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Regulating concessions of toll motorways: An empirical study on fixed vs. variable term contracts

Daniel Albalate *, Germà Bel

Universitat de Barcelona, Departament de Política Econòmica i Estructura Econòmica Mundial. Av. Diagonal 690, 08034 Barcelona, Spain

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ABSTRACT

Recent theoretical developments on concession contracts for long term infrastructure projects under uncertain demand show the benefits of allowing for flexible term contracts rather than fixing a rigid term. This study presents a simulation to compare both alternatives by using real data from the oldest Spanish toll motorways. For this purpose, we analyze how well the flexible term would have performed instead of the fixed length actually established. Our results show a huge reduction of the term of concession that would have dramatically decreased the firm's benefits and the user's overpayment due to the internalization of an unexpected traffic increase.

1. Introduction

The private sector's participation in infrastructure funding and management is growing around the world, and this increase is taking especial relevance in the case of toll motorways. Albalate et al. (forthcoming) recently noted that as the size of the private sector increases in the toll motorway sector in Europe, the more detailed and specific its regulation becomes.[1]

Privatization of toll motorways is an emerging market in the US too.[2] Indeed, there have been significant Greenfield projects in the US since the early 90s, such as the Dulles Greenway (beyond Dulles Airport in Virginia), opened in 1995, as well as several BOTs in California. More recently several Brownfield privatizations (privatizations of already existing toll motorways) have occurred: the Chicago Skyway in 2005, the Indiana Toll Road in 2006, and the Pennsylvania Turnpike in 2008, within a more general trend that includes prospects for privatization of toll motorways in New Jersey, as well as build-operate-and-transfer (BOT) concessions in Texas. Therefore, the described wave of privatization is accompanied by a renewed interest on the way the public sector regulates, and this interest can be explained by the redistributive effects[3] that can arise by the fact of giving the right to exploit a network asset as a motorway is.[4]

The recent history of motorway privatization does not provide a systematic rationale to support the private participation in this sector without further discussion. The cases of Mexico, Argentina, Colombia, Thailand and Malaysia, even the Spanish

* Corresponding author. Tel.: +34 93 4021945; fax: +34 93 4024573.
E-mail addresses: albalate@ub.edu (D. Albalate), gbel@ub.edu (G. Bel).
URL: http://www.danielalbalate.com (D. Albalate).

[1] Albalate et al. (forthcoming) argue that regulation and public ownership are partial substitutes in the European toll motorway industry. In fact, governments keep its intervention capability to intervene using specific external control once the ownership is lost.

[2] However, US has a long tradition of toll roads. In fact, there are more than 300 toll facilities in the US (Holguín-Veras et al. 2006).

[3] See Bel and Foote (forthcoming) for an analysis of the case of Chicago Skyway and Indiana Toll Road.

[4] Toll motorways enjoy some monopolistic characteristics, particularly regarding quality of service. However, it is worth taking into account that in most cases there are free roads available, and competition can arise from other transportation modes as well.

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and French experiences in the second half of the seventies, are good examples of this failure and are well documented in Gómez-Ibáñez and Meyer (1993), Fisher and Babbar (1996), Ruster (1997), Bel (1999), Engel et al. (2003) and Bel and Fageda (2005). Perverse renegotiations, huge public financial guarantees or massive public resources devoted to cover private losses, the construction of white elephants, and general firm breakdowns are just some of the consequences associated with the introduction of private funding in those experiences.[5]

Fortunately, the influential works of Engel et al. (1997, 2001) brought some light to the sources of these problems that emerged in concessions of infrastructure with huge sunk costs and uncertain demands. Since the need for huge sunk investments is significant in transport infrastructure projects, and the evolution of traffic demands cannot be foreseen for such a long period of time as it is necessary to cover initial investments, it makes sense to expect problems when the traffic received is actually lower than expected or on the contrary, when there is an unexpected increase.

Therefore, it is not surprising that Guasch (2004) finds high percentages of renegotiated contracts in sectors like transportation (54.7%) and water and sanitation (74.4%) due to their similar characteristics – huge sunk investments, long concession terms and unexpected future demands.[6] These renegotiations are caused by the pressure put by the private sector when the problem relies on low traffics and by governments when unexpected increases of traffic generates enormous benefits that threat its political acceptance. Avoiding these renegotiations becomes a challenge for policy makers. Since it is actually a relevant public policy problem, its study represents an issue of great interest for the public economy. For all these reasons, the improvement of the regulatory framework and the right assignment of risks and incentives must be taken with especial attention and accuracy, in particular when the private sector takes part.

Auctions, that serve as an instrument to introduce competition for the market in sectors where it is not possible to have competition in the market, are usually based on awarding concession contracts in which the length is established and known from the beginning. This term is usually set only on the expected evolution of traffic and on the financial factors exposed by the firm. In fact, it is the main responsible for the traffic risk assumed by the concessionaire and generally covered by state guarantees, renegotiations and transfers.

