A dynamic life cycle analysis of tyres in Western Europe[1]

A system dynamics model is developed to analyse the life cycle of truck tyres in Western Europe (van Beukering and Janssen, 2000). The main purpose of the model is to determine the most effective measures to improve the environmental performance of the truck tyre lifecycle. The model is calibrated for the period 1990-1999 and predicts developments for the period 2000-2020. The region selected includes Germany, Netherlands, United Kingdom, Belgium, France, and Luxembourg. As shown in Figure 1, the model incorporates the complete life cycle of truck tyres. The main stages identified include production, consumption, transport and solid waste management (SWM). The model allows for technological and behavioural changes over the long term and takes into account both private and external effects as monetary costs for each stage in the lifecycle. The sum of these costs is defined as the social cost. To calculate the external costs, the standard values for human health, crop, forest, material damage and global warming from the aggregation analysis for the Netherlands (see Chapter 14) were used. External values for amenity and ecosystems are excluded from the analysis.

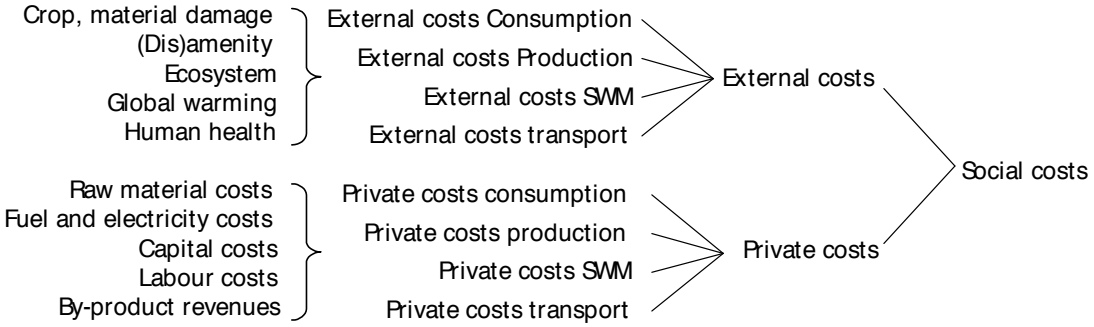

Figure 1 Cost structure of the model

Four scenarios reflecting issues in the current tyre lifecycle are tested:

- In the *base case*, technological improvements are extrapolated based on the current rate of change: the durability of tyre improves from 250 000 kilometres in 1990 to 300 000 kilometres in 2020 and fuel efficiency improves by 1.5 percent annually.
- In the *Eco-Tyre Scenario* tyres are introduced that are more expensive – in the order of 15 to 25 EURO per tyre – but consume up to 5 percent less fuel. The market share of the eco-tyre increases from 0 percent in 2000 to 40 percent by 2020.
- The majority of the drivers under-inflate their tyres. This leads to higher fuel consumption and a more rapid wearing out of the tyre. In the '*pressure scenario*' consumers reduce under-inflation from 10 percent in 2000 to 0 percent by 2020.
- Increased lifetime of tyres decreases the overall demand for new tyres. The '*lifetime scenario*' simulates a gradual increase in the lifetime of truck tyre from 250 000 in 1990 to 400 000 km by 2020.

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[1] This case study is prepared in close collaboration with M.A. Janssen of the Department of Spatial Economics, Vrije Universiteit, Amsterdam Studies, and is conducted within the MUSSIM research programme (http://www.econ.vu.nl/re/MUSSIM/mussim.htm).

Several conclusions can be drawn from the model simulations (Figure 2 and Figure 3). Almost 95 percent of external costs in the lifecycle of truck tyres is human health damage caused in the consumption stage. The main pollutants are PM_{10} and NO_x accounting for 58 and 31 percent to human health costs, respectively. The contribution of global warming to the external costs is only 2 percent. Damage to crop and material has a significant negative value because the ozone depleting effect of NO_x has a positive impact on crops yield and exceeds the negative impact of VOC and SO_2 on crop yield.

