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Sources of Errors and Biases in Traffic Forecasts for Toll Road Concessions

Thèse pour le Doctorat ès Sciences Economiques

Mention Economie des Transports

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Introduction

The demand forecast for a specific project is the main variable influencing its realization. From a public sector perspective, socio-economic evaluations are driven by demand forecasts, which gives the basis for choose and hierarchy public projects in order to maximise social welfare. From a private sector perspective, traffic forecasts are the base of financial evaluation and toll setting. Furthermore, demand forecasts are used for several other key purposes in transport policy, planning, and engineering: to calculate the capacity of infrastructure, e.g., how many lanes a bridge should have and to calculate environmental impacts, e.g., air pollution and noise.

Despite of its importance and the numerous and important developments in the field, the differences of forecast and ex-post traffic in usually very high. Some recent studies show that differences as big as 20% are much more the rule than the exception. Moreover, and despite the improved knowledge in transport demand models, it does not seem to reduce the errors in estimations over time.

A huge amount of uncertainty is associated with the forecasting exercise. First because transport is a derived demand and depends on many exogenous variables, also uncertain; because modelling is and simplification exercise, implies many assumptions and rely on field data, many times incomplete or of low quality; moreover, modelling human (in this case users) behaviour is always a dangerous enterprise.

Although these arguments could explain at least the larger part of errors associated with forecasts, one can wonder whether the agents implicated in the forecast would or could use this uncertainty strategically in their favor. In a competition for the field scheme (bids), the bidder may overestimate the demand in order to be reduce the toll included in the bid. This strategic behaviour can introduce a high bias in forecasts. Also, overoptimistic (or overpessimistic) forecasters may introduce a bias in the forecast.

We propose to focus in turn on the three main groups of agents involved in the demand forecast process. The forecasters, the project promoters and the users. Study all the issues related to them would be a too ambitious (or more concretely impossible) task. We then focus on some particular issues related to the modelling of the actors' behaviour in the context of the demand forecast for toll roads.

First, the forecaster behaviour. The forecaster can have some individual influence on the study, either by his own opinion about the project, by the external pressure he receives, or by his opinion about his own judgment capacity. Despite of the highly quantitative aspect of demand forecasting, the individual opinion about the chances of success (or failure) of a project can influence the modeling exercise in a way the results best fit the forecaster's expectation. Furthermore, if the forecaster overestimate his own capacity of decide whether a project is good or not, his individual evaluation will be biased.

Second, in particular when there is competition for the market, the project promoter behaviour has fundamental importance. Private promoters may have incentives to adjust the level of traffic in order to make the project more attractive or to have the best bid. This situation is exacerbated in regulatory frameworks in which renegotiations are easier. The opportunistic strategy consists in bidding a low price by increasing the forecast traffic level.

Then, we study the user's behaviour at two levels. First, at the aggregated level, we analyze the long term traffic growth and its relationship with the economic growth. We argue that traffic maturity results from decreasing marginal utility of transport, so that the elasticity of individual mobility with respect to the revenue decreases after a certain level of mobility is reached, implying that instead of a constant elasticity between the traffic and the GDP most models assume, we should consider a decreasing relationship between these two variables.

Second, at the disaggregated level, we study the value of travel time savings, the main variable guiding individual mode choice and probably the most important value in socio-economic evaluation as well as in demand and revenue forecast. We apply the Logit, the Mixed Logit and the Bayesian Mixed Logit models to estimate the value of time in freight transport in France.

Plan of the Manuscript

Chapter 1 presents a general introduction to the topic of errors and biases in forecasting demand for transport infrastructures and services.

Chapter 2 focus on transport forecasters' behaviour. It presents the results of the first large sample survey on forecasters' perceptions and opinions about forecasting demand for transport projects, based on an on-line survey. We first describe the main characteristics of forecasters, as age, gender, education, working sectors and experience. We then describe the last forecast forecasters prepared in terms of oldness, project's advancement, mode, financing and operation. We then turn to the models forecasters apply, the errors they declare on past forecasts and the main sources of errors according to them. We then describe the forecast environment in terms of pressure forecasters receive. These unique results provide a picture of the world of forecasters and forecasts, allowing for a better understanding of them.

