Research in Transportation Economics 100 (2023) 101250

Contents lists available at ScienceDirect

Research in Transportation Economics

journal homepage: www.elsevier.com/locate/retrec

Research paper

Establishing the first economic regulation of the Mexican rail concessions

César Rivera-Trujillo

Director of Economics Regulation at the Regulatory Agency of Rail Transport, Mexico City, Mexico

ARTICLE INFO

Keywords:
Captive shippers
Effective competition
Maximum rates
Average cost pricing

ABSTRACT

On February 2020, the Federal Economic Competition Commission (COFECE) issued a resolution on lack of effective competition in 20 routes of freight railway transportation of chemical products originating in southern Mexico. As a response, the Mexican rail regulator, the Regulatory Agency of Rail Transport (ARTF) responsible for overseeing different aspects of rail transportation, such as the economic regulation regarding tariffs, established the regulation and determined maximum rates for the provision of the rail service concerning three different concessionaires in twenty origin-destination pairs for the transportation of chlorine, ethylene oxide, anhydrous ammonia, and caustic soda.

The model used in the economic regulation consisted of establishing a maximum rate per tonne-kilometre for each combination of route and product. The maximum rate was calculated from the average total costs plus a reasonable profit given by the rate that allows a reasonable return on assets, determined through the Weighted Average Cost of Capital that allows the concessionaires to invest in a sector that is particularly capital intensive. Thus, the maximum regulated rate is equal to the rate where the concessionaire breaks even, that is makes zero profit (average cost pricing or "second best"), plus the Weighted Average Cost of Capital.

The results of the rate regulation of the Mexican rail concessions showed a significant reduction of the rates actually charged in 66% on average and 77% with respect to the registered rates. Although the implementation is not complete, as the regulation is being analyzed in the tribunals, the economic regulation showed that the rates are very far from the average cost in the absent of effective competition. More research needs to be done to evaluate the real impact of the first economic regulation of the Mexican rail concessions.

1. Introduction

In 1995, Mexican railways experienced a radical change from a large vertically integrated and government-owned railway to a system of regional concessions when the monolithic railway was restructured and concessioned during the period 1997–1999. As a result, three major regional exclusive, vertically integrated private freight railway concessions,[1] a terminal company in Mexico City (jointly owned by the three private companies and the Government) and several short lines were the new players of the rail industry. In the case of Mexico, it was decided to concession the infrastructure and operation of rail services to private companies, instead of privatizing the infrastructure as in the United States and Canada, where the operators own the infrastructure.

Although each of the three companies is a monopoly in its own region, Mexican railways are characterized by "source" or "geographic" competition (Pittman 2002). In other words, there are a number of alternative geographical sources of supply or alternative destinations available to the shipper or receiver. For instance, much of the rail traffic in Mexico is international traffic and the combination of different ports and U.S. connecting railroads can be used to provide economic alternatives (Pittman 2002). In 2021, 70.5% of the total rail freight was international traffic as shown in Table 1.

However, geographical competition mainly applies for international traffic but not for local traffic as the exclusivity of the regional concessions restrict rail competition, that is the intramodal competition. After the merger between Ferromex and Ferrosur in 2011, today, there are only two main players in the Mexican freight rail industry that remain vertically integrated private freight railway concessions, Grupo Mexico (GMexico) and Kansas City Southern de Mexico (KCSM), where the network of these two groups can be seen in Fig. 1. Both companies concentrate more than 99% of the rail traffic in Mexico as shown in Table 2. The interaction between the two main players is very low, as only about 6% of their rail network is share using trackage rights and the interlineal traffic, where freight is handled by two operators, is around

E-mail address: cesar.rivera@sct.gob.mx.

[1] The three major concessions were awarded by 50 years plus a period of exclusivity for 30 years. In 2021, the period of exclusivity for the North-Pacific concession was extended to 40 years and one month, https://www.dof.gob.mx/nota_detalle.php?codigo=5635319&fecha=16/11/2021.

https://doi.org/10.1016/j.retrec.2022.101250
Received 10 June 2022; Received in revised form 18 November 2022; Accepted 21 November 2022
Available online 5 December 2022

10% of the total tons moved by rail OECD (2020). In terms of the rates, some studies have found that, in the case of interlineal routes, the rate per kilometre for completing 5% of a route is between 7.4 and 10.7 times greater that the tariff per kilometre of the concessionaire that serves the 95% of the route (COFECE 2020).

On February 2020, the Federal Economic Competition Commission (COFECE) issued a resolution on lack of competition in 20 Origin-Destination pairs (routes) of the public freight railway transportation of four chemical products (chlorine, ethylene oxide, anhydrous ammonia and caustic soda) originating mainly in the southern region of the state of Veracruz close to the port of Coatzacoalcos. These routes are operated by either the concessionaires KCSM or by GMexico or by a combination of these two.

