4. Demand (pass. personal motor road)

Overview

Target

This view calculates the vehicle stock, vkm and pkm for vehicles included in the vehicle classes A to D of the following passenger modes: TWO WHEELERS, THREE WHEELERS and LDVS.

The vehicle stock is calculated through ownership (S-shaped) curves expressed as functions of GDP per capita. The estimation of the vehicle stock, combined with information on the annual travel per vehicle and the load factors, is also the basis for the evaluation of vkm and pkm.

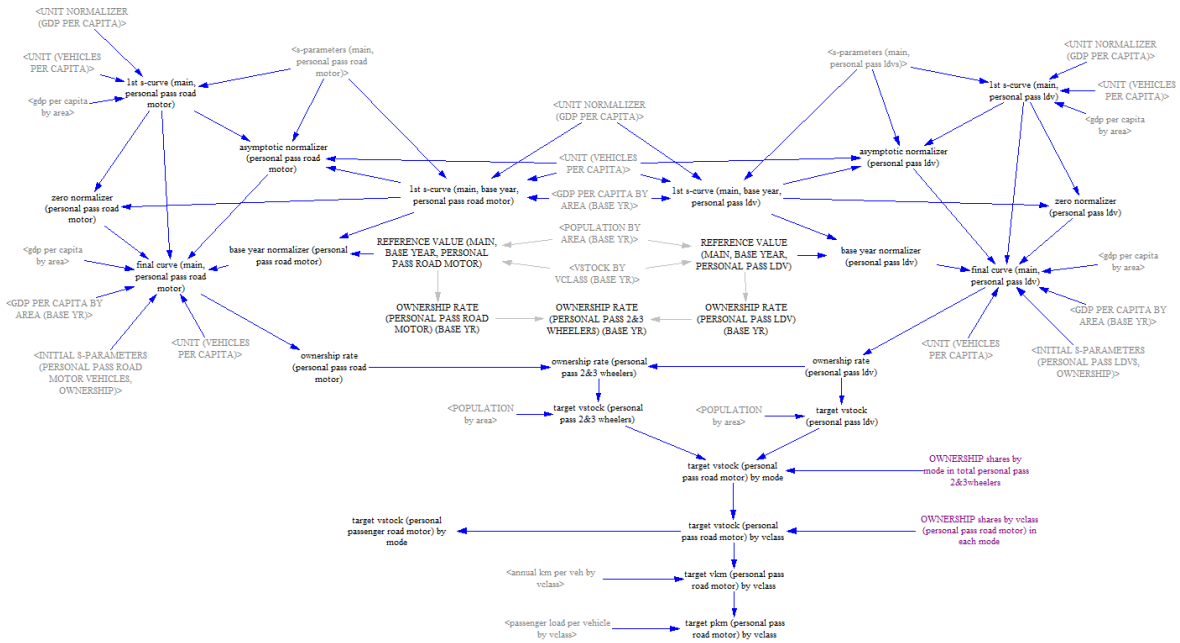
Changes in the cost of driving enter this view indirectly, via the effects on average vehicle travel and average load per vehicle.

Structure

Figure 4.1 contains an illustration of the whole view in Vensim. The top section contains variables defining ownership S-curves (as functions of GDP per capita) for light duty passenger vehicles (cars) (right) and personal passenger vehicles, including cars, two wheelers and three wheelers (left).

The central variable is the target vehicle stock by mode. 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 4.1 Demand (pass. personal motor road): Vensim sketch



Detailed description of the view

Inputs

The GDP per capita is the main driver of the parameters estimated in this view. It determines the vehicle ownership by means of S-Curves. Ownership estimates are converted into information on the vehicle stock multiplying the ownership 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 "first S-curves" evaluated in the "demand (passenger, main drivers)" view are used here to define the "final S-curves". The latter benefit from the use of normalizing parameters (normalizers) making sure that the vehicle ownerships as functions of GDP per capita are defined as lines intersecting the values of the vehicle stocks in the base year (calibration points, stored in "REFERENCE VALUE (MAIN, BASE YEAR, PERSONAL PASS ROAD MOTOR)" and "REFERENCE VALUE (MAIN, BASE YEAR, PERSONAL PASS LDV)").

