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Analysis of revenues, costs and average costs of highway concessions in Chile

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Abstract

In this document we present an analysis of the revenues generated, the total costs and average costs incurred by Chile's highway concessionaires between the years of 1995 and 2014. We have collected financial data from the Chilean Assets and Insurances Authority's website, and with this data, we have determined that the highway concessions system (as a whole) generated revenues of around 18,573 million dollars and incurred total costs of 15,455 million dollars during this period. Therefore, they have gained a profit of 3,118 million dollars. Moreover, the accumulated investment by 2014 was approximately 12,000 million dollars and, therefore, the capital revenue was 26%. However, since the concessionaires' capital structure, in general, considers 20% as equity and 80% as debt, then the equity's return rate could have been over 100%. Additionally, we estimated the average costs (unitary costs), and found that this industry presents natural monopoly characteristics because its average cost decreases as vehicle flow increases. Furthermore, we compared the average costs of main concessionaires with their weighted average fares and discovered that some of fares are over valuated between 30 and 330%.

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Keywords: Highways; Concessions; Public Private Partnership; Highway Costs.

1. Introduction

After The Melon Tunnel was contracted in 1995, a further 32 road projects were introduced in Chile. This has allowed Chile to improve its highway system, reduce its inland logistics cost and reduce the travel time in urban zones, thus increasing productivity and improving the standard of living.

By 2014, the amount of total investment allocated by private companies to road concession projects was just over than 12.000 million dollars, with 63% of this sum corresponding to interurban projects and 37% to urban highways.

The highway concessions system plays an important role in the lives of the Chilean people, since they use these highways as a way to reach destinations and to carry out social or productive activities. For these reasons, the length of travel time, cost of fares, safety levels, and the quality of other such services provided by the system are important.

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However, in Chile, travel time and fares have increased constantly throughout the years, and this has been the main focus of claims and complaints from users who perceive high levels of congestion on the roads (increment in travel time) and higher fares.

Since we realized that the cost of fares must be directly related to the producer's revenues and costs, we decided to research the total revenues, total costs and average costs of the Chile's highway concession system. Our objective is to explore the evolution of revenues and costs and to determine the approximate gap between average cost of main highway concessions that form the system and the average fare paid by users in 2014.

In order to achieve this, we collected the financial information of the highway concessionaire companies from the Chilean Assets and Insurances Authority's website (www.svs.cl). We then constructed a database with the revenues and costs of 33 companies between 1995 and 2014, which allowed us to do an aggregated analysis and determine the gap between the fares paid by system users and the average costs for main system players.

This document is organized as follows. In section 2, we present a review of the related literature associated with highway concessions, the key indexes to express the output provided by highways and the regulation process about concessions. Section 3, presents the methodology used in this research. In section 4, we present the aggregated analysis of revenues and costs incurred by highway concessionaires. Section 5, presents an analysis of concessionaire output and the estimation of average costs for Chile's highway concessions. Section 6, details a comparison between system average fares and average costs for main players. Finally, in section 7 we establish the main conclusions of the analysis.

2. Review of related literature

Infrastructure concessions fall into the literature field of Public Private Partnerships (PPP), a financial mechanism that allows the State to save funds in infrastructure, by contracting private companies to make the investment and then paying them for having built the road and thereafter for operating it. In this context, by means of public tenders the State and a company sign a contract that establishes the conditions for building and operating the highway. The private company must finance the public work construction and after that, it can operate it and charge the travelers who use the highway by means of a fare for a period of time (World Bank, 2016; Coordinación de Concesiones, 2016).

The use of PPP has spread across the world since the 1990s. According to an estimation by Gatti (2013), based on World Bank statistics, the main regions that have used this mechanism are: South America and the Caribbean, Asia and Central Europe. Some South American countries have been able to increase their public works budget through the use of PPP because of privatization policies launched in the 1990s. The main focuses of PPP are economic sectors like energy, telecommunications and transport.

In the area of transport, PPP has allowed countries like Chile to improve the standard of its highway system by means of public work concessions. In microeconomics literature, a concession highway must be considered a natural monopoly (Engel et al, 2014; Mankiw, 2002), since it allows concessionaires to discriminate between those who can pay and those who cannot. Given this, the highway could not be classed as a public good.

Additionally, natural monopolies are associated with high investment costs (fixed costs) and, therefore, their average costs decrease as the product increases. That is, they have decreasing unitary costs (Frank, 1992). Thus, natural monopolies have scale economies and, therefore, their marginal costs are lower than their average costs. For this reason, it becomes necessary to regulate their revenues or fares. This kind of monopoly classification would be a sufficient condition in a single output context over a wide range of the output, according to Joskow (2006). However, highways concessionaries' output might be multiple and additional conditions should be verified.

In order to launch a highway concession contract within a PPP context, the financial and administrative organization of private companies must start a new company denominated as Special Purpose Vehicle (SPV), whose one and only objective is to run the business which will construct and operate the new highway. To that end, the SPV acts as a sponsor for the project. The SPV ought to obtain financing and will also have to sign several contracts with building and highway operating companies (Engel et al, 2014).

According to Yescombe (2002) SPVs are high debt businesses, since, in general, they have debt to equity rates ranging from 70 to 90% because infrastructure projects require high investment. Therefore, the equity from sponsors must be complemented with debt. In these cases, Gatti (2013) says the infrastructure acts as collateral for financiers and that the debt must be repaid with the money flow generated by the project once in operation. In highway projects,

said money flow would be generated by the fares paid by the users. Consequently, after the debt (along with any interest) and the operational costs were paid, the SPV might pay dividends.

