

# **Travel Demand Modeling in two Nations at ‘Peak’ Infrastructure Construction**

*by*

Gregory L. Newmark

University of California Transportation Center

2614 Dwight Way

Berkeley, California 94720-1782

Tel: +1-510-282-8413

Fax: +1-510-643-5456

[gnewmark@berkeley.edu](mailto:gnewmark@berkeley.edu)

## **INTRODUCTION**

Travel demand modeling is a practice closely associated with the development of transportation infrastructure. For example, in the United States the emergence of this practice is inextricably linked to the creation of the Interstate highway system in the 1960s. However, where that period is characterized by the investment in a single mode, today rapidly developing nations are investing in a multiplicity of modes simultaneously. While the specific course of transportation development varies across nations, this research postulates a theoretical capacity apogee, a point of ‘peak’ infrastructure construction, and explores the role travel demand modeling plays at this critical stage.

Since such a point could only be technically identified through the prism of infinite time, this research will look for a perceived ‘peak’ and offer two heuristics for defining that point. First, at ‘peak’ infrastructure the majority of a nation’s major metropolitan areas will be investing in megaprojects across two or more modes and, second, the nation will be investing heavily in intercity connections between major domestic metropolitan areas as well as to places abroad. Two nations meeting this provisional definition of ‘peak’ infrastructure are Portugal and Israel.

Specifically, this research asks three main questions: How are these nations using travel demand models? What is motivating this use? And, what are the constraints on modeling? By exploring the role of travel demand modeling in two nations currently experiencing ‘peak’ infrastructure, this research seeks to better understand how models function in practice and to inform the majority of countries who have yet to approach this developmental stage.

## **LITERATURE REVIEW**

There has been little research detailing how travel demand models are actually used in practice. Most research has focused on specific model innovations rather than the meta-view of the role that models are playing in a specific nation. Nonetheless, there has been some relevant research.

In the United States, the Transportation Research Board (2007) recently surveyed metropolitan planning organizations (MPOs) to identify the state of the practice. The focus of the study emphasizes how models are composed and run rather than to what

purposes they are applied. The report makes nomothetic conclusions that models are used to study proposed transportation investments, assess the impacts of possible land use scenarios on travel demand, and estimate the air pollution from current and proposed vehicles use – all for the purposes of informing elected decision-makers; however, the report does not provide ideographic information to support these claims. (For example, no elected official was actually interviewed.) Nonetheless, the report is very useful for outlining the constraints on current modeling activities in the US.

## **METHODOLOGY**

This qualitative research project relies on case studies developed through open ended interviews with the major modelers and model consumers in Portugal and Israel. This work considers the nation as the relevant research unit as the consistencies of law, culture, language, and planning policy enable the practice of travel demand modeling to be characterized at such a level. Among the set of countries that reasonably could be considered to be experiencing ‘peak’ infrastructure, smaller ones have been chosen to reduce the potential for regional variability and to facilitate the consideration of a single national practice.

## **PORTUGAL**

Portugal is a nation on the western periphery of the Iberian Peninsula. The nation encompasses 92,090 square kilometers (roughly the area of Maine) and is home to a projected 10.7 million inhabitants in 2010.

### **Transportation History**

From 1926 to 1974, the country was ruled by the *Estado Novo* dictatorship and saw limited infrastructure development. The first line of the *Lisbon Metro* opened at the end of 1959 and saw expansions in 1963, 1966, and 1972. Also in 1972, the dictatorship recognized the impediments to economic growth caused by an inadequate transportation network and created a company, *Brisa*, which was given a thirty year concession to build and maintain a highway network for the nation.

In 1974, the Carnation Revolution ushered in Portugal's Third Republic and a return to democracy. While the early years of the Third Republic were politically turbulent, a stable leftist government arose and nationalized many transportation companies, including the *Lisbon Metro* and *Brisa*, which slowly developed a 300 km motorway network over a decade and a half.