To overcome the pitfalls above mentioned and to provide a useful tool for policy makers, Engel et al. (1997, 2001) and De Rus and Nombela (2004), proposed two flexible term mechanisms based on a guaranteed present revenue that makes irrelevant the length of concession for the companies holding the right to exploit the road. The length of concession now gets adjusted depending on traffic evolution and tariffs applied to users, making possible to accommodate unexpected events and to design price schemes that satisfy assignative efficiency criteria to regulate traffic demands when changing capacities becomes impossible in the short run. In addition, the use of flexible term contracts reduces the incidence of renegotiation, allowing for a more transparent and predictable scenario and smoothing the risk assumed by governments and firms.

In spite of their academic success, flexible term methods have never enjoyed a significant support in practice. Furthermore, the motorways that implemented this regulatory strategy were quite recently built and it is not possible to reasonably compare both mechanisms. For this reason, we use real data reported by two of the oldest toll motorways in Spain, ruled by a private firm under a traditional build-operate-and-transfer (BOT) concession, to check how well flexible term contracts would have performed in those cases.

The current study is organized as follows: In Section 2 the problems of fixed term contracts are exposed and the models proposed to solve the concerns above mentioned are introduced. In Section 3 we describe the simulation strategy that we follow in order to compare both mechanisms in the case of two real Spanish toll motorways while in Section 4 we provide our main results. Finally we state some concluding remarks in the Section 5.

2. Fixed vs. variable term mechanisms

Engel et al. (1996, 1997, 2001, 2002, 2003) argue that all the problems associated with private toll road experiences were mostly related to the build-operate-and-transfer (BOT) contracts agreed and awarded in traditional auctions based on the rules of minimum toll, subsidy or term Chen and Subprasom (2007)offer.[7] All these cases imply the establishment of a fixed term of concession that serves to explain most of the problems that emerged in the countries that used this policy to obtain private resources to fund motorway programs.

When a company decides to participate in a toll motorway concession auction it takes into account several factors. Demand forecasts, user's willingness to pay and building and operating costs are the most important ones. For this reason the present value expected by the firm when it studies the offer it is willing to submit in the tender is the following one:

$$PV = \sum_{t=k}^{T} P_t Q_t \frac{1}{(1+r)^t} - \sum_{t=1}^{T} Bc_t \frac{1}{(1+r)^t} - \sum_{t=k}^{T} [Oc_t(q)] \frac{1}{(1+r)^t} - \sum_{t=1}^{T} Fc_t \frac{1}{(1+r)^t} \quad (1)$$

[5] A white elephant is usually defined as a valuable possession whose upkeep is excessively expensive, and may be useless apart from its phisical value. Robinson and Torvik (2005) also defined this term as an investment project with negative social surplus, which is the meaning we take onwards.

[6] Guasch (2004) considers more than 1.000 concession contracts in Latin America in order to get solid lessons for future policy makers. The total incidence of renegotiation he finds is 30%, much lower than the incidence rate found in transportation and water and sanitation.

[7] Also, most theoretical works still base their analysis on build-operate-and-transfer frameworks. Some recent examples are Chen and Subprasom (2007) and Ubbels and Verhoef (2008).

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where P is the average toll, Q the expected traffic and r the discounting rate. Bc represents the building costs, and Oc and Fc the operational and financial costs, respectively. Although Bc takes more importance in the years before the opening, the motorway (at least some tranches) is usually opened before full construction is finished. Moreover, new enlargement projects can imply incurring in building costs in any time within the concession period. For these reasons Eq. (1) allows the presence of Bc from the first year of concession ($t = 1$) until the last year ($t = T$). On the contrary, operational costs (Oc) depend on the vehicles actually received and appear once the road is opened ($t \geqslant k$). Finally, Fc is the financial cost of this investment and can appear during the whole concession period depending on the financial policy followed. Thus, K represents the first year of operation while T is the last year of concession. Then, $t = 1, 2, \ldots, k-1, k, k+1, \ldots, T$. As Eq. (1) shows, when $t < k$ the concessionaire is building the road and does not receive toll revenues neither spends in operation. Only financial and building costs apply during this first stage.

Once the decision on toll or term offer based on the present value above described is taken, it is easy to see that if the traffic actually received is significantly lower than expected, then the company could suffer financial troubles. This circumstance is known in the auction literature as the winner's curse.[8] On the contrary, when the demand received by the road is soundly higher, then the firm's profits will increase so much that if it continues during a long period of time, then the political acceptance of the regulatory framework by the public might decrease and affect the levels of popularity enjoyed by the government.

Up to now, it would seem that the traffic risk is assumed by the winning company. However, the literature shows that private firms usually forced favorable renegotiations when the adverse scenario appeared. These renegotiations have been the general rule around as Guasch (2004) and Estache and de Rus (2000) explain, and they have caused toll increases, extended terms, state guarantees, and massive transfers to private companies (Gómez-Ibáñez and Meyer, 1993; Ruster, 1997; Bel, 1999).