Engel et al (2014), mention that the money flow of a concession system over time consists in high investment at the beginning of the process, which finances the highway construction period, throughout years 3 to 5 of the project. After that, once the works begins to operate, the SPV incurs operational, maintenance and financing costs, along with dividends.

With respect to the cost analysis (total and average costs), many of the authors of papers relating to infrastructure projects measure the costs using output indexes related to kilometers, kilometers-lane or vehicle-kilometers per year. For example, Collier et al (2013), in the context of infrastructure financed by the State, use a database with more than 300 unitary costs, measured as cost per kilometer in developing countries. This technique aims to estimate a unitary cost function that depends on labor and capital (as inputs) and highway length (as output).

In the same way, the African Development Bank (2014) with the objective of forming a large unitary costs database from projects launched between 2000 and 2010, ordered research that collected this similar information from 112 launched projects in 29 African countries. The costs were measured using kilometers-lane. This research also determined that the unitary cost of construction or repaving decreases as the kilometer-lane increases.

Additionally, Schneiderova et al (2014) show that highway building prices in the Czech Republic have increased around 30%, unlike general building prices, which have decreased. Besides that, they show the main costs in this type of project are design, land and construction. Specifically, they estimated unitary cost by kilometer and lane-kilometer, and demonstrated that the unitary cost of construction is 88% over the unitary total cost.

In Italy, Massiani and Regazzi (2008) instead chose to determine operational cost estimations for highway concessionaires using data from 2006, which measures cost in vehicle-kilometer. In Germany, Link (2006), in the context of the UNITE project (UNIfication of accounts and marginal costs for Transport Efficiency), estimated infrastructure marginal costs for trucks, measure in kilometers-truck. In the same way, the consultant company Ce Deflt (2008), compared revenues and costs for several highways in Europe, as requested by the DG Tren European Commission, and they also determined the average cost for trucks measured in vehicle-kilometer.

Lastly, regarding fares and revenues regulations in a natural monopoly context where the average cost curve decreases, microeconomic literature suggests two kinds of regulations (Varian, 2010; Frank, 1992). Firstly, it proposes setting the fare according to the average or marginal cost incurred by the monopoly. Another alternative suggests setting the capital revenue rate in such a way that the monopoly's profits are fixed. With regard to the production scale, Frank (1992) says that in a natural monopoly context, the company with the greatest share of the market might remove its competitors from the market, and for this reason, we think a hard regulation would be necessary within an infrastructure context.

To summarize the literature related to highway concessions, it is possible to conclude that concessions can be defined as projects financed mainly by PPP, in which the sponsor company is created for the sole purpose of launching and operating the works, with high levels of debt (70-90%) and low levels of equity (10-30%). With regard to the costs, the output has been measured in kilometer-lane, vehicle-kilometer and kilometers; terms which have been found in several projects. Microeconomic literature recommends two alternatives for regulating natural monopolies. These alternatives are setting fares using the average or marginal cost, or establishing a capital revenue rate. Finally, regulators must be careful in a natural monopoly context because companies who have a greater market share might eliminate the others competitors due to the advantage of scale economies.

3. Methodology

The methodology that was used to carry out this research involved identifying all the concession highway projects, whether urban or interurban, that were under construction, in the operations stage or had finished their concession period. Using these criteria, we found 33 highway projects to analyze. Table1 shows these projects with the concessionaire's name, the project name, the type of concession and the total current investment disbursed until 2014.

Table 1. Chile's Highway Concessions under Analysis.

