



Review and suggestions to the demand forecast model in highway concessions projects in Brazil

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ABSTRACT

The aim of this work points out criticism to projections of demand in projects of road concessions in Brazil's model, and propose suggestions for serving as a tool to minimize the risks of economics agents participating in the process of granting highways. The methodology of this study is divided into three phases. The first stage involves content analysis of the viability study of technical, economic and environmental (EVTEA) of the BR - 050MG and BR - 285RS, as examples of projects of economic feasibility in Brazil. The second phase is the appointment of the weaknesses of the demand projections in the projects, building criticism of the current model. Finally, the third and final stage is the construction of the proposed model in question. As a result of this investigation, the authors note that the use of such projections which are made in Brazil, may incur in spurious models, given to the need of application of time series modeling without the projected economic scenarios constructed by deterministic models. The suggestion is adopting Vector Auto Regression (VAR) models in which the rate of demand growth is explained by the growth rate of existing logistics chains in the concession area.

Keywords: Economic and financial analysis; Highway Concessions; Demand projection model; Brazil Concessions.

JEL Codes: R42, R48

INTRODUCTION

In Brazil, the toll road to private partners started by the 1990s, however, since the Federal Constitution of 1946 this partnership was predicted. This decade is also the beginning of the privatization of sectors related to the transport infrastructure process. The first granted highways in Brazil was the one that passes through the Rio-Niteroi Bridge and President Dutra Highway, linking the cities of Rio de Janeiro and São Paulo.

In the 2000s, the Brazilian government implemented the Program for the Federal Highway Concessions. A new regulatory phase began with the creation of the National Land Transportation Agency (ANTT), in 2001, under the Ministry of Transport (MT). In spite of the implementation of the model governed by this Law that aged more than eight years, Brazil has not advanced

enough to ensure a level competitive logistics equated to that observed in other countries. In the analysis of the edition published by the World Bank in 2012, ranking of global logistics performance (LPI), Brazil appears only in 45th place among one hundred fifty-five countries listed.

The pioneering road infrastructure grants dates from 1955, when France started this process. In contrast, England uses, since 1990, a model called DBFO (Design-Build-Finance-Operate), where the private sector makes the investment and the Government pays for the delivered services, practice used by Brazil, since 2001. In North America Canada, United States and Mexico have very different characteristics in their concession models. In South America, three countries stand out: Argentina, Chile and Brazil. Brazil in 2012, implemented the

Investment Program in Logistics (PIL), with a new concession model.

Currently, according to the National Transportation Agency (ANTT) Road Grant Program spans more than 11,000 km of highways, and other 5,239.7 are already granted to the private sector. Among the Midwest states, some have already concession projects to private companies, both federal highways, and state highways.

However, some risks involves the operation of the toll road. The underestimation of the demand in a given road can lead to losses for both the public sector which provides the highway, and the private sector participating as a dealer. This increases the possibility of renegotiation of contracts, which can adjust the initial grant proposal, incurring loss of benefits to economic actors involved in the process causing the loss of quality of the service provided by the dealer, and burdening the user, due to additions the amount initially proposed in the bidding process.

Thus, the problem of this research is to identify critical road demand projection model, and suggestions for pointing this projection model, serving as a tool to minimize the risk of economic agents participating in the process of granting these highways. So, the object of research is the analysis of the draft study technical, economic and environmental viability (EVTEA) of the BR and BR-050MG-285RS, and therefore pointing criticism and suggestion to the models in question.

MODELING IN THE TRANSPORTATION

As shown earlier, Brazil is currently in the process of finalizing stages of bidding for its road infrastructure. The model most recently used according to ANTT (2013) had the participation of the following agents:

- Grantor: Union represented by the National Transportation Agency (ANTT);
- Broker: Commodities and Futures BM&FBOVESPA;
- Judging: Granting Committee formed by representatives of the ANTT, but that may be aided by officials of the National Department of Transport Infrastructure (DNIT), the Ministry of Transportation, the Attorney General (AGU) and the National Bank for Economic and Social Development (BNDES), and;
- Proposers: Represented by an Accredited Representative responsible for the organization and delivery of the necessary documentation to BM&FBOVESPA and Accredited Brokerage responsible for acting on behalf of his client in the auction.