Furthermore, De Rus et al. (2000) warn that this uncertainty associated with the toll motorway business can also be transferred to the users if the company claims for higher tolls or longer terms when they decide what offer to submit in the awarding auction. As a consequence, the uncertainty is finally assumed by the users through higher tolls or longer terms when this effect is present or when the renegotiation implies the same changes in the initial contract. Finally, since we cannot forget that some road users are also tax payers[9], they are also assuming this risk when the state decides to transfer resources or when they give favorable guarantees.

In fact, companies are in the concession business to obtain returns to investment and as a means to achieve a spreading of investment risks. Being this said, no doubt this is a complex business in which there are huge amounts of money involved and important future demand uncertainty. Hence, these business characteristics provide room for strategic and opportunistic behaviour. For instance, companies can act strategically in the auction. This means that firms that are used to renegotiate, or feel themselves very close to the government, are not worried that can submit too optimistic offers, since after winning the bid they can force favourable renegotiations. On the other hand, if the project becomes not profitable once the road is operated due to low traffic, they can convince the state to rescue the firm once it suffers financial troubles. This fact implies that the winner of the auction is not always the most efficient, and Engel et al. (1997) and De Rus and Nombela (2004) assert that this is one of the worst outcomes of fixed term concessions.

The last problem is the rigidity of tolls. Prices, in the case of motorways, are usually only thought to satisfy financial needs. Under this fixed term scheme it is not possible to vary the toll in order to accommodate it to the traffic received without affecting the financial results of the firm. Unfortunately, this constraint makes impossible to fulfil the function the toll should have as a price that regulates traffic demands in order to fight congestion and overcapacity when infrastructure enlargements are not possible in the short run. The classic works by Pigou (1920), Walters (1968) and Vickrey (1969) and other recent studies like Nakamura and Kockelman (2002), De Palma et al. (2005) or Burris (2006), prove the necessity of having variable toll schemes in order to fulfil this function. However, the most common reason a government agency goes to concession route is a lack of tax revenue to support infrastructure development. For this reason, efficiency criteria in toll setting are not usually considered when franchising.

2.1. Least present value of revenue (LPVR)

To solve all the pitfalls generated by the establishment of fixed terms, Engel et al. (1997, 2001) propose a mechanism based on variable term concession contracts called the "least present value of revenues". In this mechanism the concessionaire obtains the right to receive toll revenues until a total accumulated discounted sum is reached. Once it happens, the concession finishes and the motorway is transferred. Thus, it is not possible to know how many years the concession will last because it definitely depends on the real traffic it receives and the toll setting applied.

Furthermore, the theoretical outcome developed by Engel et al. (1997) is that in a competitive auction the winner offers a present value of revenues (PVR) close to the building costs. In this seminal work, Engel et al. (1997) do not consider operating costs in their model since they argue that mathematically, this cost dimension does not change the mechanism's optimal result. Therefore, authors decided to follow a simplified model in order to prove the rationale behind this mechanism. Other

[8] The concept of the Winner's Curse was first discussed in Capen et al. (1971).

[9] As pointed out by a referee, not all road users are tax payers regarding our analysis; some users are only paying user fee taxes as they are not citizens of the governmental region.

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models, such as the proposed by De Rus and Nombela (2004), which is described below, includes operating costs to create a more real framework for variable term methods. Here we present the seminal model by Engel et al. (1997) and in the next sub-section we introduce the one proposed by De Rus and Nombela (2004).

Moreover, in practice, it also makes sense to expect the addition of a profit margin above the level established by building costs when bidding. Adding up all these elements we find that the PVR awarded, according to Engel et al. (1997) with the inclusion of this profit margin, is computed in the following form:

$$\text{PVR} = I(1+\mu) = \sum_{t=k}^{Ti} \frac{PQ_i}{(1+r)^t} \tag{2}$$

$$I = \sum_{t=1}^{T=k} Bc \frac{1}{(1+r)^t} \tag{3}$$

$$T = f(I, P, Q, \mu, r) \tag{4}$$

where I denotes the investment undertaken in order to construct the road during the building period; $\mu \in [0,1]$ is the profit margin over the total costs and the rest of variables denote the same they did in Eq. (1). Thus, the more competitive is the tender, the lower must be μ.

It is straightforward that, ceteris paribus, as higher the traffic demand is, the shorter the time of concession becomes. This is so because the PVR awarded is faster achieved. In the same way, when the motorway receives lower traffic than expected, the traffic risk is mitigated thanks to this mechanism and the term is automatically extended until the firm obtains the PVR awarded.

Therefore, the LPVR mitigates the traffic risk and rescue firm losses, while at the same time does not allow obtaining extraordinary profits caused by excessive user payments.[10] Moreover, this system based on variable terms allows the implementation of pricing schemes thought to obtain the optimal use of the road because price changes are compensated by extending or reducing the term (De Rus and Romero, 2004). Therefore, the double function of prices is achieved – financing the infrastructure and regulating traffic demands under efficiency criteria-.

2.2. Least present value of net revenue (LPVNR)

De Rus and Nombela (2004) noted that only in the limit case when the operational costs are 0 the traffic risk is fully eliminated with LVPR models. The reason comes from the fact that companies also estimate future demands and condition its offers to them because the operational costs affect the project's total cost. The longer is the term, the bigger are the operational costs incurred and therefore, the total costs that must be covered.