According to the COFECE's investigation on the routes of rail transport of chemical products originating in southern Veracruz, the existence of alternative railways or other modes of transport (road, maritime, air or pipelines) available to users for the transportation of chlorine, ethylene oxide, anhydrous ammonia, and caustic soda could not be found and the users of the rail services are subjected to conditions imposed by the two companies KCSM and GMexico along with a lack of sufficient bargaining power to negotiate rates, which may result in raised service rates as the railroad concessionaires were dominant in the provision of the rail transport of these chemical products (COFECE-004-2020).

Some of the main findings from the COFECE's investigation was that the rail freight transport service had not substitutes in the investigated routes for transportation of chlorine, ethylene oxide, anhydrous ammonia, and caustic soda, as well as, it was the safest option regarding the population and the environment, as these products are dangerous substances which require specialized equipment, procedures and care in their handling and safe transport. Thus, it was concluded that the rail transport service was the only technically and economically feasible alternative to transport these hazardous products. In the case of road transport, it was not technically and economically feasible due to capacity and rate difference as well as regulations for the safe and secure transportation of these products on these routes. Sea transport was also not a feasible substitute since the destination points are located in places geographically distant from a sea port. Similarly, air transport was not a feasible substitute since there are prohibitions on the transport of these products by air transport. Moreover, COFECE identified barriers to enter the market, absence of trackage rights and reciprocal switching. In addition, there were not alternative geographical sources of supply or alternative destinations available to the shipper, in other words, there were not geographic competition in these routes and products. Thus, the rail companies have sufficient market power to fix the rates of the public rail transport services of these hazardous products on the probed routes, as well as, restrict the supply or access to their rail networks. As a result, COFECE resolved that effective competition conditions were inexistent in 20 railway routes for transportation of these four chemicals products.

Thus, in this case, the users of these transport services were considered as captive shippers, as they have no other economically viable alternative to transport their shipment rather than the railroad company that provides the transportation service and therefore the shippers have a small elastic of demand, therefore the railroad company has the incentive to charge an extremely high markup over the marginal cost of the shipment (Wilson & Wolak, November 2018). Thus, given that the rail companies have sufficient market power on the transport services of the hazardous products on the probed routes, the demand is relatively inelastic, that is the price elasticity of demand, E_p, is small ($|E_p| < 1$). Therefore, a rate rise will cause of rise in revenue due to the marginal revenue is equal to Rate$(1+(1/E_p)$ and the effect is to sell fewer services at a higher rate (Glaister S. 1981).

With the resolution on lack of effective competition by COFECE, it was open the possibility to protect the captive shippers by the regulation of transport rates for these products in these routes by the rail regulator in Mexico the Regulatory Agency of Rail Transport (ARTF), according to the Article 47 of the Law on the Regulation of Rail Services. As a response to the lack of effective competition determined by COFECE, the Mexican rail regulator, the Regulatory Agency of Rail Transport (ARTF) responsible for overseeing different aspects of rail transportation, such as the economic regulation regarding tariffs, established the regulation and determined maximum rates for the provision of the rail service concerning three different concessionaires in twenty origin-destination pairs for the transportation of chlorine, ethylene oxide, anhydrous ammonia, and caustic soda. This was the first resolution on lack of effective competition conditions issued by COFECE since its creation in 2013 and also the first time that the ARTF issued a rate regulation since its creation in 2016.

2. Review of regulation applied to captive shippers

The restructuring of railways, through privatization or concessioning in the 1990s, adopted mainly two approaches or models of rail organization according to the degree of separation of infrastructure (e.g. railroad track) from operations (e.g. running trains): the vertically integrated model and the vertically separated model. For instance, the separation of infrastructure from operations and the access of infrastructure by third parties have been the key rail reforms for European railways within the European Union by introducing competition in the operation of services while maintaining a monopoly in the infrastructure. In contrast, the rail restructuring in north and south America has not separated the infrastructure from operations, resulting in railroad companies with certain degree of monopoly within their region or part of the network concessioned or own (Rivera-Trujillo, 2004).

Taking into account a similar organization model of the Mexican railways, vertically integrated private freight railway companies, a good and close example of captive freight shippers' rail regulation is the approach applied in the United States by the Surface Transportation Board (STB). This is the exception as rate regulation in the U. S. was eliminated by the Staggers Act (49 U.S.C., Public Law 94–473) in 1980 (Russell, 2010). Potentially captive traffic is defined by the STB as all rail traffic priced at or above the threshold of a revenue/variable cost ratio of 180 percent, where the variable cost is measured using the Uniform Rail Costing System methodology (Surface Transportation Board STB,). It is estimated that approximately 15–20 percent of rail traffic is captive in the U.S. and mainly are shippers of coal, bulk chemicals, or grain (Handbook on railway regulation 2020). In practice, to demonstrate that a rate is not reasonable, the shipper must show that the rate paid is too

Table 1
Local and international traffic by rail (million Tonne-km[a]).

