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Traffic Risk Mitigation in Highway Concession Projects

The Experience of Chile

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Abstract

Traffic risk mitigation remains a challenging aspect of highway concessions. This paper evaluates three mechanisms applied in Chile to mitigate traffic risk: the 'Minimum Income Guarantee' (MIG); the 'Least Present Value of the Revenues' (LPVR); and the 'Revenue Distribution Mechanism' (RDM). Specifically, the paper focuses on the performance of LPVR and MIG during the economic recession that took place between 1998 and 2002. In the context of this recession, the paper explains the reasons that led the government to implement the RDM mechanism. The paper gives some guidelines about the applicability of these mechanisms in other countries, highlights the beneficial features of LPVR in reducing traffic risk and avoiding concession contract renegotiations, and finally provides some recommendations as to how to make LPVR more attractive to private promoters.

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1.0 Introduction

Highway privatisations around the world have been completed using concession contracts, often in the form of Build, Operate, Transfer (BOT) projects (Gómez-Ibañez, 2003). Successful BOT projects require the proper allocation of risks among the project's stakeholders. Whereas some risks — such as construction, operational or legal risk — are clearly controllable by some stakeholders, traffic risk can not be controlled by any of them. As a result, allocating traffic risk is one of the greatest challenges in designing highway concession contracts.

Chile has been a pioneer in the implementation of traffic risk mitigation mechanisms in highway concessions. The objective of this paper is to study the effectiveness of those mechanisms, particularly the 'Least Present Value of the Revenues', and to provide recommendations for its implementation in the future.

The paper is organised as follows. The first section highlights traffic forecast challenges and provides a taxonomy of the different mechanisms to mitigate traffic risk as the context for examining the Chilean experience. The second section presents a case study of the highway concessions in Chile, focusing on three mechanisms: the 'Minimum Income Guarantee' (MIG), the 'Least Present Value of the Revenues' (LPVR), and the 'Revenue Distribution Mechanism' (RDM). The third section provides lessons based on the Chilean experience.

2.0 The Extent of Traffic Risk and Mitigation Strategies

Traffic risk depends primarily on the performance of the economy, the reaction of users, and the competition with other means of transport. Thus, none of the concession stakeholders can directly mitigate the risk. Moreover, unlike other BOT projects — such as mining and oil production — in which demand risk is usually hedged through long-term purchase contracts, highway BOT traffic risk is difficult to hedge because of the large number of customers and lack of an insurance market.

2.1 Traffic risk inaccuracy

Traffic demand is very difficult to predict. Table 1 shows the results from several studies that measure the inaccuracy of traffic demand estimation. Standard and Poor's (S&P) compared first-year forecast traffic levels with actual traffic volumes for 82 projects. The results of the study showed that, during the first year, traffic volumes averaged about 76 per cent of

Table 1
Traffic Forecast Deviation Comparison in Several Studies

Study	*Projects*	*Main geographical areas studied*	*Sample size*	*Mean (real/forecast)*	*Standard deviation*
Standard & Poor's (2004)	Toll roads	North America, North Europe, Asia, South Europe, Latin America	87	0.76	0.26
Flyvbjerg *et al.* (2004)	Free roads Toll roads	Denmark, European Union	183	1.09	0.44
Vassallo (2002)	Toll roads Shadow toll roads	South Europe, Latin America	18	1.03	0.24

their predicted values, and the error — measured through the standard deviation — was 0.26 (Bain and Wilkins, 2002; Bain and Plantagie, 2004). Some data provided by Spanish concessionaires to the author report similar results in term of standard deviation although, unlike S&P data, they do not prove any bias towards underestimation. A large and recent study by Flyvbjerg *et al*. (2005) — focused primarily on free roads in Northern Europe — also reports substantial forecasting errors; the standard deviation estimated is 0.44. Unlike the S&P study, this study shows a slight bias towards underestimation.

According to these studies, traffic forecast errors for toll highways seems to be consistently in a range between 0.20 and 0.30 in terms of standard deviation. Assuming that traffic deviations are distributed according to a normal function with mean equal to 1 and standard deviation equal to 0.25, which seems reasonable according to the empirical results, 42 per cent of the toll highway projects will experience first-year traffic misestimation of more than 20 per cent. This situation is accentuated by the fact that, as mentioned by Zhao and Kockelman (2002), the further in the future the traffic forecast, the greater the inaccuracy.

2.2 Traffic risk as a cause of renegotiation

Traffic risk in highway concessions has generally been assigned to concessionaires. That fact has often prompted asymmetrical behaviour. If ultimately the traffic is higher than expected, the concessionaire will reap excess profits, whereas if the traffic is lower, the concessionaire will incur losses, and may attempt to force a renegotiation with the government. This asymmetric behaviour has occurred for instance in Spain (Izquierdo and Vassallo, 2004).

As Guasch (2004) demonstrates, concession contract renegotiations are quite common across a range of industries. This study shows that 54.7 per cent of the transport projects analysed were renegotiated, and the average time to renegotiation after award was only 3.12 years. Further, 57 per cent of the renegotiations in the transport sector were initiated by operators, 27 per cent by governments, and only 16 per cent by a common agreement between both parties. Renegotiations are generally problematic because recontracting undermines both the credibility of the concession scheme and, more broadly, trust in the government, particularly with foreign investors. Also, renegotiations encourage concessionaires to bid based on inflated traffic forecasts.