To overcome this problem, they proposed another variable term mechanism based on a bi-dimensional bid that takes into account not only the PVR demanded, but also the operational costs that will be incurred. Again, the concession is awarded to the concessionaire that demands the lower PVR but this time will last until a determined level of net discounted income is achieved. For that reason, it is necessary to make sure that the concessionaire will receive compensation according to the operational costs declared. This method receives the name of the "least present value of net revenue".

Therefore, the PVNR awarded now introduces the operational costs (Oc) and follows the next formulation:

$$\text{PVNR} = I(1+\mu) = \sum_{t=k}^{T} [P_t Q_t - Oc_t(q)] \frac{1}{(1+r)^t} \tag{5}$$

$$I(1+\mu) = \sum_{t=1}^{T} Bc \frac{1}{(1+r)^t} \tag{6}$$

$$T = f(I, P, Q, \mu, Oc, r) \tag{7}$$

Again, the term of concession is automatically determined by the traffic received and the toll scheme established. However, in this case, the concessionaire will spend more years in achieving the level of PVR awarded because the operational costs are now subtracted from the toll revenue collected.

In fact, what both mechanisms seek is the flexibility of one of the three elements that conforms the concession in order to adjust unexpected events: prices, terms and rules. If none of these factors allows for some flexibility, renegotiations are almost inevitable in sectors with sunk investments and future unexpected demands. On the contrary, when there is some flexibility at least in one of them, the system can be adjusted through this variable mitigating the risk incurred by governments and firms and reducing the incidence of renegotiations. Since the rules are the most complex, opened and therefore, the weakest element of this triangle in practice (Fig. 1), it is worthier to liberate prices or terms as both mechanisms do.

[10] LPVR methods also present some caveats. Tirole (1997) discusses some of them. In particular he points out that under this scheme the concessionaire does not have incentives to promote demand increases. Therefore, as it is discussed in Engel et al. (2002), the mechanism is only recommended in those sectors in which demand does not respond to the actions of the concessionaire (bridges, tunnels, water reservoirs or roads).

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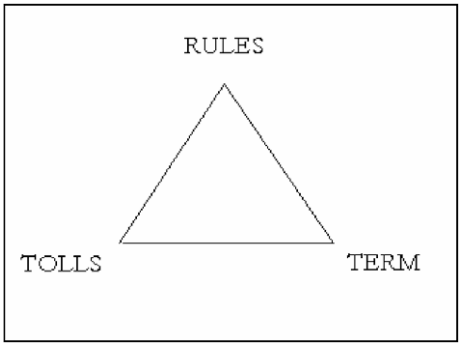

Fig. 1. Choices for changes in concessions.

3. Simulation strategy

Although the recent academic works just described support the implementation of variable term mechanisms of concession because they eliminate traffic risk and assure the most efficient winner, these have enjoyed little impact in practice. In Europe, we can find only two experiences with variable term concession contracts: the 'Second Severn' Crossing in Britain, and the Portuguese bridge 'Lusoponte'. In both cases, the term is endogenously determined but only in the British case the target variable is the total revenue accumulated.[11] However, as far as we know, only in Chile there is a well documented experience based on the LPVR approach for the toll motorway Santiago-Valparaíso and a suburban access to the city of Santiago (Góme-Lobo and Hinojosa, 2000).[12] For this case, Vasallo (2006) finds that implementing LVPR methods mitigated traffic risks and reduced renegotiation expectations during the economic recession suffered in the late nineties in Chile.

In front of the scarce experiences above mentioned and the short period of operation in the case of the Chilean roads – The "Santiago–Valparaíso" motorway and the suburban access "Acceso Nororiente a Santiago" were awarded in 1998 and 2003, respectively – it is very difficult to compare fixed term and variable term mechanisms in practice.

Nevertheless, we can use the real information on historic European toll motorways in order to compare the fixed term performance with a contra factual based on the LVRP and LVPNR models. This strategy allows for a long period of time that serves to check the most important differences on the outcome of both mechanisms.

The toll motorways chosen are the routes Montgat-Mataró and Barcelona-La Jonquera which were awarded in 1967 for a fixed period of 37 years to ACESA and represent the oldest motorways granted to the private sector in Spain. These concessions that followed a BOT contract with several favorable guarantees for the concessionaire, as it is explained in Gómez-Ibáñez and Meyer (1993), Puncel (1996), Bel (1999) and Bel and Fageda (2005), were supposed to finish at the beginning of the XXI century. However, they are still in operation thanks to several renegotiations that caused term extension until 2021 in both cases. These extensions were undertaken after a period of negotiation between the government and ACESA. In 1990, the renegotiation of the Montgat-Mataró motorway ended with a significant toll cut and the enlargement of the motorway until Palafolls (32 km.), along with the enlargement of other concessions held by ACESA. Regarding the case of the Barcelona-La Jonquera, its renegotiation arrived in 1998 in a general process of renegotiation undertaken by the government that affected several concessions and pursued selective toll cuts that were compensated not only with the length extension, but also with transfers from the budget.[13]

Since we have the available financial information disaggregated by route of ACESA for the period 1967–2000, it is possible to construct the contra factual history using this data, in particular, revenues, accumulated investment and operational costs, in order to compute the outcome in terms of years of concession under a variable term scheme like LVPR or LVPNR. Automatically this strategy allows to roughly computing the economic impact on user's welfare and the concessionaire's financial results under this flexible framework instead of the fixed term concession contract actually implemented.