Type of traffic	2017	%	2018	%	2019	%	2020	%	2021	%
Imports	43,574	50.5%	47,763	54.3%	48,751	54.7%	48,424	56.2%	54,053	58.5%
Exports	11,342	13.1%	13,054	14.8%	11,515	12.9%	10,655	12.4%	11,100	12.0%
International traffic	54,916	63.6%	60,817	69.2%	60,266	67.7%	59,078	68.5%	65,153	70.5%
Local traffic	31,400	36.4%	27,106	30.8%	28,783	32.3%	27,145	31.5%	27,283	29.5%
Total system	86,316	100.0%	87,924	100.0%	89,049	100.0%	86,224	100.0%	92,437	100.0%

Source: Agencia Reguladora del Transporte Ferroviario (2021). Anuario Estadístico Agencia Reguladora del Transporte Ferroviario, 2020. CDMX, Agencia Reguladora del Transporte Ferroviario (2021). PULSO del Sistema Ferroviario Mexicano, Diciembre 2021. CDMX.

[a] Metric Ton.

high ("rail rate is unreasonable") using the "Stand-Alone Cost" (SAC) test that simulates a "Stand-Alone Railroad" (SARR), that is a fully efficient hypothetical competitor railroad, built for the purpose of carrying the shipper's traffic, with no barriers to entry. The rail rate is unreasonable if it exceeds the costs (including a reasonable profit) of running the SARR (Surface Transportation Board STB, 2019). Unfortunately, this methodology cannot be applied to Mexico yet, as the rail regulator is developing the first regulatory costing system that will be based on the Uniform Rail Costing System (URCS) used by the STB and the Uniform Classification of Accounts and Related Railway Records (UCA) used by the Canadian transportation Agency.

One of the main differences between the Mexican and the U.S. and Canadian railways, is the absence of parallel competition in Mexico, as there are not railroad companies competing with each other over "parallel" routes as well as to and from common points. Therefore, it is expected that the percent of rail traffic captive is much higher in Mexico than in the U.S. and Canada.

3. The regulation approach

Economic regulation is aimed to promote effective competition or a proxy for competition where it is not meaningful to introduce competition (BIS 2011), as is the case of public utility industries (e.g. telecommunications, electricity, gas, water, transportation, etc.). In general, utility regulation is aimed to control profits and costs of public utilities where competitive pressures of the market do not exist (Strasser & Kohler, 1989).

Economic regulation as a way to protect consumers' interests became more relevant after the privatization of publicly-owned firms with monopoly power. A good example is the British privatization programme between 1979 and 1987, where telecommunications, water, energy and transport industries were privatized and where some of the lessons learned for the development of economic policy were the importance of increasing effective (actual or potential) competition and better long-term effectiveness of regulatory policies to contain monopoly power (Vickers & Yarrow, 1988). Since then, some of the regulatory policies applied in the UK has been the economic regulation by capping the rates of utility companies with market power to promote efficiency and fairness and at the same time providing them a return on their assets and investments (BIS 2011).

Aligned with this, the resolution issued by COFECE on lack of effective competition gives the rail regulator two alternatives, either to regulate service rates or determine trackage rights to establish competitors' access rules in the 20 routes where the absence of effective competition was declared in the transportation of chlorine, ethylene oxide, anhydrous ammonia, and caustic soda in order to promote competition for the benefit of markets and the users who hire the rail transport service of these products on these routes. The 20 routes and products where COFECE found lacking competition conditions are shown in Table 3.

The selected alternative by ARTF was capping the rates to protect captive users from "excessive rates" in the 20 routes for the four chemical products with the main objective of extracting any excess rents being earned by the rail concessionaires from the users, which can be achieved by ensuring that prices accurately reflect costs (Christopher Decker, 2015). To avoid losses from the rail companies, the methodology used by the Mexican rail regulator (ARTF) was based on the Average Total Costs (ATC) pricing also known as the "second best" (Christopher Decker, 2015), as the regulator assumed that the rail concessionaires were natural monopolies so that the ATC is greater than the Marginal Cost (MgC), in other words, the company has increasing economies of scale over the relevant range of output (Strasser & Kohler, 1989). Therefore, if the regulator set a rate equal to the MC that rate would be below the ATC and the concessionaire would have losses.