In 1986, Portugal joined the European Economic Community (now the European Union) and, in 1987, a new center-right government came to power and relaxed the centralized control of development. The new government was very committed to infrastructure creation and arranged for Portugal, beginning in 1989, to become the recipient of European Union Structural Transfer Programs funding. These monies were primarily aimed at "the development of a modern transportation infrastructure network" (Pereira and Andraz, 2005). The focus of this development was primarily for fostering private transportation through the construction of highways. The government invested heavily in *Brisa*, which doubled the motorway network to 600 km in only five years and then doubled it again by 1998 to a total of 1,300 km (Holl, 2004). Also in 1998, the Vasco Da Gamma Bridge opened spanning the Tagus River in Lisbon. This bridge is longest in Europe and was built as part of a BOT concession agreement with the concessionaire reclaiming its investment through charging tolls on the two Tagus crossings. Lastly, an enormous multimodal surface transportation center, Oriente Station, also opened in 1998 in Lisbon.

In 2002, the Porto Metro opened its first line. This above/underground light rail system was rumored to be the most expensive infrastructure project in Europe during its construction. In 2004, the Porto Airport was completely remodeled and in 2006 the Metro was extended to provide airport service. Currently, there are extensive planning efforts regarding the siting of a new airport for Lisbon as well as a third Tagus crossing, which will serve the planned high speed rail system.

### **Modeling History**

Travel demand modeling began in Portugal in the mid-1970s as the leftist government was seeking to use centralized planning to improve the economics of the newly liberated nation. In this era, the models were commissioned by public modal

agencies and typically created and run by foreign consultants. For example, the Lisbon Metro commissioned a unit of the University of Lausanne in Switzerland to develop the NOPTS metropolitan model between 1975 and 1983 to aid in the consideration of possible extensions. Similarly, the Vasco Da Gamma Bridge was planned with the help of the MICROTIS model constructed by Transes in the Netherlands.

These early models did not create a lasting impact. First, as in the case with the NOPTS and MICROTIS models, decision makers were indifferent to their findings. Second, these models were seen as part of a centralized planning apparatus that had grown suspect during the half century of dictatorship and the leftist regime that followed. Third, the infrastructure needs were so basic that they were fairly obvious and there was little need to truly balance trade-offs. Fourth, in some cases, such as a National Road Authority model that only focused on roads, the uni-modal scope hampered the accuracy of the model and its broad application and by not considering other trip types did not get good results and the project was abandoned. Finally, and perhaps most importantly, the country tacked strongly away from public sector development after 1987. In an era of almost fetishistic support for privatization, the public planning system was disrupted in the early 1990s. The public agency budgets were trimmed and their modeling efforts withered accordingly. The privatizing system removed the incentives for public agencies to maintain their own models. Furthermore, many of the people with experience with modeling left the public sector for better opportunities with private industry.

Ultimately, the move towards privatization heralded in a second era of travel demand modeling for Portugal, an era which continues to the present day.

### **Modeling Today**

Currently, travel demand models play three distinct roles in Portugal. The most dominant role is to support the tendering for concession projects. The secondary role is to provide system management information for public authorities. The tertiary role, that is only emerging, is to serve as an integrated analysis tool for government planners. These can be perceived as a modeling continuum moving from an *ad hoc*, project-by-project basis towards more comprehensive and continuous basis.

### *Modeling to Tender Concessions*

Portugal's privatization predilection has been a boon, of sorts, for travel demand modeling. The concession process has greatly increased the quantity of models, although it may be hampering their quality. Concessions have increased the pool of model consumers from just the government to include the concessionaires, who build projects, and the banks, who fund the concessionaires. In a typical tender, the government will publish a request for proposals which will be responded to by teams of potential private concessionaires. To make a bid, the teams will need to forecast the use of the proposed facility to identify both their management costs and their revenue stream. The banks that finance the teams will need to make their own independent assessment of the forecast use to judge whether to loan money to the bidders. Competitive tendering is only advantageous if there are multiple bidders; therefore, the government is incentivized to encourage several bidding teams. As each team represents the addition of two new clients for models, the concessionaire itself and the backing bank, privatization expands the pool of travel demand model consumers (and consultants). Similarly, the government is incentivized to slice transportation projects into small discrete units in order to minimize the risk of any one project and to increase the competitiveness of the bids. This subdividing process further expands the market for models.