2.3 Traffic risk mitigation approaches

A range of traffic-risk mitigation approaches has been tested. Table 2 shows a taxonomy of traffic risk-sharing mechanisms. These mechanisms can be classified according to three criteria:

(1) The variable used to trigger the measures to mitigate traffic risk (trigger variable);
(2) The extent to which risk is shared; and
(3) The compensation mechanism adopted.

The trigger variable is the variable used as a reference point for initiating either the implementation of a guarantee, the modification of contract

Table 2
Classification of Traffic-Risk Mitigation Mechanisms

		Trigger Variable								
		Annual traffic or revenues			*Accumulative traffic or revenues*			*Profits/IRR*		
Risk Sharing Approach		*Min*	*Point*	*Max*	*Min*	*Point*	*Max*	*Min*	*Point*	*Max*
Compensation	Subsidy/ payment	Approach 2: Minimum Income Guarantee Korea, Chile, Colombia								
	Toll							Approach 1: Highway concessions in France and Spain		
	Contract length				Approach 3: (1) Severn Bridge (2) LPVR–RDM Chile (3) Portugal					

conditions, or a system to share gains and losses. The trigger variable can, for example, be: traffic, revenues, profits, or internal rate of return (IRR).

The second criterion in the taxonomy is the degree to which the risk is shared. One possibility is to limit traffic risk through the establishment of a fixed target goal. A second possibility is reducing the downside by establishing a minimum target goal, so that the concessionaire is compensated only when the actual target variable falls below the minimum target goal. A third possibility is to share losses and gains through the establishment of maximum and minimum targets, outside of which, at either end, sharing mechanism is initiated.

The third criterion shown in Table 2 for classifying traffic risk-sharing mechanisms is the way in which compensation is established. Three different ways are identified in this classification: a subsidy from the government, a change in the level of tolls, or a modification of contract length.

In practice, concession contracts have primarily occupied three regions of the taxonomy. The first approach, which was developed in France (Gómez-Ibañez and Meyer, 1993; Shugart, 1998) and recently adopted by Spain with some differences (Vassallo and Gallego, 2005), consist of guaranteeing the 'economic balance' of the concession, which is generally interpreted as the expected project IRR. Generally, the compensation measures to re-establish the economic balance of the contract are not pre-established, but rather negotiated when the IRR falls above or below the target levels. This compensation can include the variation of tolls, the change of the contract length, or the provision of public subsidies.

The second approach, used in Chile and in some other developing countries such as Korea and Colombia (Irwin, 2003), guarantees either traffic or revenues, and usually has both lower and upper bands to share traffic risk between the concessionaire and the government. In the case that in one year the revenues fall below the bottom band, the government will have to pay the concessionaire the difference between the revenues guaranteed and the revenues collected. If the revenues fall above the upper band, the concessionaire has to share a percentage of the extra revenues collected with the government.

The third approach, which has been adopted in several contracts recently, is to match the duration of the concession to the precise moment when the concession achieves a target variable, generally traffic or revenues. This approach was first applied in 1990 in the concession of the Second Severn Crossing in the United Kingdom. The length of the concession was pegged to a fixed target of 'Required Cumulative Real Revenue' (Foice, 1998). Thus a figure was established in 1989 prices, which, once collected from toll income, would end the concession. Another similar experience is the Lusoponte concession in Portugal, which was awarded at the end of the 1990s. The concession agreement was designed so that the concession would expire no later than March 2028 or once a total cumulative traffic flow of 2,250 million vehicles had been reached (Lemos *et al*., 2004).

A variant of this approach is the 'Least Present Value of the Revenues' mechanism (LPVR). LPVR was developed by Engel, Fischer and Galetovic (1997, 2001) in response to a proposal from an official in the Chilean Ministry of Public Works (MOP). The concession is awarded to the bidder who offers the least present value of the accumulated revenues — discounted according to a discount rate pre-fixed in the contract — and the concession ends when that LPVR had been reached. Consequently if real traffic is ultimately higher than expected, the concession will finish earlier, whereas if it is lower the concession will finish later. This mechanism has been implemented mainly in Chile. Based on the LPVR approach, there have been some proposals, inspired by this mechanism, from academics (Nombela and De Rus, 2003; Vassallo, 2004).

The LPVR approach adds two interesting points to the Severn's and Lusoponte's experiences. First, the revenues are discounted according to a discount rate that should reflect the weighted average cost of capital (WACC) of the project. Second, the LPVR requested by the bidders becomes the key economic variable in selecting the bidder that will win the tender. Beyond the risk mitigation effect, LPVR provides the government with a price to buy out the concession, a feature thought to discourage the concessionaire from renegotiation since the government can opt to buy out the concession at the established price.

3.0 The Chilean Experience

The case of highway concessions in Chile is interesting for several reasons. First, Chile has tendered many highway concessions in the last fifteen years. Second, the government during this period designed and tested several different mechanisms. Finally, an economic recession caused a slowdown in traffic growth just a few years after the beginning of the operation of the concessions, which put to the test the performance of those mechanisms.

3.1 Highway concessions in Chile

In the early 1990s Chile introduced private capital into the transport infrastructure sector by offering BOT concessions. The concessionaire was to recover its investment from tariffs paid by users, in some cases supplemented with a subsidy from the government. In 1991, this process was reinforced with the approval of a new Public Works Concession Law, which was subsequently extended and improved in 1996.