We assume that the private firm was able to predict all the necessary investment required in the road under concession at the moment of the granting process (1967) and therefore, we can compute the PVR or PVNR of 1967 required to cover these costs by ACESA. Once computed this PVR/PVNR we must accumulate the present value of toll revenues and compute the year in which the firm obtains this PVR/PVNR. From that year on, the more revenues are collected, the more profit margin is obtaining the concessionaire.

The PVR is computed using the following formula and the year in which the concession terminates is determined when this PVR is bigger than the accumulated investment:

[11] In the case of "Lusoponte" the target variable is the accumulated traffic that the bridge receives and a case study on this experience is documented in Lemus et al. (2004). The Second Severn Crossing Experience can be consulted in Foice (1998).

[12] In 1998 the government awarded a PVR of 381 US$ for the building and operation of the toll motorway Santiago-Valparaíso. However, the government set a maximum term of 25 years.

[13] For a deeper understanding of the nature of these renegotiations see Bel (1999).

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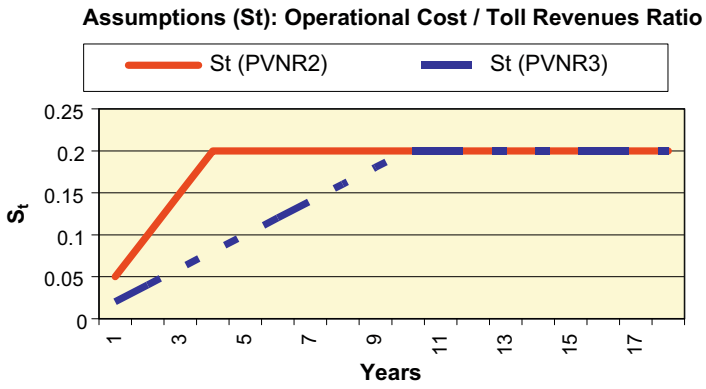

Fig. 2. Operating cost timing assumptions.

$$\mathrm{PVR}_i = \sum_{t=1}^{Ti} \frac{R_{it}}{(1+r)^t} = I_i \tag{8}$$

where R is the toll revenue obtained by ACESA in each route i and each year t. I is the total accumulated investment – this variable includes expropriations, studies and projects, assurances and general costs and finally, financial and building costs. The discounting rate used in this simulation (r) is the Spanish historic discounting rate obtained from the work by Puncel (1996) for the period 1974–1992; this discount rate is 5%. However we are going to compute the same using different discounting rates to show the stability of our results.

As stated above, the LPVR model does not consider operational costs and De Rus and Nombela (2004) showed that these costs can imply an important failure of the mechanism if they are not introduced, since demand risk would remain. For this reason, they propose the LPVNR, which subtracts operational costs from toll revenues.

In order to simulate LPVNR for the two selected motorways we need operational costs by each route and for all years. Unfortunately these costs are only available for all ACESA's routes (aggregated) not on an individual basis.

To solve this obstacle we simulate LPVNR using different assumptions on operational cost timing. Since these costs are usually close to the 20% of total toll revenues for all ACESA's concessions (aggregated), the first strategy would imply the subtraction of this percentage when computing the term of concession provided by LPVNR mechanism. This assumption is identified onwards by PVNR1:

$$\mathrm{PVNR1}_i = \sum_{t=1}^{T} \frac{R_{it} - (0.2R_{it})}{(1+r)^t} = I_i \tag{9}$$

This assumption implies that higher traffic increases maintenance cost, but this increase is considered constant and proportional to toll income during the whole concession's period. For this reason we also simulate LPVNR by assuming a different timing in this operational cost increase. In fact, it has been recognized that when it is first built the road there will be only limited maintenance required initially. The maintenance cost does not occur until the out years. For this reason we assume that the cost/revenue ratio takes an increasing and linear trend for a while – some years after the opening –, but again turns to a proportional path to traffic income, and this lasts constant until the end. We use here two different growth patterns for the first years of operation that are shown in Fig. 2. Both are linearly increasing (with different slopes) and become constant at a certain point. From that year the cost/revenue ratio keeps proportional to toll revenues (20%) until the end of the concession period (T).[14] The main difference between these new assumptions and PVNR1 in Eq. (8) is the value subtracted from toll revenues. Now, this share (S_t) can take different values according to the year of operation. Therefore, the new PVNR is computed as follows:

$$\mathrm{PVNR}_i = \sum_{t=1}^{T} \frac{R_{it} - (S_{it} \cdot R_{it})}{(1+r)^t} = I_i \tag{10}$$

where S_{it} is the percentage subtracted from toll revenues each year as operational costs. In this case, its value is not constant. It grows from a small value (small share) in the first year of operation until the 0.2 used in PVNR1 some years after the opening. Later, we also consider this 20% share as the constant ratio during the rest of the concession period. Table 1 shows the two different S_t evolving trends used, which serve to compute PVNR2 and PVNR3. As is shown in Fig. 2, PVNR2 has a more

[14] We assume a linear increase in the cost/revenue ratio in the first years of operation. Other functional forms like exponential increases do not change our main results.