While privatization has increased the demand for models, it may be retarding the demand for higher quality models. Smaller projects are inherently less risky and require less complicated models. There is limited incentive to create sophisticated regional models, when simple approaches will do. The result is a profusion of *ad hoc* models aimed narrowly at the project that is being tendered with limited consideration of other elements. Clients typically only want the model results and display little interest in the underlying assumptions that went into the model. This fosters the repeated use of simple four step models with the highest resolution of transportation analysis zones surrounding the proposed project, rather than a more comprehensive approach.

On the other hand, there is no doubt that the market for models that has been created and sustained by privatization has fostered the growth of a travel demand modeling industry. Since each project must have multiple bidders and each bidder needs its own model, such firms can be assured of employment, if not by one team then by

another. Modeling firms gain experience with each project and have an incentive to invest in developing their staff's capacity. They also have an incentive to distinguish themselves from their peers. For example, each firm favors a different modeling software platform and markets itself on that basis.

### *Modeling for Modal Management*

A secondary role for models is for the management of infrastructure, typically by a public company with a modal responsibility, such as a metropolitan bus provider or the national highway authority. These models are quite distinct from those discussed above. These models are not narrowly focused on a specific infrastructure expansion, rather they include the entire network of given provider and are aimed at tracking and optimizing operations. These models are not created and discarded, but maintained over time. Some agencies have in house capacity for this work such as *Estradas de Portugal* (EP), the highway authority, and *Carris*, the major Lisbon bus operator, although they often bring in private consultants. Other agencies such as STCP, the major Porto bus operator, or the bus operators in Coimbra and Braga do not maintain the models themselves but outsource that work to a consulting firm.

EP, the national roads authority began their current modeling program in 2002. The impetus for the project was the restructuring process of the road administration. Their current head of modeling suggested they invest in a model because EP manages so many roads for a small country and needs to report demand to the government, yet only has 24 counting stations. A model would help them have a good sense of the big picture at a low cost. Furthermore, there was a precedent for using travel demand models as they had had one in the 1970s. The model predicts the average annual daily traffic.

The *Carris* model which became operational in April 2009 is illustrative of these modal management models. *Carris*, the Lisbon bus operator, had relied for years upon senior employees riding the buses to examine ridership and suggest ways to tweak the system based on those observations. While the senior people had much experience, they could not project the full ramifications of their suggestions with the result, in the words of one modeler at *Carris*, it was "like sleeping with a blanket that is too short, you can cover one area but then another area goes uncovered." Only small changes could be made at

any one time with rather disappointing results. As *Carris* began to downsize its employees many of the most experienced left leaving no one watching the system to understand how it adjusts to demand. This vacuum required a new approach to monitoring and planning for the system. The current head of the modeling program proposed the adoption of an in house travel demand model in 1998. He had learned about modeling while in graduate school at the *Instituto Superior Técnico* (IST), Lisbon's main engineering school. A decade later *Carris* purchased an Emme2 license and began building their model with substantial help from Trenmo, a travel demand modeling firm specializing in transit operations. The purpose of the model is to predict passenger volumes to monitor the current bus ridership and propose ways to reorganize the system to be more efficient. Currently, the work has been focused on a three stage reorganization to anticipate the impacts of the opening of a new subway link on the bus ridership patterns. The emphasis is on using the management for current operations rather than focusing on long-term planning.

### *Modeling for Public Planning*

The third major use of modeling, which is emerging in fits and starts, is the public model for long range planning. This role has public agencies commissioning and maintaining multi-modal models to generally facilitate analysis and policy making for the future. This role, which is the predominant one in the United States, has existed in the past in Portugal, but did not successfully survive the privatization of many planning activities.

It appears that roughly a decade ago, the *Direcção-Geral dos Transportes Terrestres* (DGTT) began working with Matrix, a Finnish travel demand modeling company, to develop models in the Emme2 platform. A model for Lisbon was completed in 2003, but saw little use. Nonetheless, the government had purchased five Emme2 licenses and began to dole those out to different agencies, such as EP and *Faculdade de Engenharia da Universidade do Porto* (FEUP), the engineering school in Porto. The government ordered a national travel demand model from FEUP to have a strategic model to use for assessing investment regulation and economic/territorial changes in 2004.



