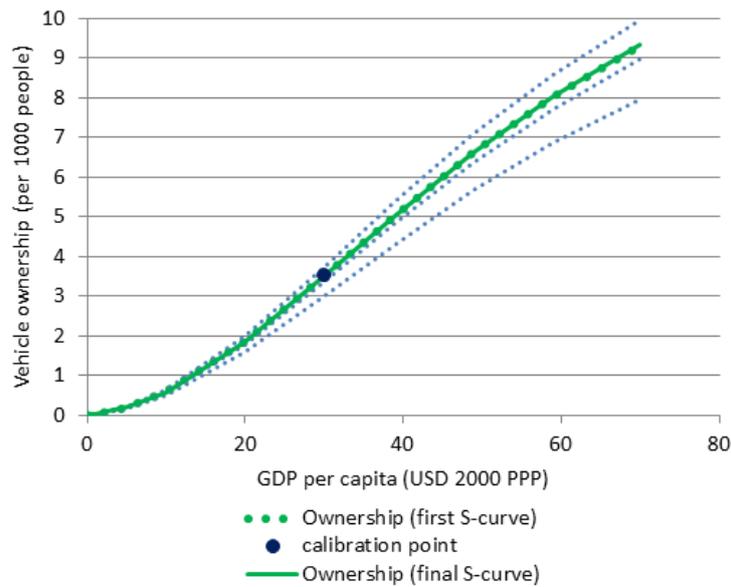
Figure 5.2 Personal passenger vessels, ownership curve: Vensim sketch



The variable "S-PARAMETERS (MAIN, PERSONAL PASS VESSELS)" includes the parameters that define the first S-Curve introduced in the view "demand (passenger, main drivers)". The final S-curve on personal vessel ownership intersects historical data stored in the variable "REFERENCE VALUE (BASE YEAR, PERSONAL PASS VESSELS)". This is then recalculated over time to consider the effect of changes in the passenger transport system ("REFERENCE VALUE (OVER TIME, PERSONAL PASS VESSELS)").

At the base year, the first S-curve coincides with the initial S-curve defined in the "demand (passenger, main drivers)" view. If, at the base year, the personal vehicle ownership falls between the LOW and HIGH driving S-curves (i.e. the highest and lowest curves of the family of guiding S-curves, represented by dotted light-blue lines in the figures), the first S-curve also coincides with the final S-curve (Figure 5.3). In this case, normalizing parameters have no effect.

**Figure 5.3** Vessel ownership: base-year evaluation of the final S-curve when the share falls between the LOW and HIGH driving S-curve range



If the reference ownership in the base year is beyond the HIGH and LOW limits, the normalizing parameters act as weights to define a final S-curve that is close to the base year reference value for values of GDP per capita next to the GDP per capita at the base year, and close to the first S-curve when the GDP per capita is far from the value assumed in the base year (i.e. towards zero and infinity on the X-AXIS) (Figure 5.4).

**Figure 5.4** Vessel ownership: base-year evaluation of the final S-curve when the share falls out of the LOW and HIGH driving S-curve range

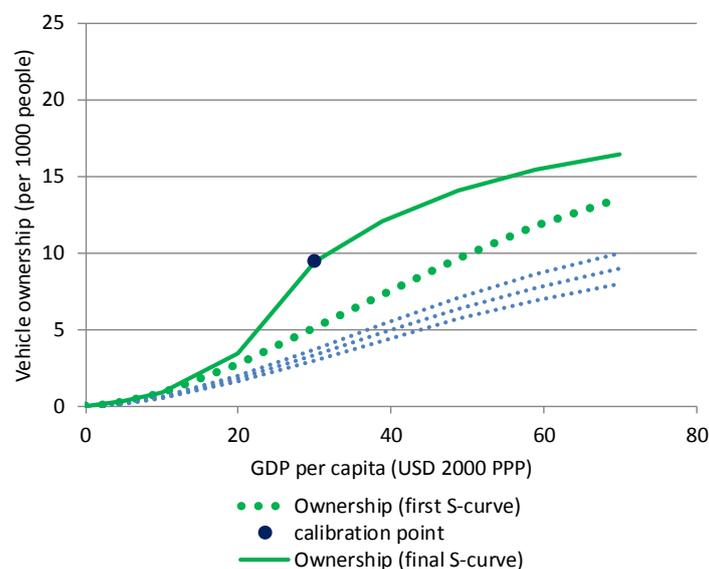
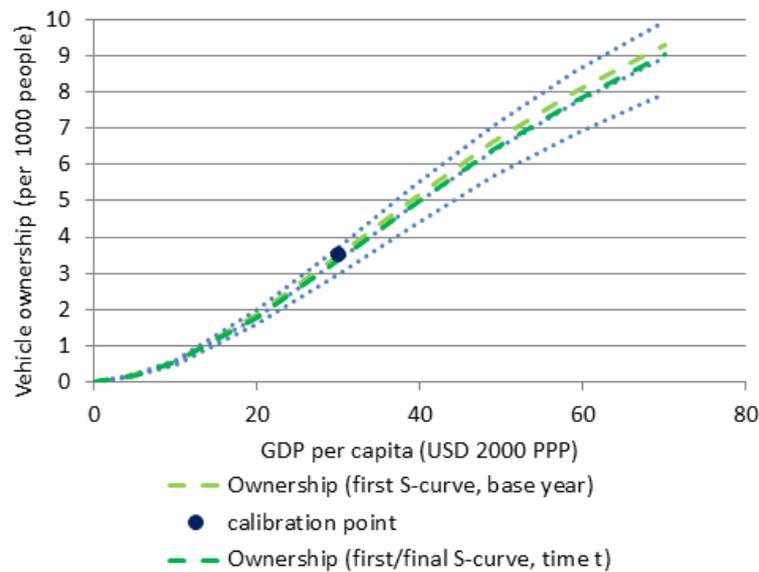


