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Part 3. Multivariate road safety models: Future research orientations and current use to forecast performance☆

Marc Gaudry[a,*], Matthieu de Lapparent[b]

[a] Agora Jules Dupuit (AJD), Université de Montréal, Montréal, Canada
[b] Institut Français des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux (IFSTTAR), Université Paris-Est, Noisy-le-Grand, France

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ABSTRACT

The third part of the state-of-the-art focuses on the future of road safety modeling and on conjectures concerning the evolution of national safety indicators. In the absence of econometric developments specific to road safety modeling, the research future must rely on pre-existing statistical procedures of econometrics applied to discrete/count and to aggregate data. In terms of contents, growing interest in the heterogeneity of road accident outcomes by category of victims could lead to treatments of this issue across research streams, say by top-down and bottom-up developments, but this speculation does not rest on extant adequate formulations of the issue of road user class and victim analysis. But understanding the time profile of aggregate national performance indicators is quite another matter.

Concerning forecasting, a key question in countries where the absolute maximum of fatalities is still to come is that of its occurrence, but the answer requires a yet missing explanation of "the mystery of 1972–1973", here hypothesized to result from the passing demographic wave (see Part 1). This ignorance affects the corresponding answer, in countries for which the maximum is long past, as to whether current performance is heading toward a minimum or toward a constant level: such a forecast can hardly be made if the maximum remains unexplained. In addition, it matters whether any envisaged asymptotic limit amounts to a natural rate combined with a random component, or includes more. It is conjectured that a regression component that would include speed, traffic density and vehicle occupancy rates could explain both the peak of 1972–1973 and the current evolution, notably of fatalities.

In the absence of a certain explanation of the Meadow/Matterhorn/Cervin peak profile of the past maximum, forecasts can only combine random terms and known explanatory factors in the notion of Conditional Expected Safety Performance, which includes that of (Conditional) Expected Maximum Insecurity (EMI) and seems preferable to Vision Zero or to alternatives based on analogs of the natural rate of unemployment. Conditional expectations do not skirt the issue of the "level of the tide" by assuming the presence of an unexplained trend level and manually changing it by shifts due to well understood specific safety measures.

Forecasts of explanatory variables require views on the political market (notably on the identity of the future median voter), on the workings of individual risk compensation, on the role of economic activity and on the chances of decoupling growth from transport demand, a weak prospect where communications appear more as gross complements than substitutes.

7. Concern for user classes: top down or bottom up?

What should the next step in road safety performance modeling be? The basic distinction between aggregate and disaggregate streams will likely continue for a long time: the merger of the two approaches is beyond the realm of current possibilities, even assuming that any safety issue can be addressed with either kind of data, which is very far from certain. Think of critical problems, such as that of the structure of the market over time and that of "the bottom of the barrel".

For instance, could "The Mystery of 1972–1973" mentioned in Section 3.2 of Part 1 ever be studied with panels of discrete data combined with credible aggregators to national values in order to explain the location of the maximum in each country (of the 30 listed in Table 4, 4 maxima in 1970, 10 in 1972, 3 in 1973, *etc.*)?

☆ Modified with permission from the INRETS publication Synthèses S62 "Un état de l'art de la modélisation structurelle des bilans nationaux de l'insécurité routière" (Paris, 2010).

* Corresponding author.
E-mail addresses: marc.gaudry@umontreal.ca (M. Gaudry), matthieu.de-lapparent@ifsttar.fr (M. de Lapparent).

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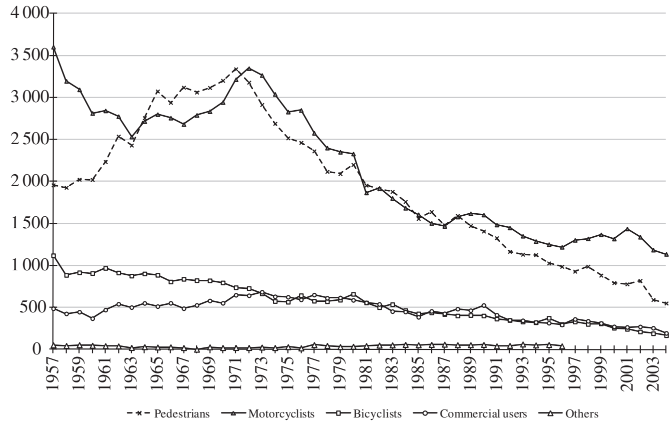

Fig. 14. Breakdown of non-automobile casualties, France, 1957–2004.