The mentioned model used the following process to obtain their estimates of traffic and consequently investments and financial returns (figure1).

The presented model observes the steps of the classical 4-step model, in which there is the first survey data that consequently calculates generation, distribution and modal split of travel, culminating in the assembly of the source and destination array. In parallel with the

steps of assembling geo-referenced network Transcad where surveys in field attributes were inserted as cost of time in minutes (ANTT, 2013) was performed.

Following the drafting of origin and destination matrix and based on Logit Model of utilities for choice of routes of vehicles, the first simulation to calibrate the model and obtain the volume of the base year, 2010, was performed. Upon receipt of this volume and model calibrated, other simulations were done with new origin and destination arrays. Such arrays were prepared through traffic projections calculated considering the evolution of the Gross Domestic Product (GDP) and the elasticity of vehicle fleet over all 25 years of the concession. This methodology made it possible to obtain the tolled volume and percentage of leakage, the latter by the difference between the base volume without impedances time cost, and volume obtained with the simulation using the impedances cost of time (ANTT, 2013).

REVIEW TO ROAD DEMAND FORECAST MODELS

Studies such as Flyvbjerg, Holm and Buhl (2005) and Cardoso et.al. (2012) indicate that the differences between estimated and realized demand exceeds 20%. The demand is overestimated by the public agent, which leads to an optimist view of the user traffic or the bad use of statistical tools to estimate demand, according table 1.

The possible bias occurs during the bidding process, since the expectation of winning a bid, a company may have an opportunistic behavior, offering a rate not enough to provide economic viability to the project return. Another step is the formation of contracts (Rocha and Garcia, 2011). Obscure and incomplete contracts not only result in higher market prices and less services quantity / quality (poor performance), but higher levels of transaction cost (Merkert and Henshe, 2013).

These incomplete contracts have loopholes to justify subsequent renegotiations, incurring changes in tariffs, increasing to rates that can guarantee financial returns to the private company, but that probably would not be able to win the bid.

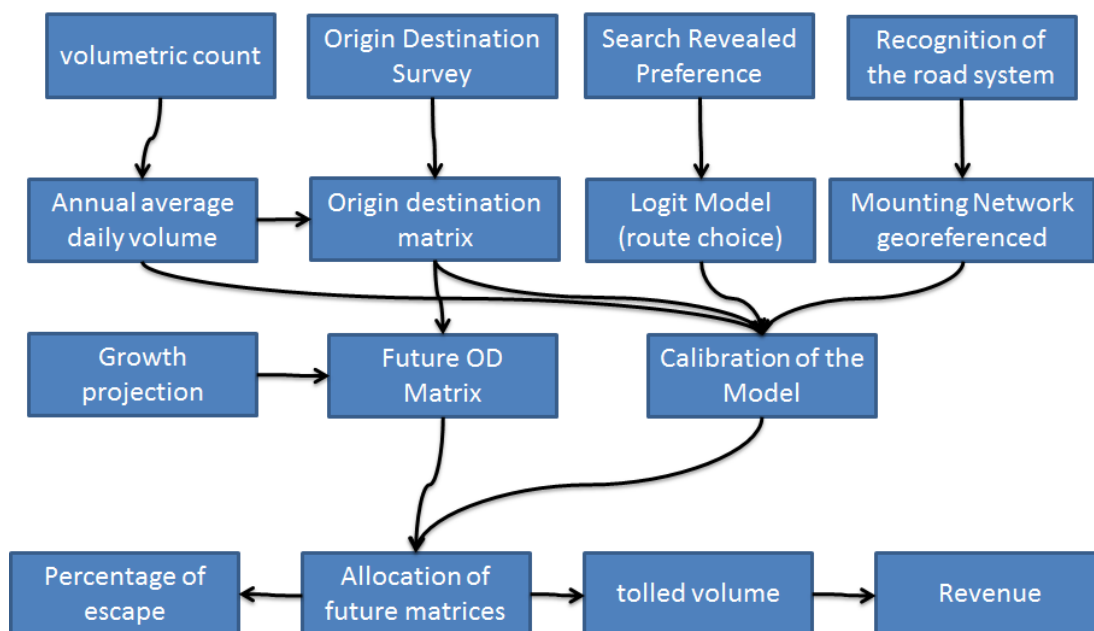
Legally, the need of contracts renegotiation is based on three basic categories of risks adopted by the National Treasury, aiming regular concession contracts and their renegotiations: demand risk, construction risk and availability risk. The concepts of these three types of risks are presented by the Statistical Office of the European Communities (EUROSTAT), in its Decision No. 13 of 2004.