	Concessionaire			
Number	**Name**	**Project Name**	**Type**	**Investment (million dollars)**
1	Sociedad Concesionaria Autopista Del Sol S.A.	Ruta 78 Santiago-San Antonio	Interurban	271
2	Sociedad Concesionaria Autopista Del Itata S.A.	Acceso Norte a Concepción	Interurban	300
3	Sociedad Concesionaria Autopista Del Aconcagua S.A.	Ruta 5 Tramo Santiago-Los Vilos	Interurban	602
4	Sociedad Concesionaria Autopista Los Libertadores S.A.	Ruta 57 Santiago-Colina-Los Andes	Interurban	194
5	Sociedad Concesionaria Del Elqui S.A.	Ruta 5 Tramo Los Vilos-La Serena	Interurban	387
6	Ruta Del Bosque Sociedad Concesionaria S.A	Ruta 5 Tramo Chillán-Collipulli	Interurban	417
7	Ruta De Los Rios Sociedad Concesionaria S.A.	Ruta 5 Tramo Temuco-Río Bueno	Interurban	345
8	Sociedad Concesionaria De Los Lagos S.A.	Ruta 5 Tramo Río Bueno-Puerto Montt	Interurban	399
9	Ruta De La Araucania Sociedad Concesionaria S.A.	Ruta 5 Tramo Collipulli-Temuco	Interurban	508
10	Sociedad Concesionaria Rutas Del Pacifico S.A.	Ruta 68 Santiago-Valparaíso-Viña del Mar	Interurban	673
11	Ruta Del Maipo Sociedad Concesionaria S.A.	Ruta 5 Tramo Santiago – Talca y Acceso Sur a Santiago	Interurban	1,357
12	Sociedad Concesionaria Litoral Central S.A.	Red Vial Litoral Central	Interurban	162
13	Sociedad Concesionaria Autopista Interportuaria S.A.	Ruta Interportuaria Talcahuano-Penco	Interurban	41
14	Sociedad Concesionaria Melipilla S.A.	Variante Melipilla	Interurban	40
15	Sociedad Concesionaria Autopista De Los Andes S.A.	Camino Internacional Ruta 60 CH	Interurban	350
16	Sociedad Concesionaria Acciona Concesiones Ruta 160 S.A.	Ruta 160 Tramo Coronel - Tres Pinos	Interurban	315
17	Sociedad Concesionaria Valles Del Desierto S.A.	Ruta 5 Tramo Vallenar – Caldera	Interurban	282
18	Sociedad Concesionaria Autopistas De Antofagasta S.A.	Autopistas de la Región de Antofagasta	Interurban	322
19	Sociedad Concesionaria Rutas Del Desierto S.A.	Alternativas de Acceso a Iquique	Interurban	166
20	Sociedad Concesionaria Valles Del Bio Bio S.A.	Autopista Concepción Cabrero	Interurban	227
21	Ruta Del Maule Sociedad Concesionaria S.A.	Ruta 5 Tramo Talca-Chillán	Interurban	355
22	Ruta Concesionaria Ruta Del Canal S.A.	Ruta 5 Tramo Puerto Montt – Pargua	Interurban	211
23	Sociedad Concesionaria Camino Nogales Puchuncavi S.A.	Camino Nogales-Puchuncaví	Interurban	19
24	Tunel El Melón	Tunel El Melón	Interurban	70
25	Sociedad Concesionaria Camino De La Madera S.A.	Camino de la Madera	Interurban	48
26	Sociedad Concesionaria Autopista Central S.A.	Sistema Norte-Sur	Urban	1,240
27	Sociedad Concesionaria Autopista Vespucio Sur S.A.	Sistema Américo Vespucio Sur, Ruta 78-Av. Grecia	Urban	924
28	Sociedad Concesionaria Vespucio Norte Express S.A.	Sistema Américo Vespucio Nor-Poniente, Av. El Salto-Ruta 78	Urban	951
29	Sociedad Concesionaria Autopista Nororiente S.A.	Acceso Nor-Oriente a Santiago	Urban	321

30	Sociedad Concesionaria Tunel San Cristobal S.A.	Variante Vespucio El Salto-Kennedy	Urban	179
31	Sociedad Concesionaria Costanera Norte S.A.	Sistema Oriente-Poniente	Urban	1,016
32	Sociedad Concesionaria AMB S.A.	Acceso Vial Aeropuerto Arturo Merino Benitez	Urban	30
33	Sociedad Concesionaria Aerovias S.A.	Acceso Vial Aeropuerto Arturo Merino Benitez (R)	Urban	30
	Total Investment			**12,752**

After that, we examined the financial reports on the Assets and Insurances Authority's website and gathered the revenues and costs for each company between 1995 and 2014. In each case, we took data related to operational and financial behavior.

Similarly, data related to vehicle flows and road characteristics of each concession was also collected from the company financial reports. Using all of the above, we constructed a database that contains 406 rows (data) by year of operation for each company and 75 columns (fields) with information organized by revenues, costs and other criteria such as vehicle flows, investment, road length, type of concession and main shareholders.

Specifically, revenues were disaggregated by financial revenues, fare revenues and other revenues. In the same way, costs were disaggregated by operational costs, depreciation, financial costs, taxes and other costs. Inside the category of operational costs we included sale costs, salaries, administration and others costs by nature. It is, however, important to notice that financial costs were mainly related to the pay of debt.

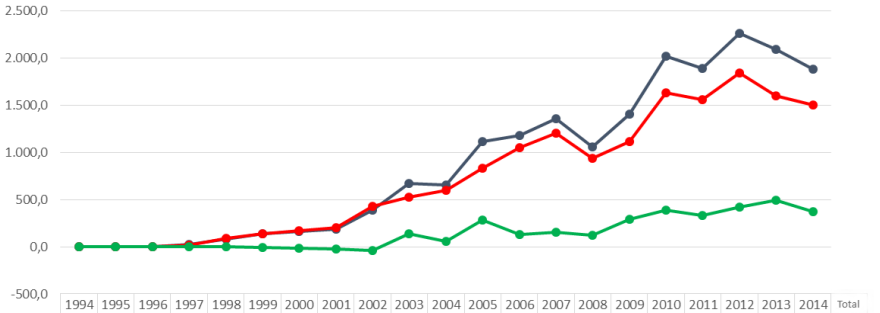
All revenue and cost figures were updated using Chile's Consumer Price Index (CPI), in order to use 2014 currency figures for estimations.

Ultimately, we have to note that it was not possible to find the necessary information about the Sociedad Aerovias' vehicle flows because after the concession project was launched it was bought by the Concesionaria AMB company for which effectively exist financial records on the Insurances and Assets Authority's website.

4. Revenues and costs analysis of Chile's highway concessions system

In this section, we present an aggregated analysis of revenues and costs of highway concessionaires between 1995 and 2014. This analysis considers the whole system and is disaggregated by concession type.

Fig1 shows the evolution of revenues and total costs of the concession system and demonstrates that both have increased over the years.