Figure 5.5 Vessel ownership: evaluation of the final S-curve when the share falls between the LOW and HIGH driving S-curves and factors such as the transport characteristic index change the first S-curve pattern over time



The evolution of the final S-Curve over time depends on the initial situation:

- When the calibration point is within the range defined by the LOW and HIGH S-curves (Figure 5.3), the normalizing parameters are not active and the final S-Curve evolves as the first S-Curve. This is the curve used to project the personal boats ownership during the simulation. Figure 5.5 shows the first and final S-Curves at the base year and at time t. The latter does not include the calibration point because it refers to a situation with a variation of the cost of driving (personal vessels ownership is not sensitive to the passenger transport characteristic index and the environmental culture index).
- When the calibration point falls beyond the limits defined by the LOW and HIGH S-curves (Figure 5.4), the final S-Curve is over time is calculated taking into account of the changes affecting the first S-Curve, but also the distance of the initial calibration point from the HIGH and LOW driving S-curves.

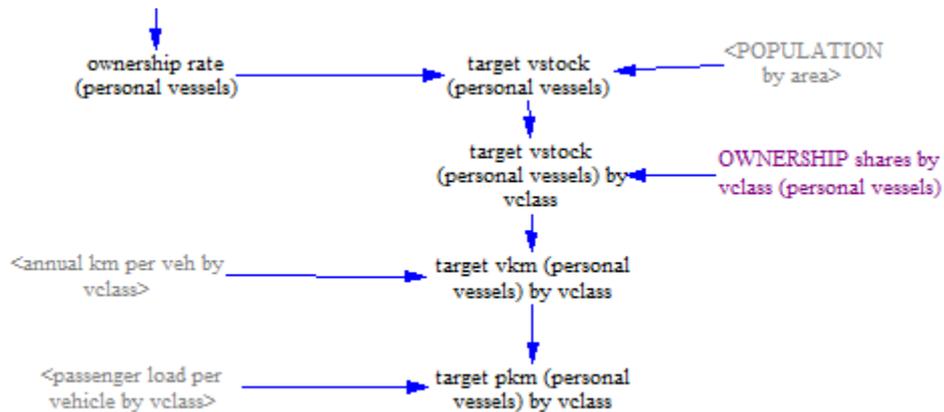
If the calibration point at the base year falls above the HIGH driving S-Curve, the reference value over time is calculated according to the following equation:

$$\begin{aligned}
 & \text{Reference value (over time)} \\
 &= \text{Initial value (i. e. passenger personal vessels ownership at the base year)} \\
 &+ \frac{(\text{First SCurve}_{GDP \text{ per capita (base year)}} - \text{Initial SCurve}_{GDP \text{ per capita (base year)}})}{\text{Upper Ceiling of SCurve families} - \text{Initial value}} \\
 &\times \frac{\text{Upper Ceiling of SCurve families} - \text{Initial SCurve}_{GDP \text{ per capita (base year)}}}{\text{Upper Ceiling of SCurve families} - \text{Initial SCurve}_{GDP \text{ per capita (base year)}}}
 \end{aligned}$$

If the calibration point at the base year falls below the LOW driving S-Curve, the equation becomes:

$$\begin{aligned}
 & \text{Reference value (over time)} \\
 &= \text{Initial value (i. e. passenger personal vessels ownership at the base year)} \\
 &+ \frac{(\text{First Curve}_{GDP \text{ per capita (base year)}} - \text{Initial Curve}_{GDP \text{ per capita (base year)}})}{\text{Initial Curve}_{GDP \text{ per capita (base year)}}} \\
 &\times \text{Initial value}
 \end{aligned}$$

Figure 5.6 Vehicle stock, vkm and pkm calculations: Vensim sketch



The product between the ownership and the population provides the target number of personal vessels, used as input in the view "vehicles by age" (top of Figure 5.6). The allocation of the vehicle stock to different vehicle classes (A to D) requires exogenous inputs by users. These inputs are introduced in the ForFITS Excel file (see the headings "VEHICLE CLASSES (EXOGENOUS PROJECTIONS)" and "Personal passenger vessels" of the "Table of contents", as well as the related tables of the "User inputs (over time)" tab).

The annual travel by vehicle class allows calculating the target vkm from the vehicle stock (center of Figure 5.6). Similarly, vkm and average load factors are used to evaluate the target pkm on personal vessels (also on Figure 5.6). The variable "ANNUAL KM PER VEH BY VCLASS", used for the determination of vkm, is calculated in the view "travel per vehicle", while the "PASSENGER LOAD PER VEHICLE BY VCLASS", used for the pkm, comes from the view "load (passenger)".