Treatment of this risk is determined by Ordinance No. 614/06 of the STN, which considers that the public partner bears the risk of demand exceeding minimum revenue guarantee is 40% of the total expected revenue stream (BRAZIL, 2006, p.9). However this can cause an expectation that their contracts may be renegotiated.

Table1. Forecasted Demand vs. 2002's Demand

Concessionaires	Forecasted Demand / 2002's Demand
Triangulo do Sol	-43,70%
Centrovias	-34,30%
Viaoeste	-32,70%
Ecovias	-18,80%
Autovias	-13,50%
Colinas	-12,20%
Renovias	-8,80%
Tebe	-4,40%
Autoban	3,70%
SPVias	4,10%
Vianorte	28,50%
Intervias	87,90%

Source: Cardoso et.al. (2012)

**Figure1.** Activities traffic study

Source: ANTT (2013)

Based on the literature referring to spurious feature of current forecast demand models used in Brazil, the criticisms that can be woven are outlined in the following paragraphs.

In the Document IPR-726/2006 prepared by DNIT (2006), it is evident that the goal of EVTEA is to determine the operational characteristics of the highway, and how it must adapt to the demand in the period of the project. For this, one should take into account the benefits derived from the increased value of agricultural

production in rural areas, and the increasing demand for goods and services to urban areas. The projection of the logistics chain of the demanded products either in the field or on the towns intercepted by the road network in study is not only one of the ways to determine the demand, but also the goal of your care in the future that the project concerns.

However, when designing the traffic flow and road demand, whether for calculating rate, or for studding the composition of the network, the matrices obtained for the

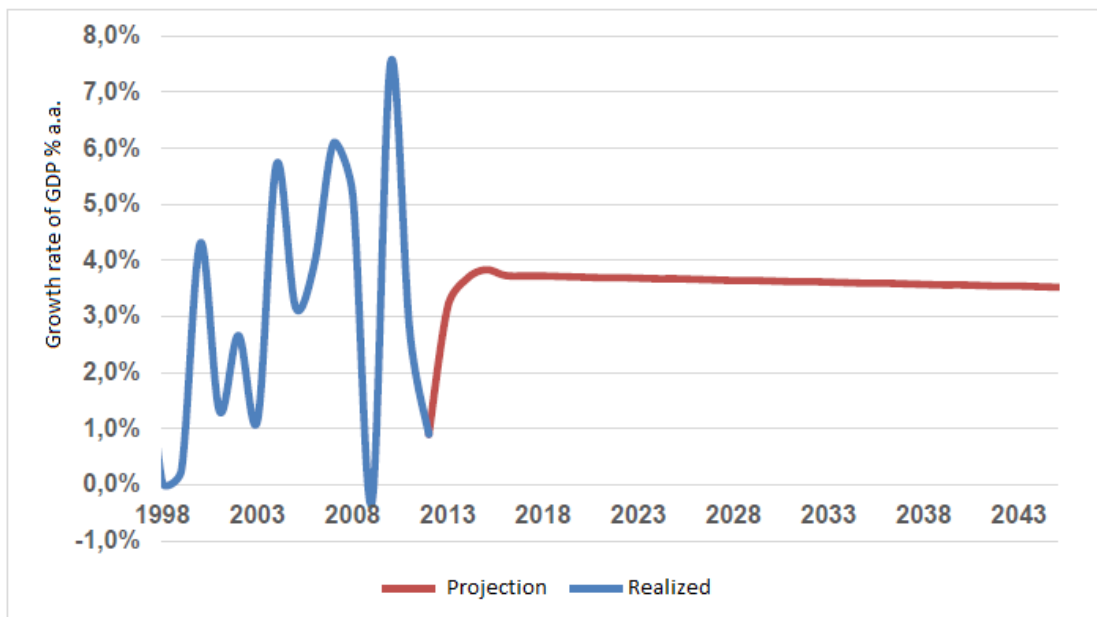


Figure2. Projection of national GDP for the period of the concession
Source: ANTT (2013)