Inputs on the annual travel and passenger load per vehicle, respectively from the views "travel per vehicle" and "load (passenger)", are used to derive the target vkm and pkm from the target vehicle stock.

Exogenous inputs on the shares in total passenger TWO and THREE WHEELERS enable to split the vehicles in the stock belonging to each mode, while exogenous assumptions on the evolution of the shares by vehicle class are used to disaggregate the target vehicle stock by vehicle class.

Calculation flow and outputs

Figure 4.2 and Figure 4.3 contain illustrations of the sections of the view allowing the definition of the "final S-curves" of vehicle ownership.

The four parameters in each of the variables "S-PARAMETERS (MAIN, PERSONAL PASS ROAD MOTOR)" and "S-PARAMETERS (MAIN, PERSONAL PASS LDVS)" define the "first S-curves" outlining the vehicle ownership patterns as functions of GDP per capita. They result from the calculations performed in the "demand (passenger, main drivers)" view.

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 reference value of the vehicle ownership curves 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 4.4). In this case, normalizing parameters have no effect.

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 4.5). In particular, the zero normalizer guides the curve between zero and the GDP per capita of the base year, while the asymptotic normalizer defines the final S-curve between the GDP per capita of the base year and infinity.

Figure 4.2 **Personal passenger vehicles, ownership curve: Vensim sketch**

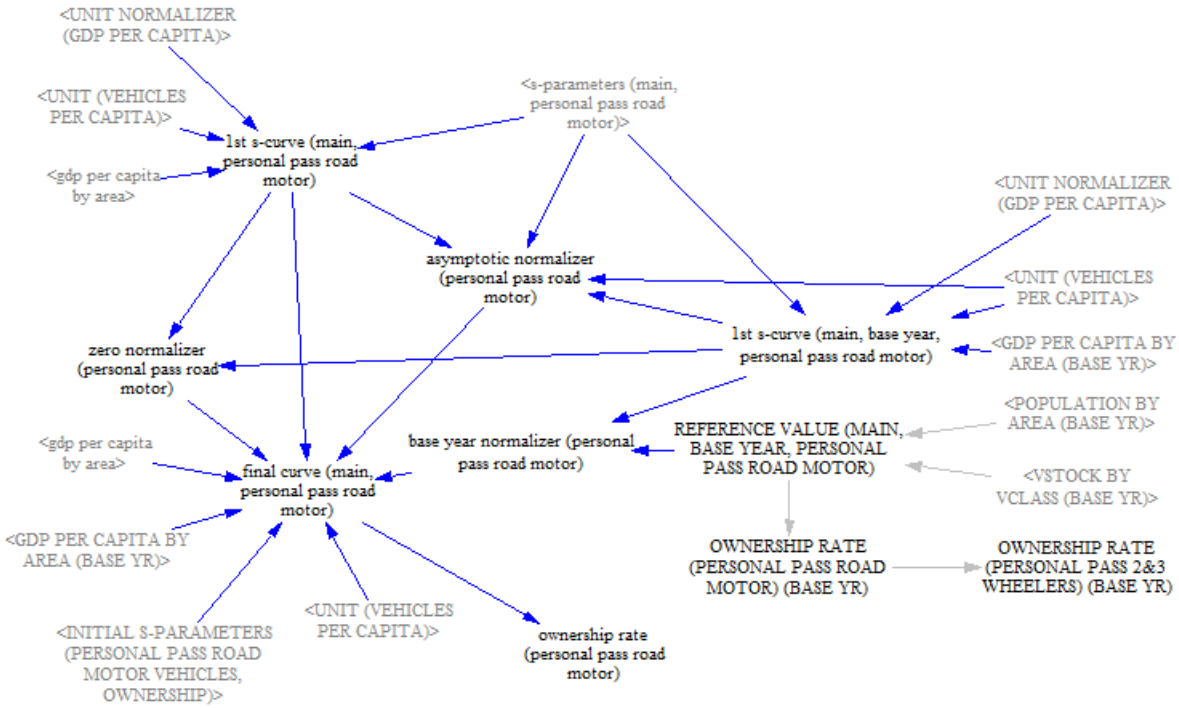


Figure 4.3 **Personal passenger light duty vehicles (cars), ownership curve: Vensim sketch**