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Table 1
Growth of the cost/revenue ratio (S_t) in PVNR2 and PVNR3.

t	1	2	3	4	5	6	7	8	9	10	>10
S_t (PVNR2)	0.05	0.10	0.15	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
S_t (PVNR3)	0.02	0.04	0.06	0.08	0.10	0.12	0.14	0.16	0.18	0.20	0.20

Table 2
Term determined by awarding mechanism. Montgat-Mataró.

Montgat-Mataró	$r = 0.04$	$r = 0.05$	$r = 0.06$	Barcelona- La Jonquera	$r = 0.04$	$r = 0.05$	$r = 0.06$
LPVR	19	20	21	LPVR	20	21	23
LPVNR1	20	21	23	LPVNR1	22	23	25
LPVNR2	20	21	23	LPVNR2	22	23	25
LPVNR3	20	21	22	LPVNR3	22	23	25
Fixed in 1969	37	37	37	Fixed in 1967	37	37	37

Table 3
Accumulated investment and PVNR by discounting rate. Montgat-Mataró (thousands euro).

Year	Investment	PVNR1 $r = 0.04$	PVNR1 $r = 0.05$	PVNR1 $r = 0.06$	PVNR2 $r = 0.04$	PVNR2 $r = 0.05$	PVNR2 $r = 0.06$	PVNR3 $r = 0.04$	PVNR3 $r = 0.05$	PVNR3 r = 0.06
1986	23,079	20,260	17,808	15,698	20,393	17,933	15,821	20,781	18,299	16,167
1987	23,115	23,403	20,298	17,844	23,535	20,528	17,968	23,923	20,894	18,314
1988	23,145	–	23,337	20,248	27,124	23,463	20,374	–	23,830	20,719
1989	23,367	–	–	22,959	–	–	23,080	–	–	23,425
1990	23,367[a]	–	–	25,946	–	–	26,070	–	–	–

Source: author's, using data contained in the economic yearbooks of ACESA 1967–2000.

[a] Data not available. We used the previous year accumulated investment because this is a variable that does not vary significantly from one year to another. Moreover, the project of enlargement started in 1991.

steep slope and reaches the 20% share very fast, while PVNR3 assumes a less steep slope, which provides a longer lag in getting the 20% proportional cost/revenue ratio.[15]

4. Results

Applying these formulas to data we find that the implementation of flexible term concession contracts would have reduced the term of concession in the routes Montgat-Mataró and Barcelona-La Jonquera given the traffic received and the tolls established during the period of concession studied. For both routes the term of concession would have finished in the late eighties and early nineties even allowing for a reasonable private margin over the accumulated investments. The reader can find a summary of the concession lengths determined by variable term models in Table 2 compared to the fixed term of 37 years established by the authorities in 1967.

In fact, as we show in Table 3, the PVNR would have exceeded the accumulated investment undertaken in the Montgat-Mataró motorway in 1988. This means, that the PVNR obtained by ACESA since those years would have fed the profit margin of the company until the end of its concession. In the case of the Barcelona-La Jonquera motorway, we find in Table 4 that the PVNR would have exceeded the accumulated investment in 1990. This result aforementioned is based on the use of a 5% discounting rate. However, as is shown in the same tables, the use of different discounting rates, in particular 4% and 6%, reports similar results. In fact, a discount rate as high as 10% is needed to obtain an outcome – in terms of concession period- similar to the one established by the government in 1967.

In any sensible case, the length determined by flexible term methods would have been soundly far from the fixed term of concession established in 1967 if we take into account that our result reports a term of concession between 20 and 23 years for the Montgat-Mataró motorway and between 22 and 25 years for the Barcelona-La Jonquera route. In both cases the term varies depending on the discounting rate used. Thus, there is a substantial difference between these terms determined by PVNR mechanism and the 37 years of concession established in 1967.

Also, it is interesting to point out that different assumptions on operational cost timing does not change the length of concession determined under the variable term contract. PVNR1, PVNR2 and PVNR3 provide the same concession terms – with

[15] Other S_t growth patterns, such as more or less steep increases for the first years of operation, do not change our main results.

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Table 4
Accumulated investment and PVNR by discounting rate. Barcelona-La Jonquera (thousands euro).