Table 3 shows the 26 highway concessions that have been successfully procured to date in Chile. Most of the interurban highway concessions were awarded between 1994 and 1998. Two features distinguish highway

Table 3

Main Characteristics of the Highways Concessions granted in Chile by Year of Award

Year of award	*Concession*	*Highway*	*Investment million US$*	*Total investment million US$*	*Main economic tender variable*
1992	Túnel del Melón	Interurban tunnel	38	38	Mix*
1994	Camino de la Madera	Interurban	26	222	Mix*
	A. Norte Concepción	Interurban	196		Tariff
1995	Santiago S. Antonio	Interurban	180	371	Tariff
	Nogales Puchancaví	Interurban	12		Tariff
	Acceso a AMB	Suburban	10		Tariff
	Talca Chillán	Interurban	169		Tariff
1996	Los Vilos Santiago	Interurban	250	648	Tariff
	Santiago Los Andes	Interurban	152		Tariff
	La Serena Los Vilos	Interurban	246		Tariff
1997	Chillán Collipulli	Interurban	241	945	Duration
	Temuco Río Bueno	Interurban	200		Upfront fee
	Río Bueno Pto. Montt	Interurban	249		Upfront fee
	Collipulli Temuco	Interurban	255		Upfront fee
1998	Santiago Talca	Interurban	575	915	Upfront fee
	Santiago Valparaíso	Interurban	340		LPVR
1999	Costanera Norte	Urban	384	384	Upfront fee
2000	Norte–Sur	Urban	442	546	Upfront fee
	Red Vial Litoral Central	Interurban	104		Subsidy
2001	Vespucio Sur	Urban	280	558	Upfront fee
	Vespucio Norte	Urban	240		Upfront fee
	Talcahuano–Penco	Suburban	19		Subsidy
	Variante de Melipilla	Suburban	19		N/A
2002	Camino Internacional Ruta 60	Interurban	180	180	N/A
2003	Acceso Nororiente a Santiago	Suburban	165	165	LPVR
2004	El Salto–Kennedy	Urban tunnel	70	70	Upfront fee

*Mix: Several economic variables are employed. N/A: Information not available.

concessions in Chile from those in other countries. First, most of the highway projects are substantial upgrades to existing roads. The typical concession contract gives the concessionaire the responsibility for widening and improving the existing road into a high performance highway, and also for the maintenance and operation of this highway during the concession term. Second, most toll highways in Chile do not have free parallel roads competing with them, since Chile is roughly 5,000 kilometres long but only 100 kilometres wide, and has a low population density. Chile is using concessions to develop both interurban and urban roads. The majority of the interurban concessions, in terms of investment volumes and kilometres of road, have been the different segments of the main north–south Pan American Highway, named Route 5. The total amount of investment in interurban highways totals more than US$ 3,400 million.

The duration of both interurban and urban concessions was generally between twenty and thirty years. Beginning in 2000, the Chilean government began to grant six new urban highway concessions in the city of Santiago. The investment in those urban projects during the last five years totalled more than US$ 1,500 million.

Concession procurement in Chile takes place in a three-stage process. The first stage is pre-qualification, to assure that bidders have both the knowledge and the resources to carry out the project. The second stage is technical evaluation of the proposals submitted by the pre-qualified bidders. The final stage is selection based on economic variables established in the bidding terms, such as tariff level, subsidy (if any) required from the State, concession term, income guarantee requested by the State, revenue offered to the State for existing infrastructure, and LPVR (Rufian, 1999).

Starting in 1998, coincident with the beginning of the operation of most of the intercity concessions, the Chilean economy faltered. GDP per capita in Chile, which had grown during the last ten years at about 7.5 per cent per year on average, declined sharply. Table 4 shows the decline in traffic on two of Chile's most heavily travelled highway concessions during this economic downturn. When traffic forecasts were carried out for most of

Table 4

Three-year Chile's GDP Growth Compared to Santiago–Talca and Santiago–Valparaiso Traffic Growth

	1989–1992 (%)	*1992–1995 (%)*	*1995–1998 (%)*	*1998–2001 (%)*	*2001–2004 (%)*
GDP Growth in real terms	7.94	7.75	5.72	2.34	3.56
AADT Growth Santiago–Talca	7.46	7.87	6.48	−0.84	2.76
AADT Growth Santiago–Valparaiso	7.20	4.54	7.64	−3.24	5.74

the interurban highway concessions (between 1992 and 1996) planners did not anticipate that, after more than a decade with annual traffic increments over 7 per cent, traffic would decline. Consequently, concessions had to cope with lower traffic levels than expected.

Chile has implemented three traffic-risk mitigation mechanisms: Minimum Income Guarantee (MIG), Least Present Value of the Revenues (LPVR), and Revenue Distribution Mechanisms (RDM). Although all three mechanisms mitigate traffic risk, there are differences between them in terms of both the extent to which they have been applied and the objective the government had with their implementation.

MIG was designed only as a way of mitigating traffic risk so that lenders would perceive less risk and as a consequence the financial cost of the project would become lower. The extent of MIG's application to the Chilean situation has been widespread, since almost all the highway concession projects have incorporated this guarantee. LPVR was not only designed as a mechanism to mitigate traffic risk, but also as a procurement mechanism detailing the terms of the regulation of the concession contracts. Unlike MIG, the application of LPVR in Chile to date has been limited; only two concessions have currently been awarded using this mechanism. RDM presents a way to mitigate traffic risk *ex-post* by means of a modification of contract terms after the 1998–2002 economic recession. At the end of 2004, six concessions had already implemented this mechanism, and many others were under renegotiation with the government.

These mechanisms are not mutually exclusive. For example, the Santiago–Valparaiso project was procured under the LPVR mechanism, and it incorporated the MIG guarantee as well. In this case, the government considered that, despite LPVR, the implementation of MIG was necessary to reduce lenders' perception of risk. Similarly, RDM is being implemented in projects that have already implemented MIG.