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Revenues (Million dollars)	0,2	2	2	23	85	135	160	183	388	667	657	1.118	1.179	1.358	1.061	1.406	2.019	1.893	2.261	2.094	1.881	18.574
Costs (Million dollars)	0,1	0,01	2	19	87	141	174	205	425	528	601	836	1.047	1.203	938	1.116	1.629	1.557	1.842	1.600	1.506	15.456
Profits (Million dollars)	0,1	2	0	3	-2	-7	-13	-22	-37	138	56	283	133	155	123	290	391	335	419	494	375	3.118

Fig. 1. Evolution of revenues, costs and profits of Chile's highway concessions. Source: Elaborated by the authors based on financial reports downloaded from the Assets and Insurances Authority's website

At the beginning profits were small. In fact, the system mainly experienced losses until 2002. Nevertheless, after 2002, capital gain almost triplicated, increasing from 138 million dollars, in 2003, to 375 million dollars, in 2014. In

that time period, both revenues and costs showed a similar behavior pattern; that is, if one increases, the other also increases, with the exception of the years 2004 and 2006 when they demonstrated opposing behaviors.

Therefore, the above information shows that, the total accumulated revenue of the concession system in the given time period was 18,574 million dollars. However, the total costs also rose to 15,456 million dollars, thus making an accumulated profit of 3,118 million dollars during the period under analysis. This figure represents a return of investment equal to 25% of a total investment of 12,752 million dollars as presented in table 1. However, if we consider only the equity disbursed by concessionaires, then the return of equity could increase to up to 100%. This is because concession contracts, in general, only require an equity less than or equal to 20% of the total investment from concessionaires.

It is important to notice that the aforementioned capital gain might finance around of 30% of the new concession works portfolio announced by President Bachelet in 2014. Inside this portfolio, the government plans to launch projects to construct highways, cable cars, civic buildings, dams, airports and logistics centers. Furthermore, if we compare this capital gain with the Ministry of Public Works' budget, it is slightly less than the amount spent annually by the Ministry as social investment, particularly since 2009 onward.

If the analysis considers the type of highway, then the interurban system has accumulated revenues of around 13,485 million dollars, between 1995 and 2014, and the urban system has generated revenues of around 5,090 million dollars since 2000.

Between 1994 and 1999, only interurban highways were in operation, and for that reason only they contributed to the total system revenues. After 1999, the urban system was launched and both types of highways began to collect fares from users. However, after 2006, when 3 out of 7 urban highways had started operations, both systems begin to share revenues. Approximately 30% of the total revenue was generated by urban system and 70% by interurban system after 2010.

With regard to the costs, the interurban system incurred 11,234 million dollars in costs, and the urban system 4,221 million dollars over the time period of analysis.

As previously explained, the urban system started post 2000 and so at the beginning only the interurban system incurred costs. However, after 2006 both systems were in operation and they shared cost ratios, in the same way as revenues with 30% of total costs designated for urban system and 70% for interurban.

In order to describe the revenues and costs of interurban and urban systems in more detail, we disaggregated both revenues and costs as described earlier in section 2. That is, revenues were disaggregated in fare revenues, financial revenues and other revenues, while costs were disaggregated in operational costs, financial costs, depreciation, taxes and other costs.

In the case of the interurban system, we mentioned before that it generated 13,485 million dollars of revenue, of which 3,277 million dollars were financial revenues; 8,503 million dollars were related to fares and 1,705 million dollars were other types of revenue. With that in mind we can see that, fare and financial revenues represent 87% of total revenues for this system during the period of analysis.

On the other hand, revenues of urban highways have risen up to 5,090 million dollars as mentioned before. From these, 594 million dollars are related to financial revenues, 4,211 million dollars are fare revenues and 285 million dollars are associated with other types of revenues. In this case, fare and financial revenues make up 94% of the total revenue, between 2000 and 2014.

As said before, throughout this period revenues mainly came from fare revenues, which formed on average around 80% of total annual revenues.

Regarding costs, interurban highways incurred 11,234 million dollars of costs, of which 5,968 million dollars were operational costs; 211 million dollars were related to depreciation; 464 million dollars were related to taxes; 3,926 million dollars were associated with financial costs (mainly for the paying of debt) and 665 million dollars were for other costs. Thus, operational and financial costs represent 88% of total costs between 1995 and 2014.

In the case of urban highways, 4,221 million dollars in costs were incurred between the years 2000 and 2014. From this amount, 1,786 million dollars came from operational costs; 1,457 million dollars were financial costs; 218 and 226 million dollars were related to depreciation and taxes respectively; and 534 million dollars came from other costs. Therefore, operational and financial costs represent 70% of the total urban costs; that is, 18% less than the figure they represent in interurban highways.

As a summary, we can conclude from the highway concessionaire's revenue and cost analysis that urban companies have accumulated around of 30% of total system revenues and interurban companies the other 70%. In the same way, urban companies have incurred in 30% of total costs and interurban ones the other 70%. Although, the main business of concessionaires should be to operate the highway we found in their financial reports they have obtained other revenues than that coming from fares. In fact, the financial and other revenues from urban highways have represented around of 17% of their total revenues after 2010.

5. Highway concessionaires' output and average cost analysis

In this section we present an analysis of the output produced by Chile's highway concessionaires and the average cost they incurred during the period of 1995 to 2014.

As we discussed in section 2, in specialized literature the output of highways has been associated mainly with the infrastructure necessary for travel and is measured in terms of kilometers or kilometers-lane of roads built.