Year	Investment	PVNR1 $R = 0.04$	PVNR1 $r = 0.05$	PVNR1 $r = 0.06$	PVNR2 $r = 0.04$	PVNR2 $r = 0.05$	PVNR2 $r = 0.06$	PVNR3 $r = 0.04$	PVNR3 $r = 0.05$	PVNR3 $r = 0.06$
1986	1,52,176	1,13,561	99,137	86,786	1,13,752	99,323	86,967	1,15,359	1,00,831	88,383
1987	1,52,982	1,31,027	1,13,561	98,716	1,31,215	1,13,744	98,897	1,32,821	1,15,251	1,00,313
1988	1,57,718	1,50,493	1,29,482	1,11,764	1,50,682	1,29,667	1,11,946	1,52,288	1,31,174	1,13,362
1989	1,61,221	1,71,607	1,46,587	1,25,654	1,71,797	1,46,774	1,25,833	1,73,404	1,48,281	1,27,249
1990	1,61,221[a]	–	1,65,254	1,40,661	–	1,65,437	1,40,840	–	1,66,944	1,42,256
1991	1,61,221[a]	–	–	1,56,377	–	–	1,56,556	–		1,57,971
1992	1,61,221[a]	–	–	1,72,815	–	–	1,72,992	–		1,74,408

Source: author's, using data contained in the economic yearbooks of ACESA 1967–2000.
[a] Data not available. We used the previous year accumulated investment because this is a variable that does not vary significantly from. Moreover, no project of enlargement started in that route during this period.

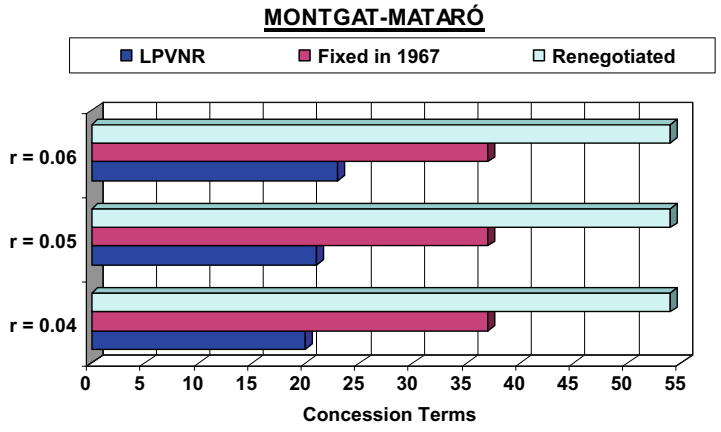

Fig. 3. Concession terms by LPVR (Montgat-Mataró).

the only exception of PVNR3 with a 6% discounting rate in the Montgat-Mataró motorway, which would have finished one year before. This result is not strange since toll revenues in the first years of operation were limited due to low traffic levels.

In Figs. 3 and 4 we graphically show a comparison between fixed and variable term methods. Although it is not fair to compare the terms derived from our analysis with the ones renegotiated – it is not the aim of this research to study and evaluate their conditions and characteristics – it is also true that both were undertaken after those years in which the PVNR would have exceeded the accumulated investments. In fact, we found that the renegotiation in the Montgat-Mataró motorway was undertaken two years after the PVNR exceeded the accumulated investment.[16] In the case of the Barcelona-La Jonquera the time gap is even longer (from 1990 to 1998). Therefore, the key comparison we want to highlight is the one between fixed and variable term mechanisms. This being said, it is also interesting to point out that the using of flexible term mechanisms would have avoided both renegotiations, if we consider that the profit margin obtained by ACESA until 1990 in the Montgat-Mataró and until 1998 in the Barcelona-La Jonquera was high enough under a variable term concession scheme.

Since we are not changing the toll setting undertaken during the period studied, the main reason that explains this reduction is the dramatic evolution of traffic enjoyed by the concessionaire. In fact, the average daily traffic (ADT) received by the Montgat-Mataro motorway was 10,393 vehicles in 1970, while in 1989 this ADT increased to 31,234. In the case of Barcelona-La Jonquera its ADT was 12,903 in 1976, year in which the whole motorway was finally constructed, while in 1991 reached the level of 27,801 vehicles. On the contrary, the average ADT for the whole toll motorways sector in Spain rose from 10,541 vehicles in 1976 to 13,999 in 1991. Thus, this increase received by the routes studied was much higher than the one experienced for the whole sector in Spain for the same period. While the demand of these motorways at the beginning of the nineties was two or even three times the demand enjoyed at the beginning of the concession, the ADT enjoyed for the whole sector did not significantly grow.

[16] This renegotiation supposed the motorway enlargement until Palafolls and toll cuts in the Montgat-Mataró concession. At the same time, other ACESA's concessions were extended.