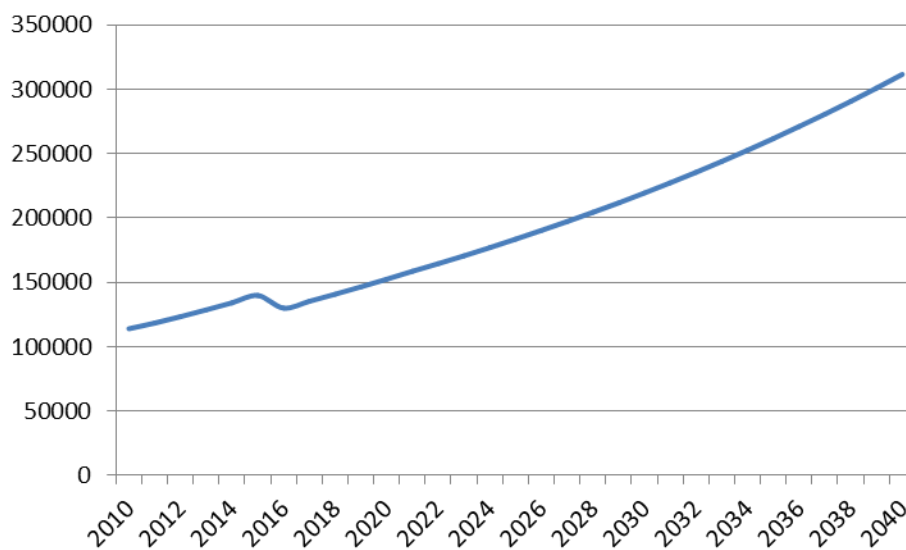


Figure3. Projection VDMA BR-050
Source: ANTT (2013)

base year were projected for future years due to the expected gross domestic product growth (GDP). For each year of the projection, was applied a linear correction factor to ensure that the sum of the values of GDP projected for micro-regions meets the overall projection of GDP Brazil. The growth of each traffic zone was then correlated with the rate of growth of the micro-region where it is inserted.

Specifically in the case of BR-285/RS, two growth rates were chosen, 4.9% per year for the first five years

and 3% per year for the projection of the 2011 traffic for the next 20 years. The growth rate of 4.9% initially adopted, is the arithmetic average of the standard growth rate (3% per year) and the average growth indicators pointed in the development of the fleet (IDA) (5.5% per year), and traffic in the corridor Brazil - Argentina for each type of vehicle (tour - 6.8%; buses - 7.1%; charge - 7.8%). Moreover, as Figure 2 above, the treatment of the series temporal of GDP, is itself questionable, as it flattens the projection of this indicator.

According to Ballou (2006), forecast methods can be divided into three groups, and one of these groups are the historical projection methods. However, the author argues that a reasonable number of historical data is required, and that your time series must be stable and well defined, so that the projection of future data efficiently represents this series. Unfortunately, it is not what happens with the data reported in Figure 2.

In this sense, the result of the projection, in the case of BR-050, shows a linear growth, as Figure 3, devoid of seasonality and committed to convey a moderate perspective, making room for future renegotiations of contracts, incurring to fail the demand projection.

The section below proposes a model that takes into account the forecast demand of the road, with the explanatory variables to forecast the supply chain of the regions where the projects are studied.

SUGGESTIONS FOR A NEW MODEL

Even being a developing field, the time series econometrics can help, since the data collected in the flow studies and supply chains is a non-stationary time series, limiting the use of linear and constant rate of growth (Gujarati, 2000).

