Accounting for heterogeneity in the efficiency of toll motorways: the Spanish case

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Abstract:

Transport infrastructures are projects of strategic and economic relevance for those geographic areas in which they are developed. The relationship between infrastructure and economic development is well-documented in the economic literature (Morrison and Schwartz, 1996; Röller and Waverman, 2001; Guasch, 2005). Indeed, there is evidence that infrastructure causes economic growth in the long-run, but with substantial variation across countries (Canning and Pedroni, 2008). This type of infrastructures is characterized by the need for high levels of investment for their construction and putting into service, traditionally through public funds. However, because of the budget constraints the Public Sector faces, during the last decades new
mechanisms for financing the infrastructures have been developed. One of them is the Public-Private Partnership system which consists on the following: the Public sector grants a private company the construction, management and maintenance of a motorway for a certain period of time, and users have to pay a rate for using them.

By the end of 2015, the toll motorways network in Spain had 54 stretches which belong to 32 concessionaires. They cover a total length of 3,307 kilometers with an average daily intensity of 19,090 vehicles. Nowadays, 8 of them have been declared in a state of insolvency since 2012\(^1\). Albalate et al. (2015) indicate that extra costs in expropriation and construction due to the real estate boom along with erroneous traffic previsions are the main reasons which have caused the current collapse of a lot of companies. Even the Public Administration has contributed to their bankruptcy as it has funded free access motorways, which actually directly compete with tolls for traffic catchment. All of this has made that the accumulated debt by concessionaires is over the 4,000 million euros in 2014.

This situation has been justified by the low levels of traffic and the extra costs, as if they were completely exogenous factors to their management. Although it is true that the demand of traffic for each motorway can be determined by exogenous factors – as the existence of free alternatives or the business cycle, among others – so that concessionaires have little capacity to increase their demand (Engel et al. 2001), it is also feasible to assume that there is a production process so that it is possible to increase the output from some variable inputs (labor force and intermediate consumptions) and quasi-fixed ones (investment in the motorways) through improvements in the quality of the infrastructure (Albalate y Rosell, 2016). Nevertheless, even under the assumption that the output is exogenously given, it is possible to study the technical efficiency from an input minimization point of view.

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The main objectives of this study are: i) to estimate the levels of technical efficiency of the different toll companies in order to obtain a ranking of them, and ii) to explain the estimated inefficiency as a function of some key variables such as the ratio of time spent in alternative routes, the number of accidents or the antiquity, among others.
In order to reach these purposes, we employ Stochastic Frontier Analysis using an input-oriented Distance Function approach.

This study is of interest for several reasons. Firstly, we analyze technical efficiency for the Spanish case, the country with the largest number of toll motorway concessionaires and the longest tradition in the Public-Private Partnership for the development of infrastructures (Albalate, 2014). Secondly, we employ a database for the years 2003-2015, a period in which a great economic growth was followed by a recession. This allows us to obtain take into account different macroeconomic environments and control for the effect of the business cycle when estimating the levels of inefficiency. Lastly, the estimation results can be helpful for the Public Sector in order to adequately design the conditions for future negotiation with the toll companies.

Toll motorways are a type of infrastructure which has experienced a notably expansion in the last two decades, both in Spain and at an international level. There are several papers which analyze how they relate to the natural environment and the social welfare, what is the optimal pricing or the competitive structure of the industry.

Despite there is a wide literature which investigates the externalities and social consequences of this type of infrastructure, there just a few empirical papers which focus their attention in the technical efficiency of those companies in charge of the construction, management and maintenance of the toll motorways. To the best of our knowledge, along this scarce literature, we can only find Odeck (2008), Benfratello et al. (2009), Welde and Odeck (2011) and Albalate and Rosell (2016).

Odeck (2008) studies the technical efficiency of 18 Norwegian toll concessionaires in the period 2001-2004 employing a non-parametric Data Envelopment Analysis (DEA) and its subsequent Malmquist Productivity indexes. Their approach is input-based as the objective of the non-profit toll companies in Norway is to minimize their factors’ inputs
to produce the predetermined outputs. Their main results are the existence of economies of scale in the industry in that larger companies tend to be more efficient compared to smaller companies. There has been a productivity increase in the sector of about 1%, and this progress is due to companies employing a newer and more effective method for collecting funds. Nonetheless, there is a huge potential for efficiency increases. An average toll company should be able to carry out its task with 16% less resource use.

Benfratello et al. (2009) conduct a parametric efficiency analysis using Stochastic Frontier Analysis applied (SFA) to a cost function. They perform their analysis using a unique dataset containing information over the 1992–2004 period for a sample of Italian motorways concessionaires. Their estimation results show that the technology adopted in the industry clearly exhibits scale economies for small to medium sizes of the network. Regarding the type of property, privately-owned concessionaires are found to have a significant cost advantage over those publicly owned. Besides, the productivity of the concessionaires has slowly but steadily increased driven by technological progress, mainly introduced in the form of new technologies for toll payments.

Welde and Odeck (2011) combine DEA and SFA methodologies for analyzing efficiency considering a dataset of 20 Norwegian toll companies between 2003-2008. Their main findings are the significant potential for efficiency improvements and further evidence that electronic tolling is a source of efficiency gains with respect to manual toll collection.