Due to the regulatory costing system is still under development, the ATC was obtained by considering the total costs reported by the concessionaires in the specific route portion of the rail network, where the absence of effective competition was declared by the COFECE, in relation to the weight of the cargo transported and the distance travelled. Thus, it recognizes both the fixed and the variable costs associated with

Fig. 1. Grupo Mexico and Kansas City Southern de Mexico rail networks.
Source: Agencia Reguladora del Transporte Ferroviario (2021).

a specific route of the rail network. The methodology also recognizes that the costs of transporting a product between two geographical points may be different depending on the physical characteristics of these products. This was captured by the differences observed in the fixed and variable factors of the maximum rate that the concessionaires register to the ARTF. Finally, the methodology also takes into account that a concessionaire has the right to obtain a reasonable level of profit and may have sufficient incentives to continue carrying out investments in the railway network. Traditional utility regulation has considered that the task of public utility regulation is to set rates such that will pay operating expenses plus a reasonable return of capital (Strasser & Kohler, 1989). Therefore, the regulation aimed sustainability as the rate must be sufficient to finance the operations and to continue investment in the rail infrastructure. A graphical representation of the regulation by ARTF can be seen in Fig. 2. If the cost information is reliable, the concessionaires will have positive benefits equals to the area $0Q_{ARTF}$* (P_{ARTF}-P_{ATC}), that is the reasonable profit.

Where.

P_{ARTF} is the regulated rate;

P_{ATC} is the rate equals to the ATC;

P_{MgC} is the rate equals to the MC;

Moreover, the regulator ARTF did not have reliable information on demand, therefore, there were not detail information on demand elasticities. However, as the captive shippers had no other economically viable alternative but the railroad services to transport the hazardous products, therefore the shippers would have a small and similar elasticity of demand for the rail services.

4. The model

The model used in the resolutions issued by the ARTF consisted in establishing a maximum rate per tonne-kilometre (tonne-km or metric Ton) for each combination of route and product. The maximum rate is calculated from three components the average total costs, a differentiating factor per product and a reasonable profit that allows the concessionaire to invest in a sector that is particularly capital intensive (ARTF 2020). The following equation is used to calculate the maximum rate per tonne-km for each combination of route and product:

$$P_{Max\ r,K} = (ATC_r)(PDF_k)(1+RP) \quad (1)$$

Where:

$P_{Max,K}$ is the maximum rate in $/tonne-km for route r and product k;

r is the route 1, 2, …n;

k is the product 1, 2, …n;

ATC_r is the Average Total Cost or Unit Cost in $/tonne-km for route r;

PDF_k is the Product Differentiating Factor for product k;

1+RP is the Reasonable Profit Factor (1+Weighted Average Cost of Capital).

To calculate the first component, the ATC in each of the regulated routes, the Total Costs (CT) of the Concessionaire of the route in question are divided by the total tonne-kilometre produced, that is:

Table 3
Routes the COFECE found lacking competition conditions.

Product	Origin(s) (Railway station)	Destination (Railway station)
Chlorine	Ing. Agustín Lira	Acocotla
	Ing. Agustín Lira	Carmela
	Ing. Agustín Lira	El Castillo
	Ing. Agustín Lira	Melchor Ocampo
	Ing. Agustín Lira	Morelia
	Ing. Agustín Lira	Nuevo Laredo
	Ing. Agustín Lira and El Castillo	Rosita
	Ing. Agustín Lira	Tochac
Ethylene oxide	Coatzacoalcos	La Junta
	Ing. Agustín Lira	Coatzacoalcos
	Ing. Agustín Lira	Doña Rosa
	Ing. Agustín Lira	Ecatepec
	Ing. Agustín Lira	Irapuato
	Ing. Agustín Lira	La Junta
	Ing. Agustín Lira	Maclovio Herrera
	Ing. Agustín Lira	Tochac
	Ing. Agustín Lira	Xalostoc
Anhydrous ammonia	Guanomex and Piedras Negras	Torreón
	Guanomex	Victoria
Caustic soda	Ing. Agustín Lira	El Castillo

Source: COFECE-004-2020, COFECE issues resolution on lack of competition in 20 routes of freight railway transportation of chemical and petrochemical products originating in southern Veracruz.

$$ATC_r = \frac{TC_r}{(tonne-km)_r} \quad (2)$$

Where:

CT_r is the sum of the total Fix Cost (FC) and the Total Variable Cost (VC) in the route r.

$(tonne\text{-}km)_r$ are the tonne-kilometre produced in route r;

FC are those expenses that do not change with the volume of traffic, that is, these costs are fixed regardless of the number of tonne-kilometres that are produced and the VC are those expenses generated by changes in the volume of traffic measured in tonne-km. Both, the Total Costs and the total tonne-kilometre produced in each of the 20 routes were obtained with information given by the concessionaires.

The rate regulation mechanism also recognizes that the costs of transporting a product between two geographical points may be different depending on the type of product (bulk commodities, perishable, hazardous materials, automobiles, intermodal, etc.). For example, that the cost of transporting grain such as corn between two points is different, on average, from the cost of transporting a chemical such as chlorine between these same points. To capture this difference, the Average Total Cost was adjusted by a factor, the Product Differentiating

Table 2
Total freight transported by the main rail companies (million Tonne-km[a]).