3.2 The minimum income guarantee

The primary mitigation mechanism used in Chile was the 'minimum income guarantee' (MIG). The total guaranteed income in present value is the same for all the bidders, and it is equal, in present value, to 70 per cent of the investment cost plus the total maintenance and operation costs estimated by the MOP. The 70 per cent figure was chosen because, as Esty (2003) shows, on average the percentage of debt in a project finance structure is 70 per cent. The mechanism was designed to allow bidders enough flexibility to establish the minimum band as long as the present value of the guaranteed revenues was no more than 70 per cent of the investment cost plus the total maintenance and operation costs. To that end, the MOP defined a range to set up the bands in the bidding terms. If the real revenues fall below the lower band in any year, the MOP will have to compensate the concessionaire for the difference between the MIG Band revenues and the real revenues at the end of that year.

If the concessionaire decided to take the MIG guarantee, it has the obligation to share part of the revenues obtained whenever real traffic is higher than expected. Two different methods have been implemented for triggering these revenue-sharing mechanisms. The first method triggers revenue-sharing when the rate of return on investment is above 15 per cent in a given year. This rate of return is estimated by the MOP according to the actual revenues and the investment and operation costs estimated initially. The second method established a symmetrical band called a 'mirror band', in such a way that if real revenues surpass this band in any year, the concessionaire has to share 50 per cent of the difference between the real revenues and the mirror band revenues with the government (Gómez-Lobo and Hinojosa, 1999).

The MIG has some important advantages. First, the traffic risk is shared, in that both unjustified profits and losses derived from uncertain traffic are avoided. Second, the debt holders will feel more comfortable because of the guarantee of part of the revenues, and consequently the financing cost of the project will be lower. This in turn will lower users' tolls.

In spite of the advantages, the MIG could be dangerous for the public sector if many concessions fail simultaneously, as might occur during a substantial economic downturn. In view of this concern, the MOP commissioned a study to address the fiscal implications derived from the implementation of the MIG in order to determine whether budgetary provisions were necessary to cover expected future payments. The study was based on a Monte Carlo simulation and concluded that the 70 per cent guarantee level was sufficiently low to avoid this problem (Gómez-Lobo and Hinojosa, 1999). This study has recurred periodically, incorporating actual information about the concessions. The last version of this study concluded that the value of all the expected cash-flows payable by the government in the form of minimum income guarantees for highway concessions, from 2004 on, totalled US$ 194 million at present value (Government of Chile, 2003). This amount represents only 3.84 per cent of the total investment involved in the highway concession programme.

The performance of the highway concessions in Chile is consistent with the MOP study findings. Almost all the road concessions procured since 1995 requested the MIG, and only two of them had performed under the bottom band at the end of 2003. The government's payout for these contracts totalled US$ 5 million (US$ 4.8 million and US$ 0.2 million for the Santiago–Los Vilos and Nogales–Puchuncaví concessions, respectively).

Despite the traffic decrease at the end of the 1990s, the total contribution from the government to the concessionaires due to MIG during the last ten years totalled less than 0.15 per cent of the toll road investment in Chile during the same period.

3.3 The LPVR mechanism

The Chilean Public Works Concession Law defined the possibility of using the sum of total revenues to be obtained by the project as the main economic variable for tendering concessions. LPVR was primarily designed as a procurement mechanism, although one of the most important consequences of LPVR was the reduction of traffic risk.

Before describing the way the LPVR approach has been applied in Chile, it is important to show the relationship between the present value of the revenues and the financial balance of a concession (equation (1)).

$$I_o - S = \sum_{i=1}^{i=n} \frac{(p_i \cdot q_i(p_i) - c_i - t_i)}{(1+\alpha)^i}, \tag{1}$$

where:

I_o: Initial investment
S: Initial subsidy provided by the government
α: Weighed average cost of capital (WACC) on the project
n: Concession term
p_i: Price for year i
$q_i(p_i)$: Actual traffic in year i depending on p_i
c_i: Operation and maintenance costs in year i
t_i: Taxes or concession fees in year i.

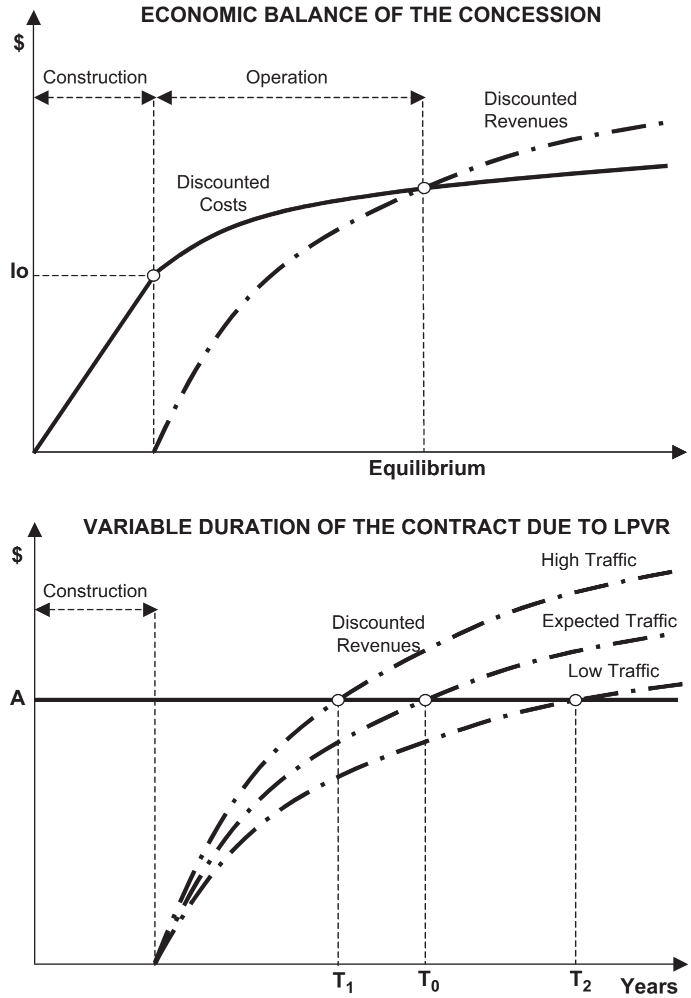
Assuming that the public authority in charge of tendering the project does not provide any subsidy at the beginning, equation (1) can be restated as:

$$I_o + \sum_{i=1}^{n} \frac{c_i + t_i}{(1+\alpha)^i} = \sum_{i=1}^{i=n} \frac{(p_i \cdot q_i(p_i))}{(1+\alpha)^i}. \tag{2}$$

The left-hand-side of the equation shows the discounted costs that the concessionaire has to bear in operating and constructing the concession, and the right-hand-side shows the revenues that the concessionaire will obtain along the contract duration. The right-hand-side of the equation reflects actual LPVR during the life of the contract. At the beginning of the concession, the left-hand-side of the equation will be much higher than the right-hand-side. However, when the operating and maintenance costs are lower than the revenues, the right-hand-side of the equation will

Figure 1

Economic Balance and Variable Duration Models of a Concession under LPVR Mechanism



grow more quickly that the left-hand-side. This is the reason why the project needs to borrow money from lenders and promoters at the beginning. The point at which the two terms of the equation are equal means that the concession has covered all its costs — according to a cost of capital equal to α. Figure 1 illustrates graphically how this condition is reached.

The auction mechanism based on the LPVR consists of granting the concession to the bidder that requires the lowest present value of the revenues to recover its costs. Supposing that the most competitive bidder — and therefore the winner — offered a net present value of the revenues equal to *A*, the concession will end when the real discounted flow of revenues reaches A. This system substantially reduces the likelihood of renegotiations in the future. If traffic is as expected, the duration of the concession will be T_0. However if the traffic is ultimately lower or higher than expected, the concession duration will be either extended or reduced. In Chile, however, the Concessions Law establishes a maximum duration of 50 years so the concession term can not be extended more than this. This fact poses the problem that if, at the end of the maximum duration, the LPVR reached is lower than the LPVR requested, the concessionaire will not be able to recover its costs.

An interesting feature of LPVR is that the discount rate can be either fixed or variable. For example, in the Santiago–Valparaiso concession, the MOP gave the bidders the choice between a fixed rate set as a risk-free rate of 6.5 per cent plus a risk premium of 4 per cent, totalling 10.5 per cent; or a variable rate established as the monthly average real risk-free rate of the financial system plus a 4 per cent risk premium.

Despite the high level of interest in the LPVR mechanism, it has been used only on a few occasions in Chile (see Table 5). The first concession using LPVR, and also the most successful, was the Santiago–Valparaiso highway (Route 68). An analysis of the procurement process of this highway can be found in Gómez-Lobo and Hinojosa (2000). Four consortia passed the technical evaluation stage. The competition for the award was fierce, and the economic offers were within a very tight range.

Table 5

Experiences in which the LPVR has been used as a Procurement Variable to Tender Highway Concession Projects in Chile

Project	*Year of tender*	*Investment*[1] *US$ million*	*PVR*[2] *US$ million*	*Maximum term (years)*	*Number of bidders*[3]	*Situation*
Santiago–Valparaiso	1998	340	381	25	4	Successfully awarded In operation
Costanera Norte	2000	384	–	30	0	Not awarded Tendered again a year later under other economic variable
Talcahuano–Penco	2001	19	–	31.5	2	Awarded No bidder arrived to the LPVR step
Acceso Nororiente	2003	165	346	40	1	Successfully awarded In construction

[1]Investment predicted by the government.
[2]Present value of the revenues offered by the granted bidder.
[3]Bidders in the last stage of the project.

The second attempt to tender a highway concession in Chile under the LPVR mechanism took place at the beginning of 1999. The highway selected was the Costanera-Norte, an urban expressway in Santiago, which joins the Northeast and the Northwest of the city passing under the downtown in a tunnel. Three factors contributed to a level of risk for this project that turned out to be much higher than previous interurban experiences. First, the construction was challenging because of both the need to construct a large tunnel below the Mapocho River so as to cross the city centre, and some unresolved environmental problems. Second, traffic risk was substantial, owing to uncertainty about the competition from other roads or means of transport in the future in the urban area. And third, the project was planned to be the first use in Chile of an electronic free-flow toll collection system scheme.

The substantial risks of the project encouraged MOP to tender this concession under the LPVR mechanism. The results of the tender, however, were disappointing. Only one consortium presented an offer and it was ultimately disqualified because the guarantee bond offered was below the level established in the bidding documents. This experience proved that the LPVR was not a magic remedy to get very risky projects off the ground without public support. In fact the project, which was re-tendered at the end of 1999 — this time not under the LPVR mechanism — was awarded without problem. This time the government committed itself to construct and finance part of the works of the project, reducing considerably the concessionaire's investment. In addition, traffic risk was reduced through establishing a minimum income guarantee band that was 25 per cent higher than usual.