A political change in the management of transportation may also lead to more public models. The state has created new regional transportation authorities to provide planning in Lisbon and Porto. These authorities are likely clients for this type of modeling and efforts have been underway in Porto to merge existing models into a regional model. To date, no efforts have advanced in Lisbon. Interestingly, the transportation authority of Coimbra is developing such a model as part of a program to construct a new tram-train.

### **Modeling Issues**

There are several recurrent issues that are affecting travel demand modeling in Portugal. These include limited data, mixed roles of universities, and the privatization of modeling.

#### *Limited Data*

A universal complaint among informants is that modeling efforts in Portugal have long been hindered by poor data. The major impediment to models is poor quality of data. Modeling clients have not been interested in demanding data as it is easier to follow political intuitions without data. There have been a few efforts at collecting travel habit data. In 1991 there was a general mobility survey for Portugal followed by one in 1993/4 for Lisbon. A national travel habit survey was undertaken by the national statistics institute again in 1998, but the sampling was very poor. A follow up national survey is scheduled for 2011. Some of the people interviewed argued that in a country whose transportation situation is changing as rapidly as Portugal, it would be better to aim for five year surveys for metropolitan areas not decennial surveys. There was a strong feeling that data collection is the responsibility of the government and the government should also work to standardize data formats and definitions.

While currently each firm will undertake their own data collection as public data is not readily available, there have been some improvements. The tolling of roads has actually greatly improved the availability of information as traffic counts are now commonplace. However, there may not be an incentive for one agency to share their information with another one. This can be particularly seen in surveying transit riders as

competing private transit companies may not let surveyors on their buses. As a result, the companies have adapted by surveying people at bus stops.

### *Role of Universities*

Portuguese universities, particularly IST and FEUP, play a tremendous role in affecting the development of travel demand models in Portugal. Most fundamentally, these institutions have been developing the knowledge and capacity for modeling within the country. Most of the travel demand modeling firms have a university professor among their founders and all of them are populated by graduates of the two major civil engineering programs. Given that university salaries are low in Portugal, it is not uncommon for professors to leverage their position, expertise, and connections to work in the private sector. Furthermore, such professors have access to the best students and can recruit them to their firms after having trained them at the expense of the state. Many informants on this project argued that the rise of people who had been trained in the universities in the public sector and other positions of power has really served to increase the interest in the potential of travel demand modeling. The universities are also locations of research in new modeling ideas, although several people criticized the universities for not making much effort to disseminate their findings. One informant suggested that because the professors run the firms they have no incentive to share their ideas with the public, but rather hoard them for themselves.

### *Privatization of Modeling*

As noted earlier, the privatization of modeling has benefits and drawbacks. While privatization has greatly expanded the market for models, many people felt that it had at the same time hindered their development. The privatization has caused most models to be made on an ad hoc basis for a specific project. This structure discourages broader models that attempt to understand the metropolitan area. Instead, models that are aimed narrowly at a single project are encouraged. These models are cheaper and easier to produce and run and since they are only examining the use of a single project rather than a panoply of options they almost always result in the support of the project they study.

The fact that models are typically made for private clients discourages their being offered to the public or shared among different modeling companies. There is therefore very little peer review (outside of market forces), and there are no user groups as people do not want to share ideas. Furthermore each firm is pushing its own software, which impedes the ability to share information.

One informant argued that even though models are on a project by project basis over time each of the modeling firms develops a relatively robust model of the whole region. One firm that specializes in public transit models has found that since their clients are public companies, they typically grant access to use portions of that work for subsequent public sector clients. In one case, the TIP sponsored the Porto model and therefore gave full access to the model to private bus operators too.

## **ISRAEL**

Israel is a nation on the eastern shore of the Mediterranean basin. The nation encompasses 22,072 square kilometers (roughly the area of New Jersey) and is home to a projected 7.3 million inhabitants in 2010.

(THIS SECTION WILL BE ADDED BY WCTR)

Holl, A., 2004. Transport Infrastructure, Agglomeration Economies, and Firm Birth: Empirical Evidence from Portugal\*, *Journal of Regional Science* 44(4), 693-712.

Pereira, A. M., Andraz, J. M., 2005. Public investment in transportation infrastructure and economic performance in Portugal, *Review of Development Economics* 9(2), 177-196.

TRB, 2007. Metropolitan Travel Forecasting: Current Practice and Future Direction, 288, 1-132.