3. Demand (passenger, nmt)

Overview

Target

Demand (passenger, nmt) projects the transport activity corresponding to walking and cycling (on personal bikes). Cycling is addressed by linking the average GDP per capita with the number of people per active bike. Walking is addressed on the basis of the population and assumptions on average travel per capita by walking.

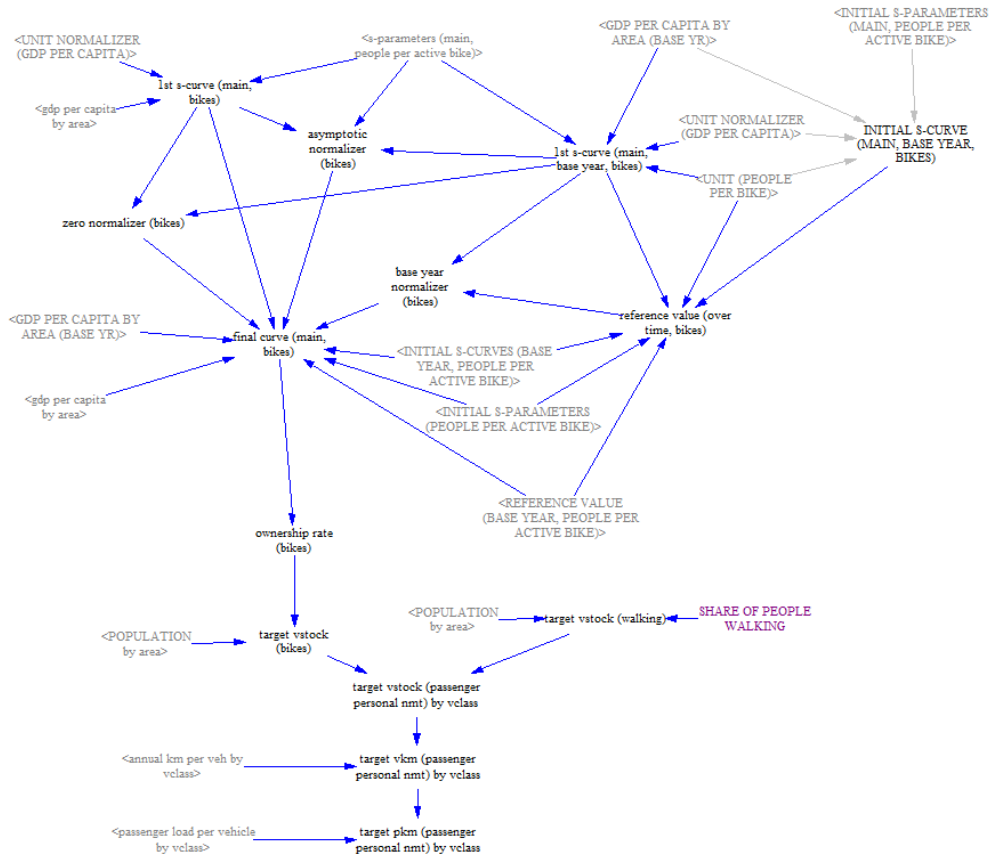
Walking and cycling (on personal bikes) correspond respectively to vehicle classes A and B of the NON-MOTORISED TRANSPORT mode.

Structure

Figure 3.1 shows the view in Vensim. The top section contains variables defining S-curves that link GDP per capita to the number of people per active bike.

The central variable is the target vehicle stock (for cycling, this is the number of active bikes; for walking, this corresponds to the number of people that are actively walking). 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 3.1 Demand (passenger, nmt): Vensim sketch



Detailed description of the view

Inputs

GDP and population are the main drivers of the S-curves defined in this view. They 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 S-curves of this view link the GDP per capita with the number of active people per bike, using the historical information (calibration point, stored in "REFERENCE VALUE (MAIN, BASE YEAR, BIKES)") as a basis for their definition. The number of people walking results from assumption on the walking share of the total population.

The inputs from the view "travel per vehicle" on the average travel per bike and the average distance walked by person enable to transform the variable vehicle stock into the variable vkm. The vkm and pkm are the same because both personal bikes and walkers have a load factor of 1.

Calculation flow and outputs

The four parameters in the variable "S-PARAMETERS (MAIN, PEOPLE PER ACTIVE BIKE)" define the "first S-curves" outlining the number of people per active bike 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 3.2). In this case, normalizing parameters have no effect.

If the reference pkm share 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 reference value when the GDP per capita is next to the GDP per capita at the base year, and close to the first S-curve when GDP per capita is far from the value assumed in the base year (equal to the first S-curve in zero and infinity on the X-AXIS) (Figure 3.3). 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.