The Chilean government tried LPVR again in 2001 for the Talcahuano–Penco road (Ruta Interportuaria) near the city of Concepcion. This project was much smaller in terms of investment than the two previous ones. The procurement terms of this project provided bidders the option of competing in terms of the LPVR as long as no subsidy was required from the State. However, the three bidders requested a subsidy, therefore the concession was awarded ultimately with a subsidy and LPVR was not used.

The last concession procured in Chile under LPVR was the 'Acceso Nor Oriente a Santiago' in 2003. This project is a suburban highway that provides easier access from the highways coming from the north of the country to the wealthy neighbourhoods in East Santiago. Although the concession was awarded, only one bidder responded. Like Costanera Norte, this project was extremely risky. The uncertainty was reflected in a high (more than twice the investment of the project) LPVR requested.

3.4 The RDM mechanism

The problems of many concessionaires as a consequence of the economic recession in Chile combined with the need for additional investment in many of the highway projects moved the government to introduce a new mechanism in order to modify the original contracts. This mechanism was called 'Revenue Distribution Mechanism' (RDM). RDM guarantees that a pre-fixed amount of revenues — in present value — will be received by the concessionaire. Thus the duration of the renegotiated concession turns from being fixed to being variable.

The government expected that the average annual traffic growth would remain at around 3.5 per cent for most of the concession contracts at the time the RDM was considered. The government gave three alternatives to the concessionaires in terms of the present value of the revenues to be guaranteed. Those three alternatives were established in terms of an average annual traffic growth of 4, 4.5, and 5 per cent respectively. Three reasons explain why the government adopted those values. First, the government decided to guarantee an amount of revenues in present value higher than the revenues forecast so as to take advantage of RDM to require additional investments upfront from the concessionaires. Second, the government decided not to guarantee an average annual traffic growth much higher than the one predicted so as to avoid a long extension of the length of the contract. Third, the government wanted to give flexibility to the concessionaires by offering them several different alternatives.

In exchange for the guarantee of extra revenues, the government required the concessionaire to carry out initial investments, which were calculated by the government as the difference between the present value of the revenues guaranteed and the present value of the revenues expected. Thus, the higher the traffic growth guaranteed, the higher will be the amount of upfront investment to be implemented by the concessionaire. The main innovation of this mechanism is that the term of the concession contract changed from fixed to variable and is therefore similar to LPVR, since the contract will expire as soon as the concessionaire has collected the revenues guaranteed in present value.

RDM causes the concession to finish earlier if average traffic growth is ultimately higher than the guaranteed level. If that happens, the concessionaire will ultimately fare worse than it would have done if it had not obtained the RDM guarantee. If the average traffic growth is ultimately the same as the guaranteed level, the concession will end in the year initially fixed. If the average traffic growth turns out ultimately to be as forecast, the concession contract will expire some years later than the term originally established in the contract.

Figure 2
RDM Mechanism

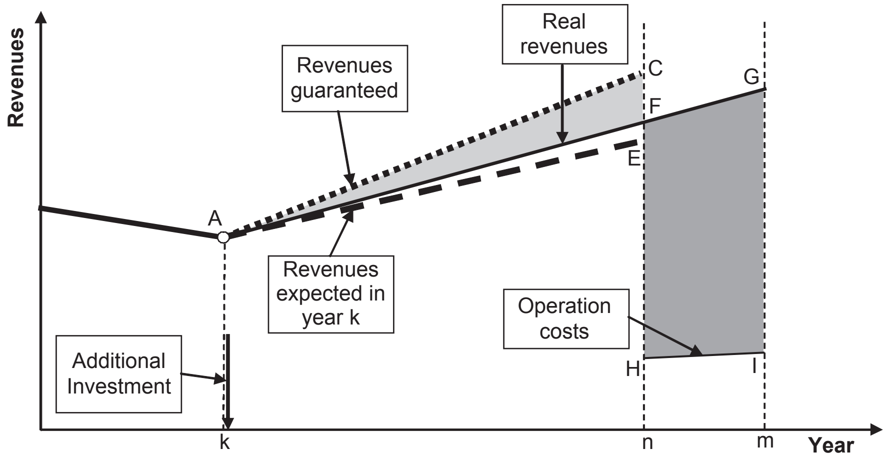


Figure 2 sketches how RDM works. Year *k* is the year in which the redefinition of the contract terms takes place. Traffic forecasts from this year on are represented by the long-stroke broken line AE. The short-stroke broken line AC represents the average traffic guaranteed — 4, 4.5, or 5 per cent according to the selection of the concessionaire. In compensation for the extra-revenues guaranteed, the concessionaire has to carry out additional investments in year *k*. These investments will be equal to the area ACE (dotted area) in present value. If, for instance, the real traffic level follows the way of the AF line, the duration of the concession contract will be extended until year *m*, in which the present value of the revenues agreed would be reached. According to the characteristics of the RDM the area FGHI in present value should be equal to the area ECF in present value.

There are three main differences between LPVR and RDM. First, under LPVR there is a competition to offer the lowest LPVR, whereas under RDM there is no competition. In this case the government offers several alternatives that can be taken or rejected by the concessionaire. Second, unlike LPVR, under RDM the public sector has a choice of obligation: whether to extend the concession contract until the present value is reached or to compensate the concessionaire for the remaining LPVR. In other words, the concessionaire will be certain to receive the whole revenues guaranteed in present value. Third, under RDM once the initial duration of the contract has been reached, the revenues calculated in order to determine the end of the concession are net revenues (revenues minus costs). The last two differences between LPVR and RDM imply that, unlike LPVR, RDM does not transfer any downside risk to the concessionaire.