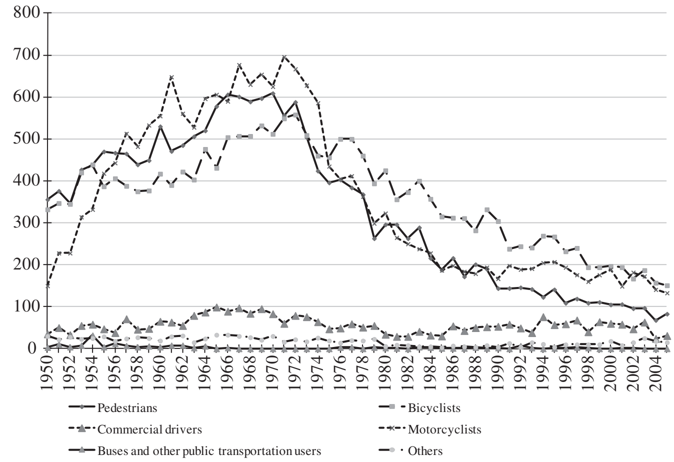

Fig. 15. Breakdown on non-automobile casualties, the Netherlands, 1950–2005.

Similarly, if the downward trend in those countries that are past their maximum in fatalities is slowing now down, or even reversing itself, how can panels help to predict an asymptote or an eventual turning point?

Conversely, how could the intrinsic dangerousness of classes of individuals identified by Weber's use of past offense records, and shown to be independent from their age and sex by the extraordinary German data of Fig. 7B of Part 1, ever be studied with aggregate data? How could one avoid using discrete data to design (and evaluate) laws and penalties in order to target problem groups instead of everybody, or even the average individual?

Despite the difficulty of, and perhaps the unwise hope for, a methodological unification of the field, a few current concerns shared by both traditions deserve to be mentioned along with more fragile hypotheses on the future of modeling,[1] particularly with respect to forecasting. The first such development is the growing interest in classes of users, mentioned rather in passing in the previous two Parts of this state-of-the-art. Clearly, classes of victims change in relative importance over time and user behavior is heterogeneous in specific ways that should matter for the understanding of the quantity and evolution of national totals themselves.

7.1. *The top-down ways are many*

7.1.1. *Should totals be disaggregated into user classes?*

If we try to explain the 1972–1973 "mystery peak" in the death toll on roads, an issue of particular importance to countries where this toll is still rising, breaking down the toll by category will not necessarily help us find a causal relationship. In France for example, the only user category that did not peak in 1972, together with pedestrians and car drivers, is cyclists (see Fig. 14, from Orselli, 2004).

7.1.1.1. Total behavior and behavior of the components. How do subtotals of fatalities evolve for the 12 other countries than France (listed in Table 4) sharing with France the moment[2] of their maximum in 1972–1973? This question has not been studied, but one can look at some particular cases, like The Netherlands (which peaked in 1972 as well), in Fig. 15 where the breakdown by user category is similar to that for France. Pedestrian deaths peaked in 1972–1973 in both countries, but the similarity ends there. The number of cyclist[3] deaths peaked in 1972–1973 in the Netherlands but not in France, and the number of light utility vehicle deaths peaked in 1972–1973 in France but did so years before, between 1965 and 1969, in the Netherlands.

Thus, a simultaneous global maximum is not a proof that user categories behave the same way as the totals. A multi-national modeling analysis might help us better understand the 1972–1973 phenomenon, but its potential results can hardly be relied on. Figs. 14 and 15 illustrate the need for disaggregated analyses of user categories but do not suggest any way of doing it.

7.1.1.2. How to analyze the components?. There are basically two ways of analyzing the time series of data for user categories. First, one could directly formulate an equation for each category; second, one can try to explain category shares. In this latter case, the probable approach would be "quasi-direct", with the number of victims by category expressed as the product of a model explaining all victims by another explaining their shares or probabilities of occurrence.

With the first option, how could one explain and forecast the evolution of each component separately? For instance, we know that the number of victims of motorized two-wheel crashes depends on the size of the fleet, as Fig. 16 shows with 56 observations in the Netherlands.[4]

But then, how can one distinguish the influence on each victim category of its own fleet from that of other fleets? In the same way, how does regulation, often designed for one specific category of road users influence outcomes for other categories? If all variables are used in all equations, it becomes difficult to separate what influences mostly the total from what affects primarily a given category, as the second option better allows for by its very structure.

The "Quasi-direct format" is commonly used in the analysis of transport demand. It makes it possible to reassign certain variables (*e.g.* the gradual implementation of the safety helmet regulation[5]) from the model part explaining the total number of victims (where

[1] The statistical methods of econometrics applied to transport will continue to improve. At this point in time though, we have not seen or heard of a statistical or econometric method that has been developed *specifically* for road accident analysis in the way the Logit surge has been driven by the study of mode choice since 1975.

[2] As in most countries the yearly maximum is in August, countries that had their yearly maximum of fatalities in a certain year, such as 1972, probably had their actual maximum in the same month.

[3] Bicycles are commonly used in the Netherlands, often as a means of transport to go to work.

[4] It appears that there was a 40% increase in registration of motorized two-wheels in Paris from 2002 to 2007. Given the relationship between accidents and size of fleet seen in the Netherlands, we can expect a larger number of victims in this category in France as well.

[5] Safety helmet regulation was introduced gradually in France. In June 1973, it applied to motorcycles and outside city limits, and to drivers only. The regulation was further extended in 1975, 1976 and 1979.