We turn then to the study of the optimism and overconfidence in transport forecasts. Optimism and overconfidence in general are recognized human traits; most of us are overconfident about our own abilities and overoptimists about the future. There is also a growing literature in behavioural economics and finance arguing that the role of optimism in economic decisions and economic forecasts is not negligible.

We analyze the overoptimistic bias by comparing the distribution of stated errors with actual errors found in literature; we also compare the own skillful of subjects in doing forecasts with studies showing self-evaluations of a common skill - driving. We finally propose a regression of the competence, quality and errors on the main forecasters' and projects' specific variables.

Results show that the distribution of errors transport forecasters state has a smaller average magnitude and a smaller variance than those found in literature. Comparing forecasters perception of their own competence with the results found in literature about drivers skill self-evaluation, however, we could not find a significant difference, meaning that the forecasters' overconfidence is in line with what could be viewed as a normal human overconfidence level.

The regression analysis finds that elder, more experienced forecasters working in the university tend to more valuate their competence. Also, the experience seems to be the only significant variable driving the self-appreciation regarding the quality of own results. There is also a relationship between the stated error in the last forecast and their self-evaluation about competence.

In chapter 3, we study the bidders' strategic behaviour in auctions for road concessions. We address three questions in turn. First, we investigate the overall effects of the winner's curse on bidding behaviour in such auctions. Second, we examine the effects of the winner's curse on contract auctions with differing levels of common-value components. Third, we investigate how the winner's curse affects bidding behaviour in such auctions when we account for the possibility for bidders to renegotiate.

Using a unique, self-constructed, dataset of 49 worldwide road concessions, we show that the winner's curse effect is particularly strong in toll road concession contract auctions. Thus, we show that bidders bid less aggressively in toll road concession auctions when they expect more competition. Besides, we observe that this winner's curse effect is even larger for projects where the common uncertainty is greater. Moreover, we show that the winner's curse effect is weaker when the likelihood of renegotiation is higher, i.e. bidders will bid more strategically in weaker institutional frameworks, in which renegotiations are easier. Besides, our conclusion contrasts with standard results. While the traditional implication would be that more competition is not always desirable when the winner's curse is particularly strong, we show that, in toll road concession contract auctions, more competition may be always desirable.

Chapter 4 focus on the aggregated users' behaviour, in particular in the long term traffic maturity. We argue that traffic maturity results from decreasing marginal utility of transport. The elasticity of individual mobility with respect to the revenue decreases after a certain level of mobility is reached. In order to find evidences of decreasing elasticity we analyse a cross-section time-series sample including 40 French motorways' sections. This analysis shows that decreasing elasticity can be observed in the long term.

Introduction

We then propose a decreasing function for the traffic elasticity with respect to the economic growth, which depends on the traffic level on the road.

Although "unconditional" decreasing elasticities were already proposed in the literature, this is the first work, as far as we know, putting this idea in evidence and giving it a functional form. This model provides better interpretation of the coupling between traffic and economic growth, and a better long-term forecast.

In chapter 5 we study the main individual modal choice variable, the value of time. The value of travel time savings is a fundamental concept in transport economics and its size strongly affects the socio-economic evaluation of transport schemes. Financial assessment of tolled roads rely upon the value of time as the main (or even the unique) willingness to pay measure. Values of time estimates, which primarily represent behavioural values, as then increasingly been used as measures of out-of-pocket money. In this setting, one of the main issues regarding the value of time is its distribution over the population.

We discuss the importance of the value of time and its particular role in the case of private motorways and present the econometric models currently used to estimate it, giving a special attention to the Bayesian procedures, since it is a relatively new method with only a few results in the literature. We also discuss the main challenges in estimating the value of travel time savings. We then describe the revealed preference survey we realized, including 1027 vehicles in order to study the trade-off between the free roads and the tolled motorway.

We apply the Logit, the Mixed Logit and the Bayesian Mixed Logit models to estimate the value of time in freight transport in France. Estimations with mixed logit faced many difficulties, as expected. These difficulties could be avoided using the Bayesian procedures, providing also the opportunity of properly integrating a priori beliefs.

Results show that 1) using a single constant value of time, representative of an average, can lead to demand overestimation, 2) the estimated average value of time of freight transport in France is about \in 45, depending on the load/empty and hire/own account variables, which implies that 3) the standard value recommended in France should be reviewed upwards.