Over time, when factors such as the transport characteristic index displace the first S-curve, the calculation of the final S-Curve takes place as follows:

- If the initial reference value is within the range set by the LOW and HIGH drivers, then the final S-Curve will be always exactly the same as the first S-Curve (even if the first S-Curve falls beyond the limits during the simulation due to policy inputs). Figure 3.4 shows that the final S-Curve over time may not contain the base year point (while it always does in the base year). This happens when the characteristics of the transport system have changed compared to the initial conditions, taking into account of the effects of the transport characteristic index, behavioural changes and cost differences.

- If the initial reference value is not within the range set by the LOW and HIGH drivers, the normalizers always apply. This allows drawing a final curve that equals the first S-Curve in zero and infinity, while also containing the reference value recalculated over time.
  If the initial reference value is above the HIGH driving S-Curve, the reference value at time t is obtained from the following equation:

$$Reference\ value\ (over\ time)$$
$$= Initial\ value\ (i.e.\ people\ per\ active\ bike\ at\ the\ base\ year)$$
$$+ (First\ SCurve_{GDP\ per\ capita\ (base\ year)} - Initial\ SCurve_{GDP\ per\ capita\ (base\ year)})$$
$$\times \frac{Upper\ Ceiling\ of\ SCurve\ families - Initial\ value}{Upper\ Ceiling\ of\ SCurve\ families - Initial\ SCurve_{GDP\ per\ capita\ (base\ year)}}$$

  If the base year point is below the LOW driving S-Curve, the equation becomes:

$$Reference\ value\ (over\ time)$$
$$= Initial\ value\ (i.e.\ people\ per\ active\ bike\ at\ the\ base\ year)$$
$$+ \frac{(First\ Curve_{GDP\ per\ capita\ (base\ year)} - Initial\ Curve_{GDP\ per\ capita\ (base\ year)})}{Initial\ Curve_{GDP\ per\ caita\ (base\ year)}}$$
$$\times Initial\ value$$

The initial reference value is evaluated at the base year on the basis of historical information. The recalculation over time of the reference value aims to take into account of the effects of the transport characteristic index, behavioural changes and cost differences. The vertical displacement is assumed to be proportional to the difference of the initial S-Curve (calibrated at the base year) and the first S-Curve (influenced by changes of the passenger transport system) at the GDP per capita at the base year.Figure 3.2 People per active bike: base-year evaluation of the final S-curve when the share falls between the LOW and HIGH driving S-curve range

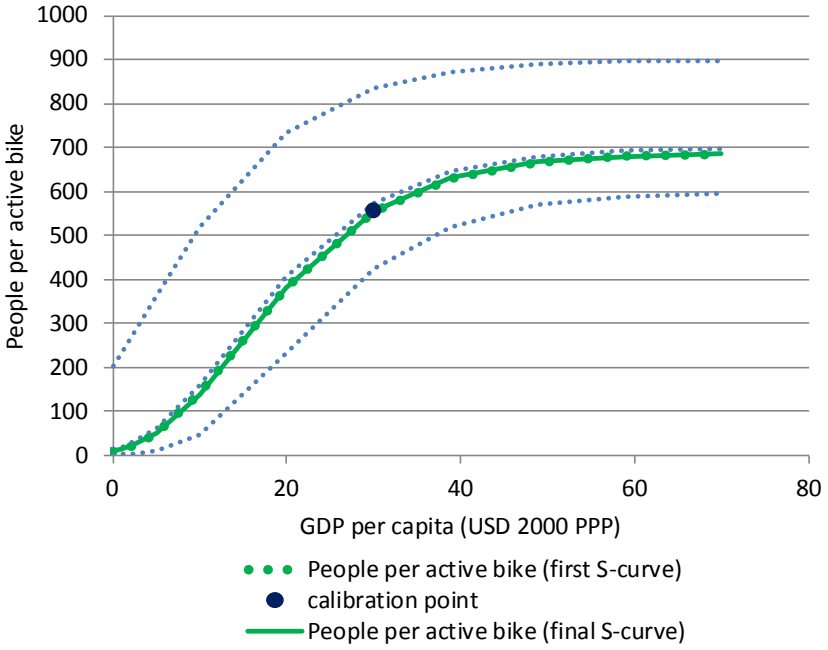


Figure 3.3 People per active bike: base-year evaluation of the final S-curve when the share falls out of the LOW and HIGH driving S-curve range