In the same way, other authors establish the highway's output could be measured in vehicles-kilometers, an index which links the length of the infrastructure with the transport demand.

In order to fully consider these two different approaches to measuring the highways' outputs we collected information about the characteristics of the road network, such as its length, and the flow of vehicles that used the highway system during the period of analysis. With this data we estimated average costs measured annually as US$ per vehicle-kilometer and US$ per vehicle.

Table2 below shows how the network has grown year by year, as for both interurban and urban roads.

Table 2. Total network length of highway concession system. Source: Elaborated by the authors based on www.concesiones.cl

Year	Whole Highway Concession System (km)	Interurban Highway Concession System (km)	Urban Highway Concession System (km)
1995	5	5	
1996	113	113	
1997	139	139	
1998	228	228	
1999	553	553	
2000	1.059	1.059	
2001	1.375	1.375	
2002	1.734	1.734	
2003	1.734	1734	
2004	1.892	1.819	72
2005	1.936	1.834	101
2006	1.960	1.834	125
2007	2.003	1.834	168
2008	2.029	1.834	194
2009	2.029	1.834	194
2010	2.295	2.100	194
2011	2.612	2.417	194
2012	2.612	2.417	194
2013	2.612	2.417	194
2014	2.923	2.728	194

Currently, the total road length of all highway concessions is 2,923 kilometers, of which 2,728 kilometers form part of the interurban system and 194 kilometers are urban highways. Given that, urban highways represent barely 7% of total length.

Fig2, meanwhile, presents the number of vehicles that have used the concession system over the years.

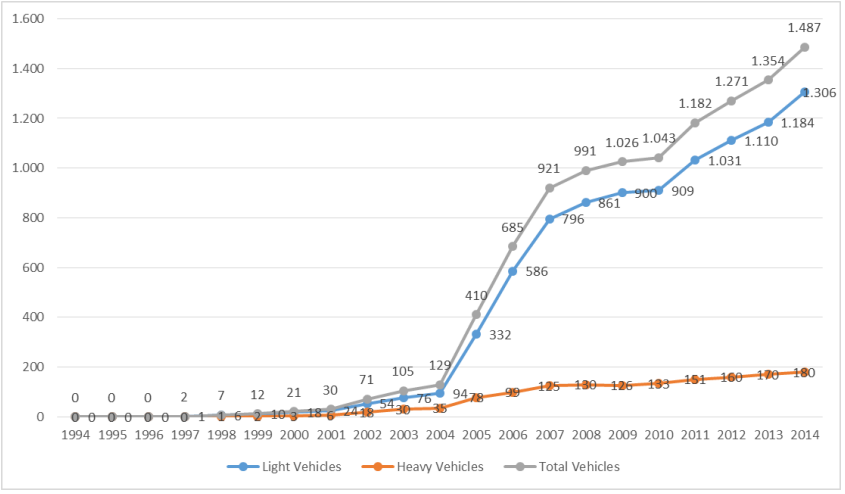


Fig. 2. Total, light and heavy vehicle flow on highway concession system (millions). Source: Elaborated by the authors based on information published on concessionaires' financial reports

One can see that the total flow experienced an explosion in growth after 2004, increasing from less than 200 million vehicles in 2004 to more than 1,400 million vehicles in 2014, mainly due to the increment of light vehicles. Heavy vehicles, however, have experienced a steadily growth over the years and remained under 200 million vehicles during the period of analysis.

If the analysis is carried out based on vehicle flow in the two types of concessions, Fig3 shows a great difference between the different concessions systems. Vehicle flow on urban highways increased quickly since 2004, increasing from 13 million to 1,210 million vehicles a year, whilst the flow of traffic on interurban highways has increased slowly, reaching barely 277 million vehicles a year in 2014.

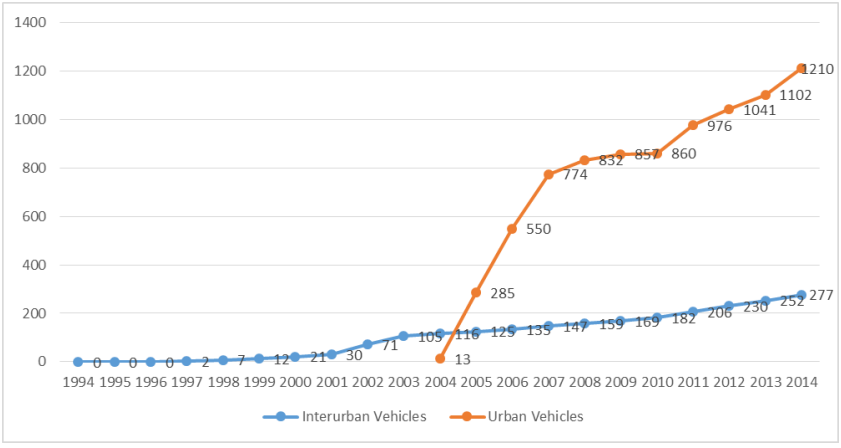


Fig. 3. Vehicle flow by type of concession (millions). Source: Elaborated by the authors based on information published on concessionaires' financial reports

We think that the growth of light vehicles flows on urban highways was due to two factors. One factor is that from 2004 to 2005 the entry rate of vehicles into Santiago (Chile's Metropolis) increased from 1% to 7%, according to the National Statistics Institute, which was greater than in all the country. This rate has remained constant over the years in Santiago, thus increasing the traffic flow on the concession system. The other factor was the launch of Transantiago in 2005. Transantiago, Santiago's new public transport system, had many operational problems to begin with low frequencies of buses that prompted many to travel by car throughout the city.