Freight rail companies	2017	%	2018	%	2019	%	2020	%	2021	%
Grupo Mexico	54,483	63.1%	56,459	64.2%	57,348	64.4%	55,693	64.6%	61,443	66.5%
Kansas City Southern de México	30,410	35.2%	29,940	34.1%	30,160	33.9%	29,599	34.3%	30,396	32.9%
Subtotal	54,483	98.4%	56,459	98.3%	57,348	98.3%	55,693	98.9%	61,443	99.4%
Other rail companies	1,424	1.6%	1,525	1.7%	1,541	1.7%	932	1.1%	598	0.6%
Total system	86,316	100.0%	87,924	100.0%	89,049	100.0%	86,224	100.0%	92,437	100.0%

Source: Agencia Reguladora del Transporte Ferroviario (2021). Anuario Estadístico Agencia Reguladora del Transporte Ferroviario, 2020. CDMX. Agencia Reguladora del Transporte Ferroviario (2021). PULSO del Sistema Ferroviario Mexicano, Diciembre 2021. CDMX.

[a] Metric Ton.

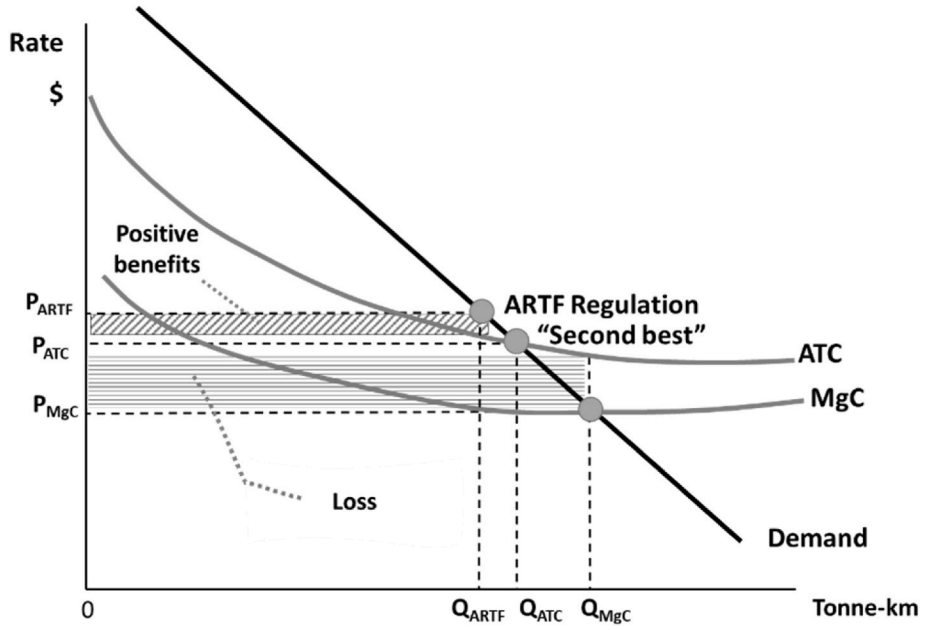

Fig. 2. ARTF's regulation.

Factor (PDF), to estimate a specific Average Total Cost by product. The PDF or the difference in transportation costs by product was obtained by the difference observed in the fixed and variable factors of the maximum rates by product that the concessionaires register,[2] commonly on a yearly basis, with the ARTF according to the Article 46 of the Law on the Regulation of Rail Services. It was assumed that the difference in the registered rates by product is equal to the difference in the transportation costs by product. Therefore, the higher the maximum rate registered, the higher is the transportation costs, where transportation cost is related to the type and the specialization of the railcar equipment. For instance, the product with the higher maximum rates registered among the concessionaires is the transport of vehicles and in average the registered rates are 2.75 times higher than the average. Therefore, with the assumption made in this study, the transportation costs of the vehicles by rail are 2.75 times higher than the Average Total Cost. It is important to mention that the registered rates do not reflect the real prices charged by the rail companies to users as these are not public.

Thus, to calculate the second component, the differentiating factor by product or PDF for each of the routes, the maximum average registered rate is compared with the maximum registered rate of the product to which it is required to apply the rate regulation as shown as follows:

$$PDF_{k,r} = \left(\frac{PD_{k,r} - APD_r}{APD_r}\right) + 1 \tag{3}$$

$$PD_{k,r} = FF_k + VF_k * d_r \tag{4}$$

$$APD_r = AFF_k + AVF_k * d_r \tag{5}$$

where:

PD_k is Product Differentiation of product k in route r;
FF_k is the Fixed Factor of product k;
VF_k is the Variable Factor of product k;
d_r is the Distance of route r in kilometers;
APD_r is the Average Product Differentiation in route r;
AFF_k is the Average Fixed Factor;
AVF_k is the Average Variable Factor;

Fig. 3 shows and example of the calculation of the maximum registered rates of chlorine, ethylene oxide, anhydrous ammonia, and caustic soda with respect to the average registered rate using the fixed and variable factors of the concessionaire Ferromex for a weight of 100 tonnes and 500 km. Since the average registered rate is equivalent to 1, in this case, the differentiating factor by product would be 1.44, 1.36, 1.3 and 0.85 for the anhydrous ammonia, ethylene oxide, chlorine and caustic soda, respectively.