Thus, the suggested methodology uses the concept of co-integration of time series, since the two or more series suggest indicative of a long-term relationship. Estimating an equation for the flow of traffic and another for the demand of the logistics chain, for the highways in question, the Ordinary Least Squares (OLS) can be used as precursor to an estimate of Vector Auto Regression (VAR). The VAR is similar to the models of simultaneous equations, but it benefits for the problem in hand, incurring in the treatment of endogenous variables, and other exogenous (Gujarati, 2000).

$$X_t = A_0 + A_1 X_{t-1} + \dots + A_p X_{t-p} + B_0 + B_1 X_{t-1} + \dots + B_p X_{t-p} + e_t$$

Where:

A_0 is the vector of intercepts terms;

A_1, \dots, A_p matrices are $N \times N$ coefficients relating lagged values of the endogenous variables;

B_0, \dots, B_p matrices are $N \times N$ reporting current and lagged values of exogenous variables;

e_t is a vector $N \times 1$ errors.

In order to establish whether there is causality between the projected growth in supply chain and demand of road, it is suggested the Granger causality test. According to Paranaíba, Alves and Marques (2011), it is an F-test where the null hypothesis is that there is no causal relationship between the variables tested. A variable X causes in the terms of Granger one variable Y, then the lagged values of variable X influences the behavior of the variable Y (Melo and Lima, 2009).

Gujarati (2000) affirms that the methodology of Granger must be used with great caution, as it is very sensitive to the size of the lag used in the model. To use this causality methodology it is important that the time series are co-integrated. According to Pindyck and Rubinfeld (2004) if x and y series present behavior of random walk, but the first difference of both are stationary it is easy to test your co-integration. For checking if the series are stationaries, it is suggested the ADF unit root test.

To test whether X causes Y it's verified the null hypothesis that "X does not cause Y", as the estimated of two regressions; one unrestricted and another restricted:

$$Y_t = \sum_{i=1}^n \alpha_i X_{t-i} + \sum_{j=1}^n \beta_j Y_{t-j} + u_t$$

$$X_t = \sum_{i=1}^m \lambda_i X_{t-i} + \sum_{j=1}^m \delta_j Y_{t-j} + v_t$$

The hypothesis that X does not cause Y is rejected when the coefficient group is significantly different from zero, where the error terms are non-correlated. The sum of squared residuals of each regression is used to calculate the statistic F-test and the group of coefficients. The unrestricted regression presupposes that the current X values are related to past values of X itself, as well as with the lagged values of Y. The restricted regression, on the other hand, causes a similar behavior for the Y variable. In general, as soon as the future cannot predict the past, if the variable X caused the variable Y, then X changes should precede temporarily Y changes.

Validation of Model

In order to validate the model, the criterion chosen was to adopt simulation as an enabling tool for pointing out the interference of several variables belonging to the proposed model.

When using the term simulation, it refers to any analytical method which proposes 'Mimic' real life, especially when analyzes are mathematically complex or difficult to reproduce. Without the aid of a simulation, the cash flow of a projected road concession, does not usually demonstrate a more likely scenario. Simulating a model means, definitely, contributing to show the risks and the probability of the model to be built.

In this sense, observed the importance of using a simulation to validate models of road concession, as well as identifying the economic and financial sustainability, the literature shows a dense usage of Monte Carlo simulation method.

Several authors, used the Monte Carlo simulation in their modeling applied to Public Private Partnership (PPP), like Zhang and Asce (2005; 2009). In concession contracts, Cruz and Marques (2013), Almassi, Asce and

Thompson (2013) are authors who used the Monte Carlo simulation in their publications, specifically to PPPs in the transport sector.

The Monte Carlo simulation is a method which allows the choice of random values and through the probability distribution, of these variables, results the probability distribution of the IRR of the project. Thus, it is possible to calculate the probability of the IRR model, validating it.