More recently, Albalate and Rosell (2016) examine productive and cost efficiency in the Spanish toll motorways sector for a time span of 26 years (1988-2015) using data for 32 concessionaires. Their main objective is to distinguish between transient and persistent efficiency as the literature has failed to pay sufficient attention to this distinction. To do so, they apply both production and cost frontier models assuming a Cobb-Douglas form. Among their results it is worthwhile to highlight once again the significant technical progress, the existing wide margin for economies of scale, the fact that transient efficiency is higher than persistent one because concessionaires operate in a non-competitive environment and regional-owned companies are more efficiency than their State-owned counterparts.
Toll motorways exist in Spain since 1967 when the “Spanish National Motorways Program” was approved. This program foresaw the construction of 3,160 kilometers of toll motorways. This direct toll system in which users pay the infrastructure instead of taxpayers offer quite important incentives for their construction in those areas with high commercial traffic and growth perspectives. Because of this, the Mediterranean and the Ebro’s Valley areas were prioritized. In 1967, the first 167 kilometers of toll motorways in Spain were under construction and two years later 34 kilometers more started on operation corresponding to the stretch Montgat-Palafolls. These almost fifty years of experience have contributed to the notable worldwide expansion of Spanish concessionaires which have become prominent in many of the countries with the most significant toll roads programs (Carpintero, 2011).

There were two main waves in total length evolution of toll motorways under the exploitation of private companies in the period 1967-2015. The first one corresponds to the early seventies, when the total length changes from 500 kilometers on operation in 1970 to 2,000 in 1975. Since then until the end of the nineties, the total extension of the toll infrastructure remained virtually constant. In the beginning of the twenty-first century, there was a second wage between 2000 and 2005 by which the total length reached the 3,250 kilometers of extension.

In 2010, some concessionaire companies started to show some economic problems. The Public Sector tried to help them by different measures: increases both in the rates they charge users and in the duration of the concession, loans to finance extra costs and the establishment of a compensation account for which the State covered the differences between expected and income. However, these measures were not enough. Banks ask for the execution of the Patrimonial Responsibility of the Administration, a type of contractual safeguard which covers the undertaken risk of the concessionaires, being in practice a kind of rescue which uses Public money to safe private companies. Given this State guarantee, the private investors (mainly construction companies) who are behind the private concessionaires have some incentives to undertake investments of uncertain profitability or to fall into extra costs in detriment of taxpayers (Albalate and Bel, 2009), as it has effectively happened.
In this paper, we employ a new self-constructed dataset for Spain, which have been obtained from two difference sources. The first one is the Annual Reports of the Toll Motorways Sector in Spain, which the Ministry of Development annually offers. This dataset reports information regarding the traffic volume, the number of accidents and the length of the different toll stretches, among other variables. What is more, they also present balance data sheets about the concessionary companies. The second source employed was the Iberian Balance Sheets Analysis System, which completes the information provided by the Annual Reports.

Our study covers the period 2003-2015 and this allows us to identify how the macroeconomic environment affects the traffic volume of toll motorways. The resulting dataset involves 32 concessionary companies. However, not all of them were on operation during the whole study period as some mergers between them took place. Moreover, some of them have disappeared due to their bankruptcy declaration after 2013. Consequently, we have an unbalanced panel data set with 334 observations.

The main output a toll motorway produces is the traffic volume circulating through it. Two magnitudes are the most commonly used in economic and financial studies for measuring the traffic volume, namely: average daily traffic and vehicles per kilometer. The former shows the average number of vehicles passing through gauging stations whereas the latter is defined as “the total sum of the kilometers traveled by all the vehicles which use the given motorway in a certain period of time”. For both of them, it is possible to distinguish between two types of vehicles: light and heavy. We believe this distinction is worthwhile as heavy and light vehicles are intrinsically different in terms of asphalt degradation.

As for the inputs, workers were classified into two categories: the total number of employees in maintenance tasks on the one hand, and the total employees at tolls and general services, on the other. Likewise, regarding the capital input we also considered

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2 In our estimations, we only considered 31 concessionaire companies because we lack relevant data from one of them (Interbiak).
two categories: a quasi-fixed input (capital stock) and a variable input (the value of intermediate consumptions).

In order to analyze the technical efficiency of a toll motorway, we believe that it is essential to control for the alternatives. In this sense, the traffic volume of a certain toll motorway will be influenced by kind, quality and technical characteristics of the existing free alternatives (dual carriageways, motorways, national route, etc.). Ignoring this factor may cause the efficiency estimates to be biased as it is possible that your apparently efficiency is due to the fact that there is not a good alternative for going over the same stretch. Thus, to quantify the effect of the presence of free alternatives on users’ decision-making, an additional variable was included: the average time required to go over the same origin and destination through the fastest free access alternative related to toll’s. For its calculation, we employed a GPS system which quantifies the estimated time (minutes) that it would take to travel through a passenger car, on ideal circulation conditions.

Finally, the following variables were included as controls: antiquity, shareholding composition, number of stretches and if the concessionaire if “state-owned” or “regional-owned”.

We have used a flexible specification (translog) for the input distance function. The preliminary results obtained so far indicate that the estimated parameters have the appropriate sign, and thus the function fulfills the theoretical conditions: non-decreasing in inputs (the two types of employees and intermediate consumptions) and non-increasing in outputs (traffic of light and heavy vehicles). In addition, we have contrasted that the quasi-fixed input (capital stock) are complementary to the rest of variable factors. We also highlight the contribution of the free alternatives to toll motorways in order to determine the technological frontier. Besides, it has been found the existence of significant returns to scale in the sector. Concessionary companies’ specific inefficiency is assumed to be time-varying and is affected by observable heterogeneity of motorways and environmental factors. Our results suggest that the economic crisis and the regional ownership of highways have a negative impact on efficiency levels.
REFERENCES