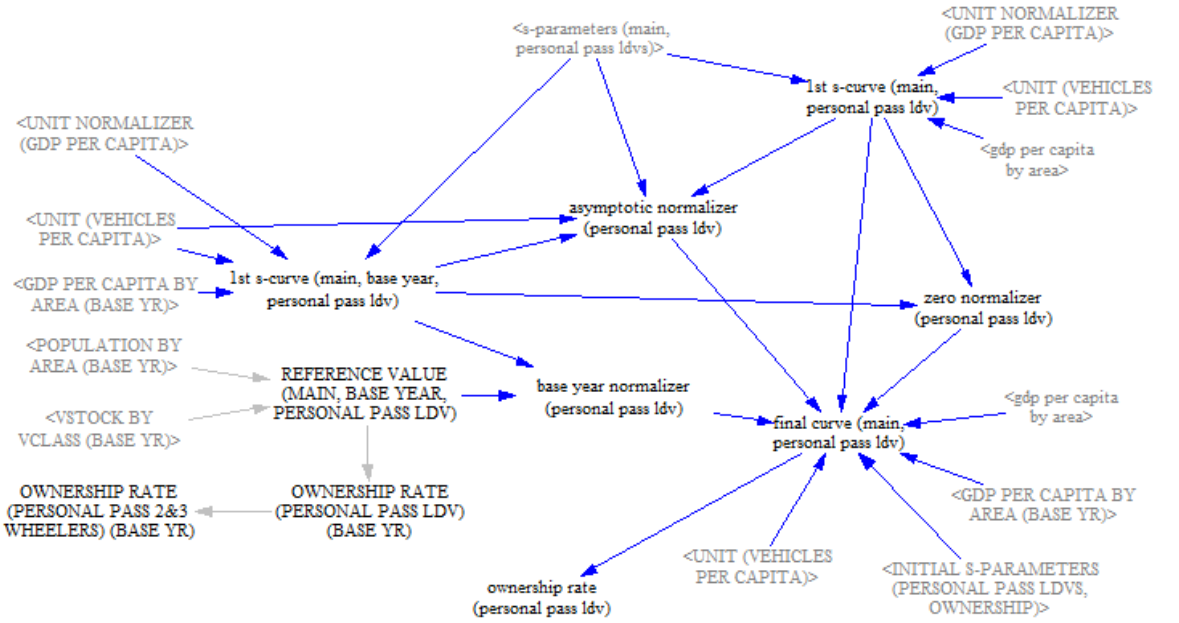


Figure 4.4 Vehicle ownership: base-year evaluation of the final S-curve when the share falls between the LOW and HIGH driving S-curve range