The additional investments required by RDM have to be approved by the MOP. The amount of these investments in the year envisaged for their realisation — year k — is fixed by the MOP according to equation (3):

$$AI_k = \sum_{i=k}^{i=n} \frac{RG_i - RE_i}{(1+\theta)^{i-k}}, \tag{3}$$

where:

AI_k: Additional investment required in year k
θ: Discount rate equal to the cost of capital (9.5 per cent annually)
RE_i: Revenues expected in year i calculated by the government
RG_i: Revenues guaranteed in year i.

The discount rate adopted was fixed by the MOP as 9.5 per cent annually, according to the MOP's estimations of the weighted average cost of capital based on previous tenders. In principle, if the guarantee was correctly priced, concessionaires should be indifferent as to whether to buy this guarantee, or to choose any of the three guarantee alternatives offered. However, almost all the concessionaires so far have shown an interest in purchasing the guarantee, and all of them have chosen the highest one (average annual growth equal to 5 per cent). That issue seems to show that actually the discount rate adopted by the government to calculate the present value of the revenues (equal to 9.5 per cent) was higher than the real discount rate as perceived by the companies.

An explanation for that difference could be that the Chilean Government did not take into account the fact that the discount rate (weighted average cost of capital) to be applied to the RDM should be lower than the discount rate before the project has been constructed. Two reasons justify that fact. First, as the project has already been constructed, the uncertainty regarding construction costs and traffic generation is much reduced. Second, the modification of the contract from fixed to variable length substantially reduces the risk of the project and consequently the discount rate to be adopted.

The latter reason can be regarded in another way. The RDM guarantees a certain amount of revenue, which includes both the expected revenues and some additional revenues. The additional investment in compensation for the additional revenues is estimated as the present value of the additional revenues discounted at a rate of 9.5 per cent. However, that does not take into account that the risk of the whole project has substantially diminished since the expected revenues are in fact guaranteed. This approach is undoubtedly one of the main reasons why the RDM mechanism became so popular among concessionaires and why all of them chose the highest guarantee.

RDM is not a substitute for the 'Minimum Income Guarantee' (MIG). MIG has the role of providing security to lenders and reducing the financial cost of the project, while RDM has the role of mitigating shareholders' traffic risk. The revenues adopted by RDM in order to calculate the present value that will eventually determine the end of the concession contract are the revenues that the concessionaire actually collects no matter where they come from. For instance, it could happen that, after the RDM has been implemented, the traffic growth greatly increased and, according to the MIG approach, the concessionaire should share with the government part of those extra-revenues collected above the upper band. In that case, the concessionaire should pay to the government the amount of money that the MIG approach establishes for the corresponding year. However, the revenues paid to the government are not taken into account in estimating the present value of the revenues that will eventually determine the end of the concession contract. The revenues that are to be calculated for that purpose are the revenues actually received by the company.

Table 6 shows the highway concessions where the concessionaire has already purchased the RDM. Between 1994 and 1998 fourteen highway concessions were awarded in Chile. By the beginning of 2005 six highway concessionaires had purchased the RDM mechanism and many other concessionaires were negotiating with the MOP in order to acquire the guarantee. The RDM guarantee has been used by some of the concessionaires as collateral for new bonds to finance the additional highways investment required by the RDM. For instance, the Santiago–Talca highway — the largest project using the RDM guarantee — issued a new bond in 2004 to finance both a second phase of the project and the additional works required by the RDM.

Table 6

Characteristics of the Highway Concessions which have already purchased the RDM in Chile

Project	*Year concession awarded*	*First year of operation*	*Initial duration (years)*	*Premium (US$ million)*	*Initial investment (US$ million)*
Camino de la Madera	1994	1996	25	3.06	26
Camino Nogales Puchuncaví	1995	1997	22	1.47	12
Ruta 5 Tramo Talca–Chillán	1995	1998	10	29.00	169
Ruta 5 Tramo Chillán–Collipulli	1997	2001	22	19.89	241
Ruta 5 Tramo Collipulli–Temuco	1997	2002	25	25.23	255
Ruta 5 Tramo Santiago–Talca	1998	2002	25	73.73	575

3.5 The consequences of the 1998–2002 recession

Chile's economic recession from 1998 to 2002 provides an opportunity to assess the performance of traffic and income guarantees under lower-than-projected traffic volumes. Although the recession caused economic growth to be lower than predicted, Chile's recession is not comparable to other huge recessions experienced in Latin America, which reduced GDP by more than 10 per cent in a year (that is, Argentina 2002, Venezuela 2003, Mexico 1995). The recession affected the shareholders more than the lenders, since the payback of the loans was largely covered by MIG. The concession shareholders attempted to renegotiate the contract terms based on an article of the Chilean Concession Law that permits the economic terms of the concession to be modified in case of unpredictable circumstances. The Ministry of Public Works rejected this approach on the grounds that the concessionaires' traffic risk was mitigated through the MIG, and because the Chilean concession model clearly defined traffic risk as a risk to be held by the concessionaire, regardless of any guarantees that could be applicable according to the law.

At the same time that the concessionaires were arguing for renegotiation, the MOP realised that additional investments would be necessary in most of the highway concession projects. Some designs of earlier concessions were now thought to be inadequate (poor connections to the local network, safety problems, and so on). A common problem was that additional pedestrian and road bridges were needed to provide access all along the highway.