If we analyze traffic flow by vehicle type in each type of concession, we can see that light vehicles make up a greater percentage of flow than heavy vehicles in the interurban system. Proportionally around 80% of the total traffic flow has been made up of light vehicles and around 20% heavy vehicles over the years. This is very similar to the urban system case (light vehicles represent about the 90% of the total flow).

Using the above information, we were able to estimate the average cost for each company for both type of concessions, measured in US$/vehicles-kilometer (US$/veh-km) and US$/vehicles-year (US$/veh).

We present here the average costs estimation taking into consideration the vehicles per year index as the highway concessionaires' output (the output index vehicles-kilometer has the same behavior). As we shown earlier, many authors in related literature use number of vehicles combined with kilometers as highway output, which shows a correlation between travel demand and necessary inputs to travel, but could be ambiguous because the same vehicle-kilometer could be produced with several different combinations of vehicles and kilometers. For this reason, we are inclined to think that highway operators are transport providers who with inputs like capital, employees and in this case, with a highway can provide people make trips to reach their destinations and carry out activities. Given that, and following Jara-Díaz (2007) who establishes that transport operators produce opportunities to travel (trips) and we think veh/year is a more appropriate way to analyze the output produced by highway concessionaires. Fig4a and 4b shows the average costs of interurban and urban case measured as US$/veh a year, where we have labeled each observation with the number assigned to each concessionaire in Table 1.

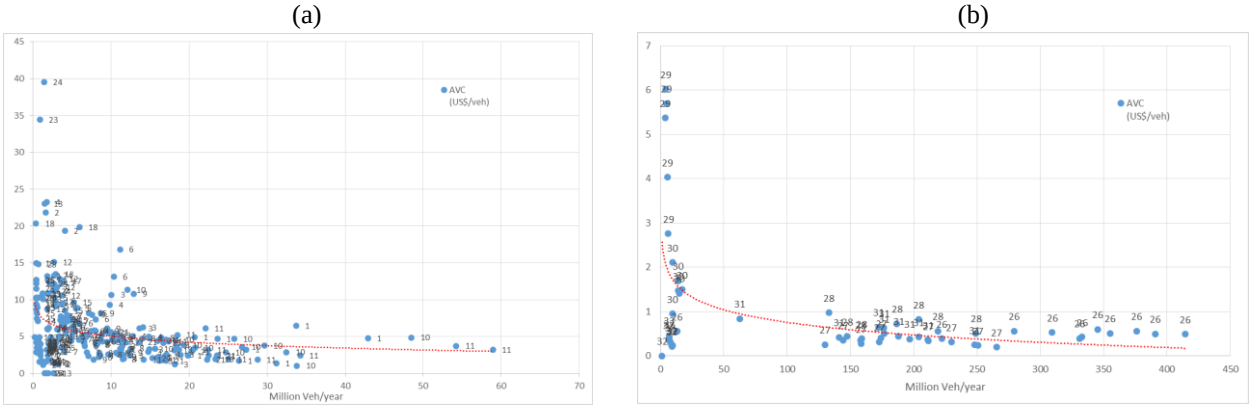


Fig. 4. (a) Interurban Average Costs Measured in US$/Veh; (b) Urban Average Costs Measured in US$/Veh. Source: Elaborated by the authors based on information published on concessionaires' financial reports

From the fig4a - although a cloud of points has been plotted between 0 and 30 million of vehicles/year - an L shaped curve (the red line) can be seen. It shows the cost falls from as high as 40 US$/veh to less than 5 US$/veh when vehicle flow increases to over 30 million a year.

Fig4b, presents the average costs for the urban system, measured in US$/veh. As in the previous case, the average cost curve has a similar shape (shown by the red line); that is, an L shape which decreases as vehicle flow increases. In this case, the average cost ranges from 6US$/veh to less than 1 US$/veh, which is smaller than the interurban range. However, it should be noted that the maximum urban vehicle flow is almost 7 times greater than the interurban flow, with up to 400 million vehicles a year using the urban system, as opposed to just 60 million vehicles a year on the interurban system. This could explain the difference between the average costs of the two systems.

All the average cost curves presented above show that average cost decreases as output increases regardless of the output index used, which proves the presence of scale economies.

Now, if we view the results obtained according to Joskow (2006), who establishes the existence of scale economies in a single output context as a sufficient condition for determining a natural monopoly, we can say this industry has this characteristics of a natural monopoly. In fact, we noticed in all the above charts that the average costs curve decreases over a long-range output. With this in mind, it is necessary that fares or profits regulations are made stricter, since otherwise companies with lower average costs could dominate the market in the long term. In Chile's highway concession system, this could mean that many different highways (projects in Table 1) could all have the same group of shareholders.

For example, in the interurban case from fig4a we can see that concessionaires 1, 3, 10, 11 and 21 are the 5 big players of this market. In fact, in 2014 their vehicle flow formed 169 million veh/year of the 277 million veh/year that used the interurban system, which makes up 61% of total vehicle flow. Table 3 shows the owners of these big players as well as some information about each concession.

Table 3. Owners of interurban big players. Source: Elaborated by the authors based on concessionaires' financial reports.