By taking into account the first and the second component, to estimate a specific Average Total Cost by product, into the regulated rate, is intended for the railway to recover its costs on each of the 20 routes.

Finally, the third component, the Reasonable Profit Factor, includes as a reasonable profit as a financial measure whose purpose is to encompass a single figure that expresses in percentage terms the total cost of a company's financing sources, proportionally weighting the debt and share capital, in other words the Weighted Average Cost of Capital (WACC). In this case, the WACC is taken as an approximation for the opportunity cost of capital. Therefore, the ATRF approach included a reasonable return on the assets as a reasonable profit that allows remuneration of shareholders' equity in the same way that an efficient activity would have remunerated it in a comparable risk sector using for such purpose the calculation of the Weighted Average Cost of Capital for each concessionaire.

The relevant variables for the calculation of the Weighted Average Cost of Capital were based on financial information of rail companies operating in Mexico and comparable companies operating in North America, in terms of their revenue, that is Class I railways.[3] The Weighted Average Cost of Capital (WACC) is defined as the average of the cost of debt and the cost of equity capital, weighted by their respective participation in the capital structure and is calculated using the following formula:

$$\boldsymbol{CCPP} = \boldsymbol{C_e}\,\frac{\boldsymbol{E}}{\boldsymbol{D}+\boldsymbol{E}} + \boldsymbol{C_d}\,(\mathbf{1}-\boldsymbol{T})\frac{\boldsymbol{D}}{\boldsymbol{E}+\boldsymbol{D}} \tag{6}$$

where:

[2] The origin of these factors is prior the concessions and were based on different parameters, generally related to cost, the economic situation of the country, inflation and salaries.

[3] In the US, for 2020, a Class I railroad is any carrier earning revenue greater than $900 million. https://www.stb.gov/reports-data/economic-data/.

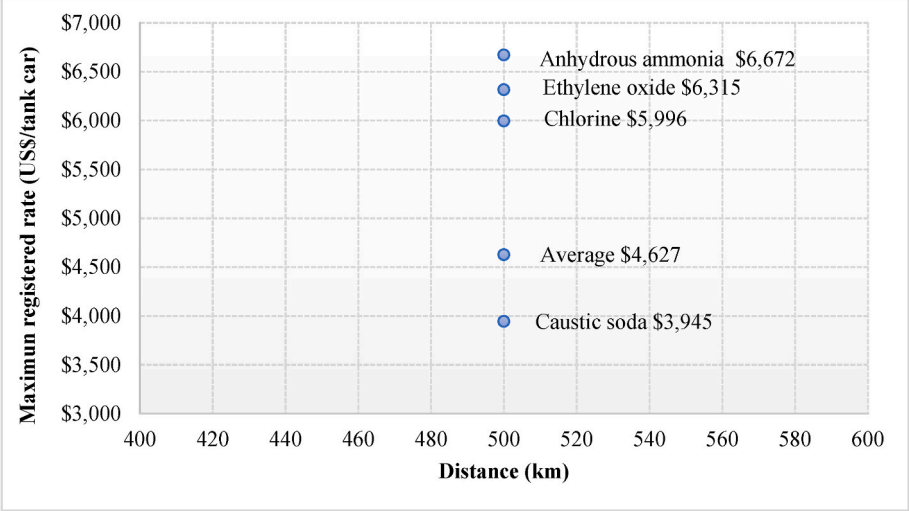

Fig. 3. ARTF's maximum registered rates (US$/tank car).
Source: Maximum rates registered rates in ARTF for Ferromex in 2019

C_e is the Cost of equity;
C_d is the Cost of debt;
E is the market value of the firm's equity;
D is the market value of the firm's debt;
$D + E$ is the total value of capital (equity plus debt);
$E/(D + E)$ is the percentage of capital that is equity;
$D/(D + E)$ is the percentage of capital that is debt;
T is the tax rate;

The cost of equity of each concessionaire was calculated using the Capital Asset Pricing Model (CAPM)

$$CAPM = C_e = R_f + \beta R_e \quad (7)$$

where:

C_e is the cost of equity or expected return of investment;

R_f is the risk-free rate based on the US 30-year bond rate (2.88%) plus a country risk premium associated with Mexico (2.02%)[4];

β is the systemic or non-diversifiable risk in the equity relative to the market;

Table 4 shows the rail companies used to estimate the average unlevered beta.