This is the reason why the MOP decided to apply the RDM guarantee. The MOP permitted the possibility of obtaining this guarantee to all the highway concessions that were awarded before 2000. The sole exception was the Santiago–Valparaiso concession, which was the only highway project then in operation that had been tendered under the LPVR mechanism. This is an interesting demonstration that LPVR performed very well in terms of traffic risk mitigation, since it is the only concession that neither the government nor the concessionaire tried to renegotiate.

4.0 Lessons from the Chilean Experience

LPVR is conceptually very attractive for several reasons. First, a variable term is a highly effective compensation method that neither commits public resources nor entails tariff increases. Second, LPVR sets up a clear buy-out price. And third, LPVR reduces renegotiation expectations so the bidders have less incentive to inflate their offers. However, among the 26 road projects that were granted in Chile during the last decade, only four were tendered, and only two were successfully awarded under this approach.

In a set of interviews conducted by the author in Chile, all the stakeholders — the MOP, the concessionaires, university professors, and so on — point to the strong opposition from concessionaires as the main reason limiting the application of LPVR. Concessionaires' concerns about LPVR are threefold. First, LPVR does not improve the capacity of the project to fulfill its commitments to the lenders every year. Second, the variable length of the contract makes the concession operation difficult to organise since resource planning cannot be programmed in advance. Finally, LPVR always limits the upside profitability of the concessionaire but not always the downside, so the mechanism is not symmetric.

Chile's experience suggests that the first two criticisms are not a major concern. Regarding the first criticism, the Santiago–Valparaiso highway bond issued in 2002 was the largest and least expensive infrastructure bond issued in Chile until then. Due to the variability of the concession term, the bond was structured with a mechanism of mandatory prepayment. Regarding the operational organisation and resource planning, the Santiago–Valparaiso experience demonstrates that information about actual traffic during the concession facilitates the prediction of when the contract will end. Thus there is ample time for resource planning. Moreover, the organisation of the concession operation under a variable term approach was ultimately not as complicated as expected.

The third criticism — an asymmetrical risk profile — is of concern. As Brealey, Cooper, and Habib (1996) assert, private shareholders are interested in the upside of the project. This is easy to understand since, as concession projects are usually highly leveraged, the sponsors expect a large upside that compensates for the possibility of losing all their capital. Concessionaires are also interested in avoiding the downside because this way the lenders perceive lower risk, permitting the concessionaires to enjoy the benefits stemming from higher leverage and lower interest rates.

The risk profile drawn by LPVR is the opposite of the concessionaire desires described above. On the one hand, the upside is almost non-existent. On the other hand, as a maximum duration is established in the concession contract, the concessionaire bears the risk that the project will not reach the LPVR requested at the maximum term. This is the reason why promoters regard this mechanism as asymmetrical. This asymmetry was already pointed out by Gómez-Ibañez (2003) who mentions that whereas the government has a call option on the project for the remaining present value of the contract, the concessionaire does not have a put option whereby it can sell the project to the government at the end of the contract in exchange for the present value remaining.

The duration constraint problem is difficult to solve with an extension of the concession contract duration. First, the maximum duration is limited by the Concession Law so it is not legally possible to establish concession durations longer than 50 years in Chile. Second, even if there was not a duration limit, it would not seem appropriate to establish very long durations since the longer the duration the more difficult it is to specify complete contracts. An interesting approach to solving this problem is the one developed by RDM. This mechanism forces the government to pay the LPVR left at the end or extend the concession until the LPVR requested is ultimately reached. In this extension, the government can modify the contract with the concessionaire to adapt the new environmental and technological requirements.

Three lessons can be highlighted from Chile's experience. The first lesson is that establishing a mechanism, such as LPVR, to mitigate traffic risk based on extending or reducing the concession length has been demonstrated to work quite well with the caveat that the risk profile drawn by it was not well-regarded by private promoters. Moreover, LPVR has proved effective in reducing renegotiation expectations. In fact, as a result of the 1998–2002 economic recession, the LPVR-based Santiago–Valparaiso concession was the only one where the government did not allow the possibility of reopening renegotiation.

The second lesson is that, unlike LPVR, the establishment of a mechanism like MIG does not reduce renegotiation pressures from promoters when the traffic is lower than expected. Moreover, although this mechanism behaved reasonably well in Chile during the 1998–2002 economic crisis, such a crisis was very small compared to the economic crises suffered by other developing countries in the last few decades. This fact suggests that, in spite of the good performance of MIG in Chile, it still transfers an important risk because of the important correlation between traffic and economic growth. This point can be a serious problem for the implementation of this mechanism in unstable economies.

The third lesson is that, although the risk profile of this mechanism was not initially attractive for private investors, the mechanism seems to become more attractive when the downside risk is limited. This lesson, however, has to be approached carefully. Chilean concessionaires assert that they positively respond to a mechanism, such as RDM, in which the downside risk is eliminated. Yet the success of RDM among concessionaires seems to be motivated not only by this factor, but also by an overestimation of the discount rate.

These lessons suggest that LPVR is a very attractive mechanism for procuring highway concessions and limiting traffic risk. However, from experience so far, two measures can be suggested that can help to improve concessionaires' perception on LPVR. First, there is a need to implement a limit on the downside risk. Second, it is necessary to establish a minimum concession duration in such a way that the concessionaire will enjoy an upside if the traffic is higher than expected.

Since to date LPVR has been implemented only in highway concessions, it would be useful to devote future research to studying the applicability of LPVR to demand-risk mitigation in other infrastructure facilities — such as railroads, ports, airports, water and sewage facilities, and so on — and even to long-term service contracts.

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