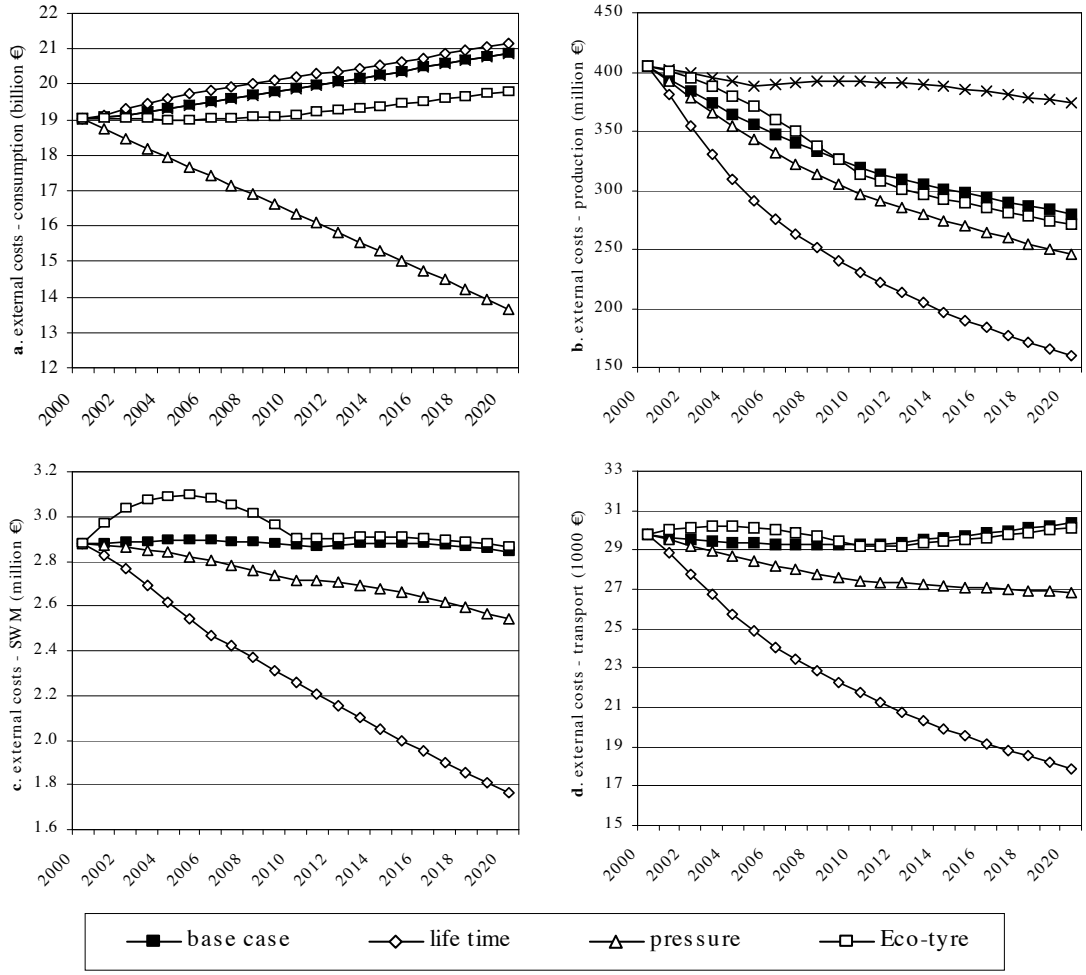

Figure 2 Aggregated external costs in separate stages of the lifecycle of truck tyres

Although at present most policy interventions in the tyre lifecycle focus on waste managers and tyre-manufacturers, the consumer is the most powerful stakeholder when it comes to improving the environmental performance. By improving the monitoring and management of the tyre pressure, environmental gains can be achieved that are not realisable by technological or economic changes in the other stages. Also the second best option – utilising eco-tyres rather than the normal tyre – lies within the domain of the consumer. Typically, both options can be realised at negative private costs. In other words, the environmental improvements in the tyre cycle with the highest potential are both

win-win options. Deficiency in driver-awareness and lack of user-friendly pressure equipment may be reasons why consumers are not already realising these options.

The role of tyre-manufacturers is still of crucial importance in creating a more sustainable tyre lifecycle. By improving the durability and fuel efficiency of tyres, significant improvements can be achieved. From the perspective of the tyre manufacturer it is more rational to focus on fuel efficiency because this avoids shrinking of the sales market. In introducing eco-tyres in the traditional market, however, it is important that the retreading industry simultaneously makes the shift to these new tyres. Retreading techniques require certain modifications that are only economically feasible if the retread market for eco-tyres has sufficient volume. Therefore, the government could play a role in developing and promoting new retreading techniques for eco-tyres.

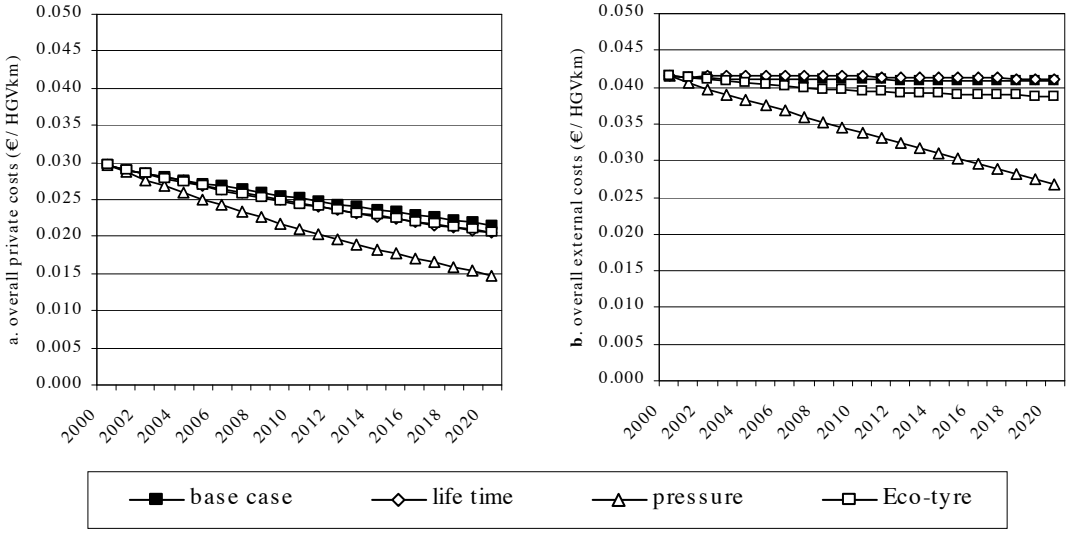

Figure 3 Private (a) and external (b) costs aggregated over the lifecycle of truck tyres

Note: The unit €/HGVkm expresses the overall private and external cost per kilometre of a Heavy Good Vehicle (HGV) with a capacity of 10 tonnes and a loading efficiency of 75 percent.

The waste stage of tyres also deserves additional attention. Eventually every tyre will reach the end of its functional life and therefore has to be utilised as efficiently as possible. To create incentives for the individual member countries, the European Commission defined strict targets that need to be met in the next few decades. Most standards simulated in the model are in line with these targets.

References:

Janssen, M.A. and P.J.H. van Beukering (2000). A dynamic life cycle analysis of tyres in Western Europe. W00/0?. Institute for Environmental Studies. Amsterdam. http://www.econ.vu.nl/re/MUSSIM/publications.htm