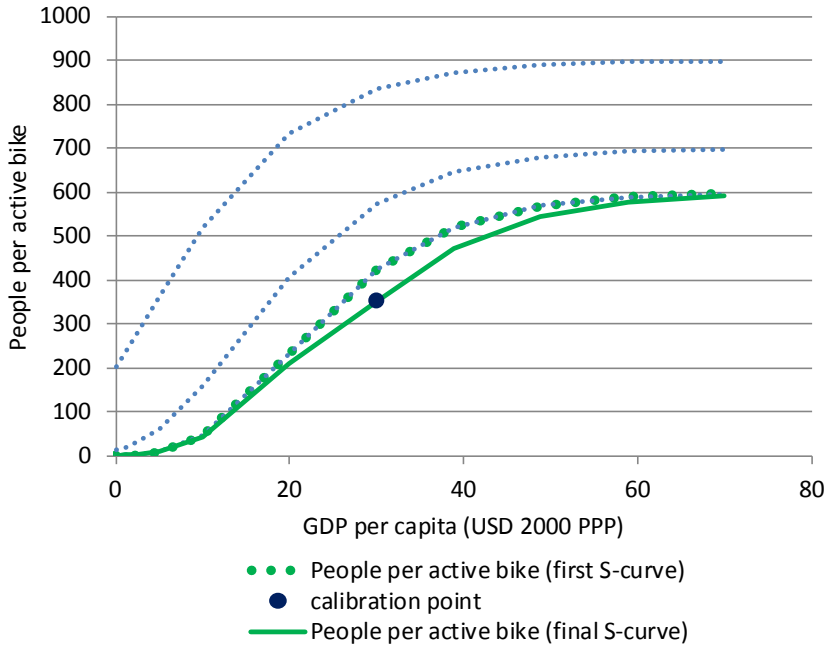
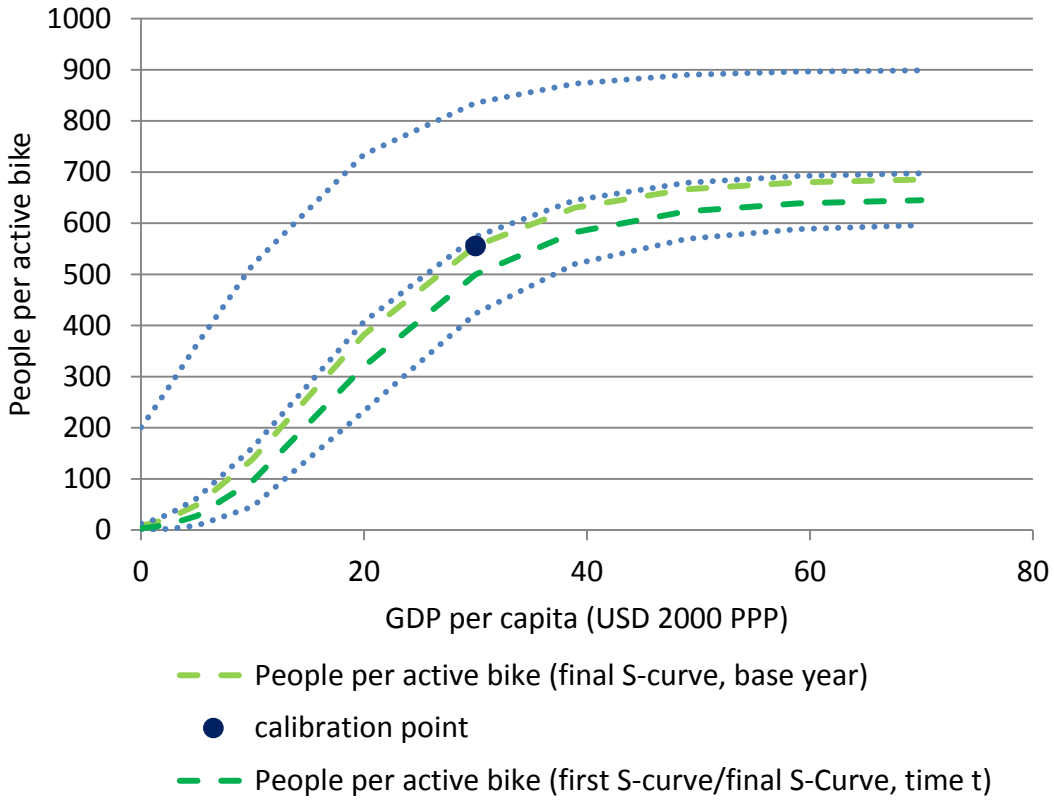


Figure 3.4 People per active bike: evaluation of the final S-curve when the share falls between the LOW and HIGH driving S-curves and factors such as the transport characteristic index change the first S-curve pattern over time



The final S-Curve defines the number of people per active bike. Multiplied by the population, it results in the target number of active bikes (used for the "vehicle stock" variable).

The number of active bikes for personal use and the number of people walking (obtained by the product of population and the assume share that is actively walking) are allocated to the corresponding vehicle classes within the NON-MOTORISED TRANSPORT mode (classes B and A, respectively). The vehicle stock values, as well as inputs on annual travel and load factors, allow calculating the vkm and pkm by vehicle class (Figure 3.5).

Figure 3.5 **Vehicle stock, vkm and pkm calculations: Vensim sketch**