Concessionaire Number	Project Name	Owners (Company Name)	Description and Characteristics	Revenue 2014 (million dollars)	Vehicle Flow 2014 (million)
1	Ruta 78 Santiago-San Antonio	Abertis	Ruta 78 highway is a 132 kilometers long road which links Santiago* with San Antonio Port, Chile's main port.	65.6	33.8
3	Ruta 5 Tramo Santiago-Los Vilos	Globalvía Infraestructura Chile and Globalvía Inversiones S.A.	This is a section of Ruta 5** highway, which links Santiago, and the the northern town of Los Vilos. It is 218 kilometers long.	108.8	18.5
10	Ruta 68 Santiago-Valparaíso-Viña del Mar	Abertis	Ruta 68 highway is a 141 kilometers long road which links Santiago and Valparaíso, Chile's second main port.	116.4	34.3
11	Ruta 5 Tramo Santiago – Talca y Acceso Sur a Santiago	Intervial and ISA	This is a 266 kilometers long section of the Ruta 5 highway, which links Santiago and Talca, a city in the South of Chile.	235.8	58.9
21	Ruta 5 Tramo Talca-Chillán	Intervial and ISA	This is another section of the Ruta 5 highway, which continues south from the previously mentioned section of the highway.	44.2	23.4

* Santiago is the Chile's capital, named also "Región Metropolitana"

**Ruta 5 highway is Chile's main road that links the country from north to south

This demonstrate that only a few companies dominate this market. In this case, in fact, just three companies control more than 60% of total interurban flow, and in 2014, they also generated 45% of total interurban system revenue.

In the urban case, fig4b, shows that concessionaires 26, 27, 28 and 31 are the 4 big players. In fact, they concentrated 97% of total urban flow in 2014, given that out of the 1,210 million veh/year that used the system, around 1,177 million veh/year used these concessions. The owners of these concessionaires and a description of the projects are shown in Table 4, below.

Table 4. Owners of urban big players. Source: Elaborated by the authors based on concessionaires' financial reports.

Concessionaire Number	Project's Name	Owners (Company Name)	Description and Characteristics	Revenue 2014 (million dollars)	Vehicle Flow 2014 (million)
26	Sistema Norte-Sur	Central Korbana and Abertis	Sistema Norte – Sur is 60 kilometers long and is the urban section of Ruta 5 highway as it passes through Santiago (Region Metropolitana). It links Santiago with the north and the south of the country.	202.1	414.4
27	Sistema Américo Vespucio Sur, Ruta 78-Av. Grecia	Grupo Costanera	Américo Vespucio Avenue is one of the most important roads in Santiago. It is a ring road and this concession refers to the southern section which is 24 kilometers long.	51.8	265.5
28	Sistema Américo Vespucio Nor-Poniente, Av. El Salto-Ruta 78	Taurus Holding Chile and Bookfield America – infrastructure Holding.	This is the 29 kilometers long north-western section of Américo Vespucio avenue.	126.8	249.2
31	Sistema Oriente-Poniente	Grupo Costanera	This is a 43 kilometers long road which links the eastern and western zones of Santiago	60.3	248.0

Table 4 shows that there are in fact three different urban highway owners who generated 72% of total revenue in 2014. It is worth noting that Abertis again appears as a concessionaire controlling one of the most important highways (Ruta 5). Thus, Abertis controls the urban flow from north to south in Santiago, and the interurban flow to the west, towards Chile's main Ports and the main beach towns.

On the other hand, Grupo Costanera controls the east and west flow in Santiago. In this way, with the Sistema Oriente-Poniente, Santiago's high earners who live in the north-eastern zone of the city can travel more quickly to the main business district, located downtown. With Américo Vespucio Sur, Grupo Costanera can take people from middle-low income groups from several south parts of the city and connect them with zones of Santiago where the factories and industries are located, or with Ruta 5 highway to enable them to reach downtown Santiago.

All of this show a growing monopolization of the urban and interurban trip market. In fact, it is important to note that Grupo Costanera is also the owner of Acceso Nororiente a Santiago (29 in Table 1) which connects the northern zone of Santiago with its Sistema Oriente-Poniente (31 in Table 1). Besides this, in 2016 Abertis bought Sistema Norte Sur, and it also bought a private proposal related to a new highway in Santiago. These pieces of evidence prove the natural monopoly characteristics exist in the industry due to the existence of scale economies. It shows that big players want to expand in order to increase their traffic flow and so reduce their average costs and increase their profits.

6. Comparison between average fares and average costs of big players

As we mentioned before, this industry has natural monopoly characteristics and therefore fares paid by users should be similar to average costs in order for the concessionaire costs to be covered by their revenues.

In order to examine this, we calculated aggregated fares for each of the big players and compared these with their 2014 average costs. The fares were aggregated because each highway has different fares depending on vehicle type and time of day, which is measured as Ch$/veh, according to the Chilean Concessions Agency website (www.concesiones.cl).

We calculated simple average fares and also fares weighted by type of vehicle flow. However, we finally used weighted fares to carry out the analysis because they better reflected the revenue generated by the concessionaires (according to the participation in traffic flow of each type of vehicle).

It is important to note that we only had access to the 2015 fares because the Chilean Concessions Agency does not maintain a register of fares from previous years. We therefore calculated the variation percentage of the 2014 Consumer Price Index, and discounted it from the fares for both urban and interurban big players. The urban fares for 2015 were further discounted by a 3.5% factor established by re-adjustability formula in their tender documents.