CONCLUSION

The aim of this article is to evaluate the methods used in forecasting demand in highway concession projects in Brazil. Therefore, it was presented that these projections have spurious nature in the form how they are made in Brazil. The suggestion brought up in this paper is using the projected growth of the logistics chain in the region's highway on the demand forecast model. It is believed that it is more influenced by this than by national socioeconomic indicators, like GDP, as used actually in the mentioned studies.

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REFERENCES

- Almassi A, Asce BM, Thompson M (2013) Real Options-Based Approach for Valuation of Government Guarantees in Public-Private Partnerships. *American Society of Civil Engineers*. 19:196-204.
- ANTT (2013). Estudos aprovados Vol.2 – Estudo de Tráfego. AGÊNCIA NACIONAL DE TRANSPORTES TERRESTRES. Disponível em <http://www.antt.gov.br>. Acessado em: 21/08/2013
- Ballou RH (2006) Gerenciamento da Cadeia de Suprimentos/ logística empresarial. 5ª Edição. Porto Alegre – Bookman. Pp616.
- Cardoso ABC, Aquino ACB, Anuatti NF, Cardoso RL (2012). Dinâmica dos ajustes contratuais em concessão de rodovias no estado de São Paulo. *Revista de Administração Pública* [online]. 46(5):1295-1315.
- Cruz CO, Marques RC (2013). Using the Economic and Financial Reequilibrium Model to Decrease Infrastructure Contract Incompleteness. *American Society of Civil Engineers*. 19:58-66.
- DNIT (2006). Diretrizes Básicas para Elaboração de Estudos e Projetos Rodoviários. Escopos Básicos/Instruções de Serviço. IPR-726/2006. (EB-101: Estudos de Viabilidade Técnico-Econômica Ambiental De Rodovias).
- DNIT (2011). Estudo De Viabilidade Técnica, Econômica E Ambiental (EVTEA) Para Adequação De Capacidade, Melhoria Da Segurança E Eliminação De Pontos Críticos Na Rodovia BR – 285/RS. República Federativa do Brasil, Ministério dos Transportes - Departamento Nacional de Infra-Estrutura de Transportes – DNIT.
- EUROSTAT (2004). Statistical Office of the European Communities. New decision of Eurostat on deficit and debt Treatment of public-private partnerships. Decision 13. Eurostat Press Office: LUXEMBOURG.
- INTERNATIONAL FEDERATION OF ACCOUNTANTS. Governance in the Public Sector: A Governing Body Perspective. International Public Sector Study. Public Sector Committee, 2001.
- Gujarati DN (2004). *Econometria Básica*. 3ª Edição. São Paulo – Makron Books.
- Jeerangsuwan T Said, H Kandil, A Ukkusuri S (2012). Optimization Application for Financial Viability Evaluation of PPP Toll Road Projects. *Construction Research Congress*. 2329-2338.
- Melo AS, Lima RC (2009). Biocombustíveis E Culturas Alimentares: Um Estudo Da Relação De Causalidade Entre Os Preços Do Açúcar E Do Etanol No Brasil. *Sociedade Brasileira de Economia, Administração e Sociologia Rural – Congresso Sober Porto Alegre*.
- Merkert R, Hensher DA (2013). Regulation, trust and contractual incentives around transport contracts: Is there anything bus operators can learn from public air service contracts? *Research in Transportation Economics*. 39:67-78.
- Paranaíba AC, Alves GLF, MARQUES IC (2011). Um Estudo De Causalidade De Preços Recentes Do Açúcar Cristal No Mercado Interno. In: 49º Congresso da Sociedade Brasileira de Economia, Administração e Sociologia Rural, 2011, Belo Horizonte. 49º Congresso da Sociedade Brasileira de Economia, Administração e Sociologia Rural.
- Pindyck RS, Rubinfeld DL (2004). *Econometria, modelos & previsões*. Ed. Campus, Rio de Janeiro
- Zhang X, ASCE M (2005). Financial Viability Analysis and Capital Structure Optimization in Privatized Public Infrastructure Projects. *J. Construction Engineering and Management*. 131:656-668.
- ZHANG X, ASCE M (2009). Win-Win Concession Period Determination Methodology. *Journal of Construction Engineering and Management*. 135:550-558.

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