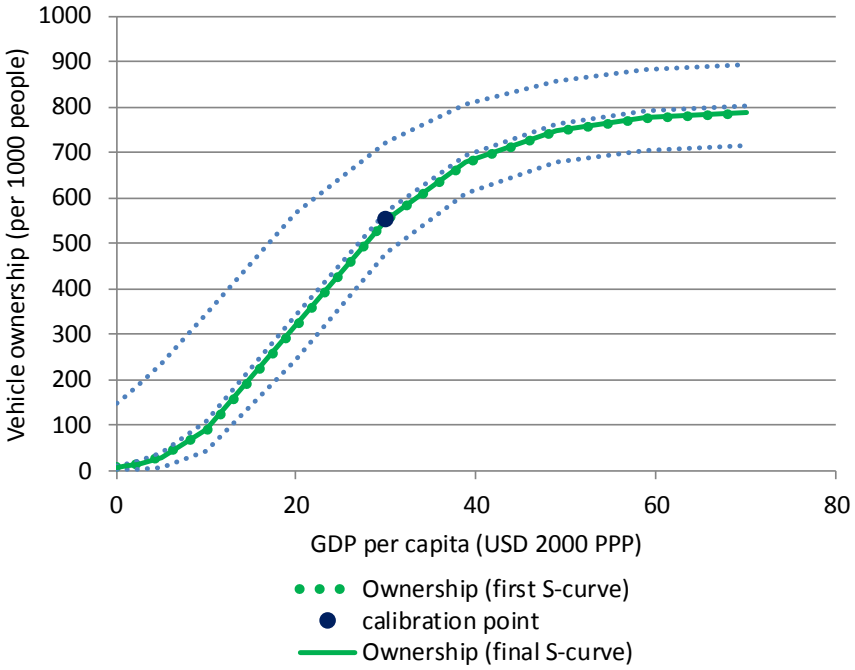
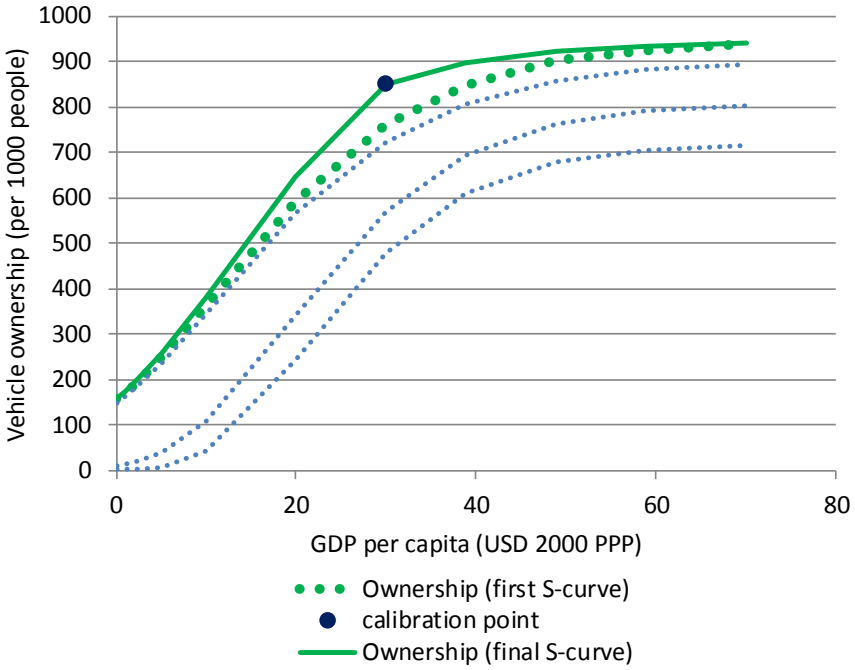


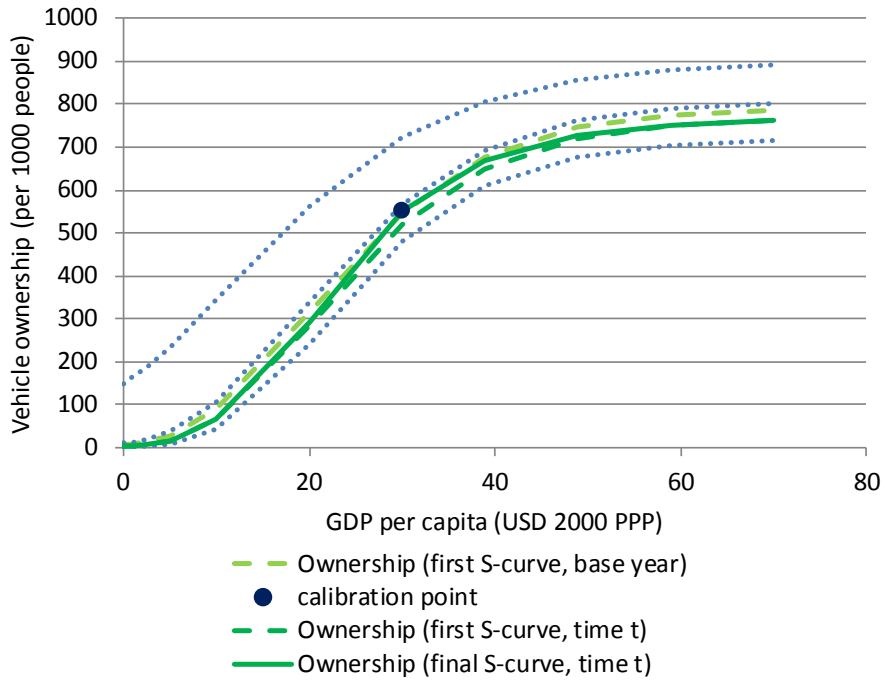
Figure 4.5 Vehicle ownership: base-year evaluation of the final S-curve when the share falls out of the LOW and HIGH driving S-curve range



Over time, when factors such as the transport characteristic index displace the first S-curve, it is possible that, even for vehicle ownerships falling between the LOW and HIGH driving S-curves, the first S-curve does not intercept the base year reference point. In these cases it is necessary to move across different curves belonging to the family of guiding S-curves. The normalizers allow the

definition of a final S-curve that describes the pattern of the share of pkm under these circumstances (Figure 4.6).

