UNCERTAINTY IN LONG TERM FORECASTING OF TRAVEL DEMAND FROM DEMOGRAPHIC MODELLING

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The main goal of this paper is to evaluate the error due to the calibration of demographic modelling approach for transport demand.

1 Transport demand forecast with a Demographic approach.

The longitudinal approach highlights the complex impact of age. In a dated temporal context, it consists of three interlinked dimensions:

- the « Standard Life Cycle Profile » indicates the evolution of mobility related to age and correspond to a stabilised pattern of behaviour,
- the « Generation Gaps » which identifies the behaviour of individuals born during the same period, and therefore sharing a common life experience, allow us to place this profile in a historical perspective,
- the « Period Effect » which indicates the impact of global socio-economic context.

If we take the example of car ownership, which is a major factor affecting mobility, a longitudinal analysis applied to the French data at the national level (Madre & Gallez, 1992) shows the importance of gaps between successive generations, as well as the remarkable stability of the curves throughout the life cycle. Once the respective influences of age and generation have been isolated, it appears that the effect of the global economic context (petroleum crisis and post crisis, economics growth, recession, …) can be considered as residual. As we founded similar results for the mobility, we specified an « Age-Cohort » model, which can be treated as a model of analysis of variance with two factors:

$$\pi_{a,k} = \alpha_a + \gamma_k + \varepsilon_{a,k}$$
Where:

\( \pi_{a,k} \) : measures a characteristic or behaviour (number of trips per day, number of kilometers travelled daily) observed at the date \( t = a+k \) (year of the survey), when the age of the individual who belongs to the generation \( k \) (defined by his date of birth) is equal to \( a \);

\( \alpha_a \) : measures the behaviour of the generation of reference at the age \( a \). This allows us to define a « Standard Profile » during the life cycle;

\( \gamma_k \) : measures the gap between the cohort \( g \) and the generation of reference \( \gamma_{1907} \);

\( \varepsilon_{a,k} \) : the residual of the model.

The unit of measurement which was used is five years, both for the definition of the generations and for the description of the standard life profiles, except when the samples are small we aggregate them (individuals who are aged more than 85 years old are in the age group “85-+”, and the individual born before 1907 are in the generation group “1907-1911”). This unit being standard in demographic analysis.

The calibration of an Age-Cohort model type (analysis of variance) needs the knowledge of the individual’s mobility behaviour through at least 2 periods of time. Since we wanted to avoid the case where there is no residual, we took cities where we have more than 3 surveys, the analysis will be based on the “Paris metropolitan region” (4 Global surveys, 1977, 1984, 1992 and 1998).

The main idea in our approach is to outline the variables of age (with its component of life cycle and generation), of gender, of spatial distribution, of motorization. For the projection the metropolitan region was divided in three zones: the central city, the inner suburbs and the outer suburbs.

Individual Motorization: to measure the availability of the automobile, we use as a proxy, a factor relating to a household without a car, with one car, or with two or more cars. This criterion proves quite discriminatory relative to the level of mobility (increasing with motorization). We adjust the model for the three categories, adult men, adult women and the young (under 25 years old).

Global mobility: the analysis of mobility is measured in two ways in terms of the frequency of trips (average number of trips per person for a typical week day) and in terms of distance (number of kilometers travelled per person for a typical week day).
2 UNCERTAINTY IN TRANSPORT DEMAND FORECAST WITH A DEMOGRAPHIC APPROACH

There are three sources of errors in demographic modelling:
- the uncertainty due to the calibration of the model,
- the uncertainty due to the behaviour of future cohorts, which have not yet been observed (the gap of future generations and the generation of reference are unknown),
- and the uncertainty due to population forecasts it is generally admitted that demographic projections are quite reliable.

This paper will focus on the way to evaluate the first type of uncertainty throughout different manners:
- in retrospective, by comparing the results of the model with estimates from the surveys (see figure 1);
- for short term forecasts, by calibrating the model without the last set of data and comparing the results of the model and the data from the last survey taking into account the sampling error;
- for long term forecasts, by generalising the last method i.e. we calibrate as many models as the number of years of observations (the data from one survey are withdrawn for the calibration of each model), the variance of the estimation is given by the jackknife technique (Quenouille, 1949; Quenouille, 1956; Durbin, 1959) (see figure 2).

In this validation process we will look at various parameters, i.e. the global mobility in terms of number of trips per day and number of kilometers travelled per day. We will focus on the distance travelled, because it is less stable, and its growth is the source of environmental problem. The results should help to give a better understanding of the reliability of the age–cohorts models both for describing current trends and for forecasting toward different time horizons. The results on second cause of uncertainty (due to the behaviour of future cohorts), which are easier to obtain, will be presented at the conference.
Figure 1: comparison between data from surveys and the model of daily distance travelled.

Figure 2: Confidence interval for long term forecasts of daily distance travelled per person.

REFERENCE