Table 4
Average Betas for the comparable rail companies

Company	Levered Beta	Debt-to-Equity ratio (D/E)	Tax rate	Unlevered beta
Canadian National Railway	1.11	1.426916468	0.23085	0.53
Norfolk Southern	1.23	0.782402529	0.23383	0.77
Canadian Pacific Railway	1.27	3.164096761	0.23085	0.37
Kansas City Southern	1.20	1.139830413	0.23383	0.64
Union Pacific Corporail	1.24	2.136142983	0.23383	0.47
			Average	**0.56**

Source: Agencia Reguladora del Transporte Ferroviario (2020), Resolutions on rail rate regulation by ARTF: public versions. https://www.gob.mx/artf/documentos/resoluciones-en-materia-de-regulacion-economica

[4] Data used by the Federal Institute of Telecommunications of Mexico, ift 2020.

Table 5 shows the Cost of Capital Pre-Tax rates for each rail company in 2020.

Finally, Table 6 shows the average transportation cost, the Maximun Regulated Rate as well as the Maximun Registered Rates for the 20 routes where the absence of effective competition was declared in the transportation of chlorine, ethylene oxide, anhydrous ammonia, and caustic soda for each rail concessionaire in 2020. The average transportation cost was obtained by dividing the Maximun Regulated Rate with the Reasonable Profit Factor (1+WACC), which can be found in the public versions of the ARTF's resolutions on rail rate regulation in 2020. Thus, the difference between the Maximun Regulated Rate and the Average Transport Cost is equivalent to the average rate of return to persuade investors to provide capital to the rail industry.

Given that the rail companies have market power within these 20 routes for the transportation of these four products and that the shippers have an inelastic demand, without the rate regulation, the rail concessionaires have the incentive to charge up to the Maximun Registered Rate.

According to the current legislation (Lineamientos 2020), the regulated rates, that are based on costs given by the concessionaires, must be updated every year by the Producer Price Index and the regulatory model could be reviewed no later than a 5-year period. Therefore, the regulated rail companies will have the incentive to be more efficient by reducing the production costs of the rail transport services during this period, as the lower the costs, the higher the economic profits will be obtained by the regulated rail companies.

Finally, the impact of the rate regulation on the rail companies, in terms of their income, is very low, as the regulation only applies to the 20 routes for the four chemical products where the absence of effective competition was declared by the COFECE, which represents, in average, approximately 1.3% of their total income. In contrast, the impact on the users is high, as the reduction of the rates is significant by setting rates based on costs plus a reasonable profit. The actual reduction will depend of the characteristics of the individual contracts with the users in terms

Table 5
Cost of Capital Pre-Tax rates.

Company	Cost of Capital Pre-Tax rate
Ferromex	9.40%
Kansas City Southern de México	9.81%
Ferrosur	9.22%

Source: ARTF Resolutions on rail rate regulation by ARTF: public versions.

Table 6
Maximun Regulated Rates vs Maximun Regulated Rates in 2020.