Table 5, below, shows a comparison between weighted average fares and average costs for urban big players.

Table 5. Comparison between 2014 average cost and weighted average fare for urban big players. Source: Elaborated by the authors.

Concessionaire Number	Project's Name	Average Cost (US$/veh)	Weighted Average Fare (US$/veh)	Percentage Difference (%)
26	Sistema Norte-Sur	0,49	0,57	17
27	Sistema Américo Vespucio Sur, Ruta 78-Av. Grecia	0,19	0,54	175
28	Sistema Américo Vespucio Nor-Poniente, Av. El Salto-Ruta 78	0,51	0,53	4
31	Sistema Oriente-Poniente	0,24	0,67	174

From the table above, the huge percentage difference between average cost and fare in Sistema Oriente Poniente and Sistema Américo Vespucio Sur is immediately striking. Both projects are controlled by the Grupo Costanera. On the other hand, Sistema Norte – Sur, run by Abertis has a 17% difference, and Sistema Américo Vespucio Nor Poniente, only a 4% difference. Clearly, there is a wide range of fare returns, which would explain why Abertis and Grupo Costanera want to expand their market share, as we previously mentioned.

We carried out the same analysis for the interurban big players, and the results are presented in Table 6, below.

Table 6. Comparison between 2014 average cost and weighted average fare for interurban big players. Source: Elaborated by the authors.

Concessionaire Number	Project Name	Average Cost (US$/veh)	Weighted Average Fare (US$/veh)	Percentage Difference (%)
1	Ruta 78 Santiago-San Antonio	1,06	4,54	330
3	Ruta 5 Tramo Santiago-Los Vilos	5,23	6,23	19
10	Ruta 68 Santiago-Valparaíso-Viña del Mar	2,43	3,15	30
11	Ruta 5 Tramo Santiago – Talca y Acceso Sur a Santiago	3,22	4,17	30
21	Ruta 5 Tramo Talca-Chillán	1,92	4,70	145

As in the urban case, interurban big players have a high fares return in comparison with their average costs, ranging from 19 to 330%. It is clearly necessary to adjust fares according to average costs. This would mean that users or the State could get some of the provider surplus, and it would build a more social friendly market in which customers believe they are paying a fair amount and receiving good service. Nowadays, road users question the legitimacy of the system every time concessionaires raise their fares supported by contracts but without improving the level of service.

7. Synthesis and conclusions

In this paper we have verified that highway concessionaires have generated 18,674 million dollars of revenue, and have incurred 15, 456 million dollars of costs between 1995 and 2014. Thus, this business generated around 3,118 million dollars in profit during this time period. This amount of money is similar to annual average budget for Chile's Ministry of Public Works and could fund 30% of the new concessions' portfolio 2014-2020. Furthermore, this profit represents a return of investment of nearly 25% if we consider the total investment disbursed until 2014. However, if we take into account that contracts require only a 20% of the investment as equity, then the return of equity could be greater than 100% for some concessionaires.

Regarding revenues, the interurban system collects around 70% of total annual revenues, whilst the urban system collects the other 30%. We were able to verify that fares were the main source of revenue for both systems. However, it is worth noting that annually, post 2009, financial revenues represent more than 40% of the interurban system's total revenue, but just over 10% for the urban system. However, according to contracts the concessionaire business should only be dedicated to operating their highways and not to generating other revenues.

Regarding the costs, the proportions are similar to the proportions of revenues, since interurban highways represent 70% of the total annual costs, and urban highways the other 30%, during the period in which both system were in operation. However, it is important to note that urban operational costs as percentage of total costs show a declining curve since 2004, whilst interurban costs have had ups and downs between 1994 and 2014. We think that operational costs is an important issue which should be annually supervised in order to guarantee the level of highway service.

Meanwhile, average costs were measured using two output indexes, US$/veh-km and US$/veh. In both cases, we based our analysis on a review of related literature, which allowed us to confirm L-shape curves over a long range output for both interurban and urban highways. Given that, and according to Joskow (2006), this industry displays natural monopoly characteristics because average cost declines as vehicle flow increases. This shows the existence of scale economies in a single output context, and means that concessionaires with a greater market share will want to expand their output in order to lower costs and so dominate the market.

We examined the behavior of this industry using veh/year as output index, and saw that just three companies control the urban market with 97% of vehicle flow, which represented 72% of the total revenue in 2014. On the other hand, also three companies control just 45% of total interurban revenues associated with 61% of total vehicle flow.

Additionally, we compared the average costs and average fares for the big players in each market and found that in general, fares are overestimated, with the exception of Sistema Américo Vespucio Nor Poniente. The percentage difference ranged from 17 to 330%, demonstrating the need to improve fare determination methodology in order for fares to reflect average costs. This would be good for users who could see fare reductions, or for the State who could take a proportion of provider surplus and redistribute the funds to create better infrastructure for the welfare of the people.

With all of the above information taken into consideration, we think that this industry should be regulated more strictly than it is today, because the behavior of the big players displays the characteristics of a natural monopoly. For example, an institution that supervises the annual operations and finance performances of the concessionaires, could be necessary. Furthermore, considering our results, a review of the methodology of fares determination could also be necessary. The State should consider concessionaires' average costs in order to set fares, or set a return of equity for this business. A multi output scheme should also be considered because we think that the marginal cost of light and heavy vehicles would be different.

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