Figure 4.6 **Vehicle 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 final S-Curve (evaluated in each time step) is the tool used by ForFITS to define the evolution of the vehicle ownership for personal passenger road transport vehicles and light duty passenger road transport vehicles (LDVs).

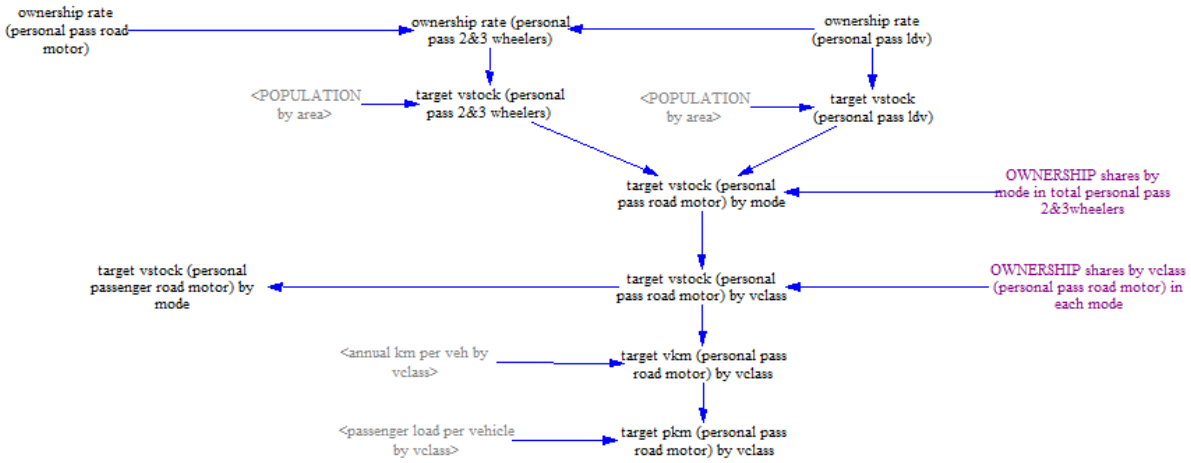
The difference between the vehicle ownership for personal passenger road transport vehicles and LDVS equals the ownership rate corresponding to personal passenger TWO WHEELERS and THREE WHEELERS (together).

The ownership rate multiplied by the population gives the number of vehicles (vehicle stock) targeted over time (top part of Figure 4.7):

$$vehicle\ stock\ (vehicles) = Ownership\ rate\ \left(\frac{vehicles}{people}\right) \times Population\ (people)$$

The high differences, across different global regions, characterizing the repartition between two and three wheelers within the total stock of these vehicles is the reason of the need for a user input (see the headings "MODAL SHARES (EXOGENOUS PROJECTIONS)" and "Modal shares between 2- and 3-wheelers" in the "Table of contents" tab of the ForFITS Excel file, as well as the related tables in the "User inputs (over time)" tab). Exogenous inputs from the ForFITS Excel file also enable to disaggregate the vehicle stock across the different vehicle classes in each mode (TWO WHEELERS, THREE WHEELERS and LDVS) (see the heading " VEHICLE CLASSES (EXOGENOUS PROJECTIONS) " and relevant sub-headings in the "Table of contents" tab of the ForFITS Excel file, as well as the corresponding tables in the "User inputs (over time)" tab).

Figure 4.7 **Vehicle stock, vkm and pkm calculations: Vensim sketch**



Finally, the product between the vehicle stock by vehicle class and the endogenous input on annual travel per vehicle provides the target vkm (Figure 4.7). The latter, further multiplied by the passenger load factor per vehicle, leads to the target pkm over time (also on Figure 4.7).