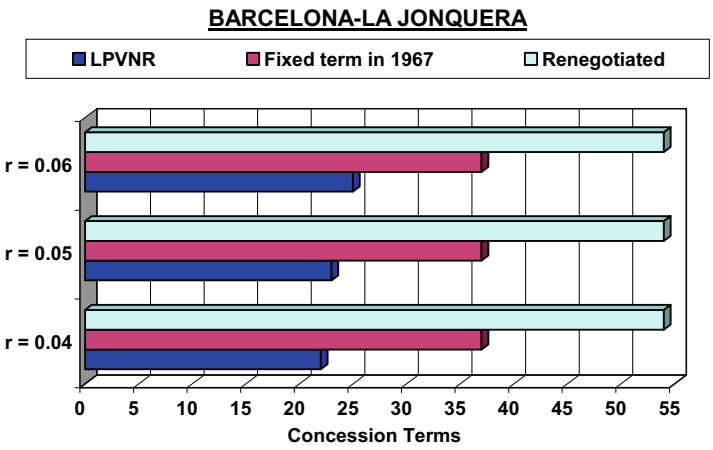

Fig. 4. Concession terms by LPVNR (Barcelona-La Jonquera).

Table 5
Toll revenue and accumulated PVNR by time interval in the Barcelona-La Jonquera (thousands euro).

Time interval	Accumulated toll revenues	%	Accumulated PVNR 1	%	Accumulated PVNR 2	%	Accumulated PVNR 3	%
1967–2000	15,57,980	100	3,75,155	100	3,75,339	100	3,76,847	100
1967–1990	4,88,875	31	1,65,253	44	1,65,437	44	1,66,944	44
1991–2000	10,69,104	69	2,09,903	56	2,09,903	56	2,09,903	56

Source: author's, using data contained in the economic yearbooks of ACESA 1967–2000.

As a result, we can show that with flexible term concession contracts we can avoid extraordinary profit margins derived from unexpected traffic increases. To justify this, we compute the accumulated level of PVR and PVNR of 1967 obtained by ACESA until 2000. As Table 5 shows, we find that the PVNR1, which is the most conservative, was more than two times the 1990s accumulated investment in the Barcelona-La Jonquera motorway (375 million euro).[17] It means a huge profit margin based on the collection of more than 1.069 million euro paid by the users between 1991 and 2000 that could be limited thanks to variable term mechanisms as we have checked above.

Therefore, these cases exemplify one of the problems derived from the establishment of a fixed length of concession. When unexpected increases of traffic appear, the firm obtains enormous profits during a continuous period of time affecting the public acceptance of the concession system and debilitating the role played by the regulation implemented by the government.

To sum up, the case study considered is a clear example of unexpected demand increases that are finally translated into user overpayments, too much private profits and as a result, a weaker acceptance of the public policy applied.

5. Concluding remarks

The growing participation of the private sector in toll motorways implies a renewed interest for regulation and for the nature of the public intervention. In fact, worldwide experiences show perverse outcomes that can be summarized in generalized renegotiations, huge public resources transferred to private firms and the establishment of favorable guarantees. In the end, these drawbacks affect the welfare of the users because they were finally assuming the traffic risk of the business incurring in overpayments or just getting damaged as taxpayers. Solving these pitfalls and assuring the best outcome from the private participation means a new and an encouraging challenge for policy makers.

Recent theoretical developments and the accurate study of some experiences assert that the rigidity of the contractual framework, in particular the fixed term of concession usually awarded, is found as the main cause of most of the problems aforementioned and suffered in infrastructure projects with huge sunk costs and uncertain demands.

The literature offers two alternative mechanisms of concession based on variable term solutions in order to avoid these drawbacks. The least present value of revenues (Engel et al., 1997) and the least present value of net revenues (De Rus and Nombela, 2004) rely on the idea that traffic risk must be internalized in the contractual framework, letting the length of the contract to be adapted depending on the traffic actually received. This means that routes with lower demands than expected

[17] It is not possible to compute the same for the Montgat-Mataró motorway because of the concession renegotiation in 1990, already explained. These changes do not allow to compare both situations as we do in the Barcelona-La Jonquera toll motorway.

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would rest under concession for a longer period until the concessionaire obtains a specific present value of revenues amount. On the contrary, when the motorway lives an unexpected traffic increase, the period of concession becomes shorter.

Since these mechanisms enjoy little impact in the real world and the scarce experiences that chose variable term contracts do not allow for a real comparison yet, we used real data from the two oldest Spanish toll motorways to compare the implementation of fixed and flexible term models. The simulation relies on the construction of a contra factual to check the performance of LPVR and LPVNR methods in those motorways. Since we had available data for toll revenues and accumulated investment for each route, it was possible to compute and determine the year in which the concession would have ended with both variable term models.

Our results show that the implementation of variable term contracts would have dramatically reduced the concession period and consequently, the user's overpayment and the company's profits. Since the routes studied suffered an unexpected and spectacular traffic increase, much higher than the one experienced by the whole Spanish toll motorways sector, it makes sense to find short concession periods between 20 and 25 years instead of the 37 years established in the initial contract.

Therefore, variable term models mitigate traffic risks and as a result, are powerful tools to improve the social welfare. Furthermore, they are also able to reinforce the public acceptance and support enjoyed by the regulation applied by the government.

Variable term models have been well established from a theoretical point of view, although its use in practice has been scarce insofar. Gathering and analyzing empirical evidence on the practical working of these models can help to increase its using in public-private partnerships.

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