Product	No.	Route	Rail company	Average Transport Cost (US $/tonne-km)	Maximun Regulated Rate (US $/tonne-km)	Maximun Registered Rate (US $/tonne-km)
Chlorine	1	**Ing. Agustín Lira - Acocotla**	Ferrosur	$0.023	$0.025	$0.098
	2	**Ing. Agustín Lira - Carmela**	Ferrosur	$0.023	$0.025	$0.098
	3	**Ing. Agustín Lira - Melchor Ocampo**	Ferrosur	$0.024	$0.026	$0.094
	4	**Ing. Agustín Lira - Tochac**	Ferrosur	$0.023	$0.025	$0.101
	5	**Ing. Agustín Lira - El Castillo**				
		Ing. Agustín Lira - Lechería	Ferrosur	$0.022	$0.024	$0.094
		Lechería - El Castillo	Ferromex	$0.017	$0.019	$0.165
		El Castillo - Celaya	Ferromex	$0.018	$0.020	$0.120
	6	**Ing. Agustín Lira - Morelia**				
		Ing. Agustín Lira - Lechería	Ferrosur	$0.022	$0.024	$0.094
		Lechería - Morelia	KCSM	$0.016	$0.018	$0.122
	7	**Ing. Agustín Lira - Nuevo Laredo**				
		Ing. Agustín Lira - Lechería	Ferrosur	$0.022	$0.024	$0.094
		Lechería - Nuevo Laredo	KCSM	$0.016	$0.017	$0.100
	8	**Ing. Agustín Lira - Rosita**				
		Ing. Agustín Lira - Lechería	Ferrosur	$0.022	$0.024	$0.094
		Lechería - Rosita	KCSM	$0.016	$0.017	$0.099
Ethylene oxide	9	**Ing. Agustín Lira - Ecatepec**	Ferrosur	$0.027	$0.030	$0.114
	10	**Ing. Agustín Lira - Coatzacoalcos**	Ferrosur	$0.164	$0.179	$0.495
	11	**Ing. Agustín Lira - Tochac**	Ferrosur	$0.028	$0.031	$0.122
	12	**Ing. Agustín Lira - Xalostoc**	Ferrosur	$0.027	$0.029	$0.114
	13	**Ing. Agustín Lira - Irapuato**				
		Ing. Agustín Lira - Lechería	Ferrosur	$0.027	$0.029	$0.114
		Lechería - Irapuato	Ferromex	$0.019	$0.021	$0.173
	14	**Ing. Agustín Lira - La Junta**				
		Ing. Agustín Lira - Lechería	Ferrosur	$0.027	$0.029	$0.114
		Lechería - La Junta	Ferromex	$0.019	$0.020	$0.103
	15	**Coatzacoalcos - La Junta**				
		Coatzacoalcos - Lechería	Ferrosur	$0.027	$0.030	$0.114
		Lechería - La Junta	Ferromex	$0.019	$0.020	$0.127
	16	**Ing. Agustín Lira - Maclovio Herrera**				
		Ing. Agustín Lira - Lechería	Ferrosur	$0.027	$0.029	$0.114
		Lechería - Maclovio Herrera	KCSM	$0.017	$0.019	$0.131
	17	**Ing. Agustín Lira - Doña Rosa**				
		Ing. Agustín Lira - Lechería	Ferrosur	$0.027	$0.029	$0.114
		Lechería - Doña Rosa	KCSM	$0.017	$0.019	$0.131
Anhydrous ammonia	18	**Guanomex - Victoria**				
		Guanomex - Lechería	Ferrosur	$0.029	$0.032	$0.131
		Lechería - Victoria	Ferromex	$0.037	$0.040	$0.094
	19	**Guanomex - Torreón**				
		Guanomex - Lechería	Ferrosur	$0.029	$0.032	$0.131
		Lechería - Torreón	Ferromex	$0.017	$0.019	$0.111
Caustic soda	20	**Ing. Agustín Lira - El Castillo**				
		Ing. Agustín Lira - Lechería	Ferrosur	$0.017	$0.018	$0.070
		Lechería - El Castillo	Ferromex	$0.011	$0.012	$0.106

Source: Agencia Reguladora del Transporte Ferroviario (2019), Resolutions on rail rate regulation by ARTF 2020: public versions.

of the frequency and volume of the shipments which are confidential. Nevertheless, as a result of the economic regulation from ARTF by capping the rates to protect captive users caused a significant reduction of the rates actually charged in 66% on average and 77% with respect to the registered rates.

5. Conclusions

In 2020, the Mexican rail regulator ARTF issued its first resolutions on economic regulation since its creation in 2016. The acts were derived from the declaration of absence of competition issued by the Federal Economic Competition Commission, related to the transportation of several chemical products in 20 routes in the south of the state of Veracruz.

As a result, ARTF determined maximum rates for the provision of the rail services with respect to 3 rail concessionaires in 20 origin-destination pairs in the transportation of 4 products (chlorine, ethylene oxide, anhydrous ammonia, and caustic soda. The maximum rates are based on the average production costs of the freight rail transport services of a specific product plus a reasonable profit equal to the Weighted Average Cost of Capital, in such a way that it provides the companies with the adequate income to recover their fixed and variable costs, as well as a reasonable profit that allows them to continue making investments. The foregoing will allow for a healthy railway system, that is, with adequate income to operate and maintain the railway network, as well as to continue with the necessary investments to meet current and future demand.

Given the current regulation, while the regulatory model does not change, the rail companies will have the incentive to be more efficient by reducing the production costs of the regulated rail transport services. This is because the regulated rates are based on costs given by the rail companies and are only updated by the Producer Price Index every year. Thus, the lower the costs, the higher the profits will be obtained by the rail companies.

The results of the rate regulation of the Mexican rail concessions showed a significant reduction of the rates actually charged in 66% on

average and 77% with respect to the registered rates. Although the implementation is not complete, as the regulation is being analyzed in the tribunals, the economic regulation showed that the rates are very far from the average cost in the absent of effective competition. One of the main lessons learned by ARTF was the importance on having access to adequate and good quality information on the economical and operational performance of the rail concessionaires in order to make effective, fair and sounds economy regulatory policies (Richard & Martín Rodríguez, 1999). More research needs to be done to evaluate the real impact of the first economic regulation of the Mexican rail concessions.

CRediT authorship contribution statement

César Rivera-Trujillo: Conceptualization, Methodology, Software, Data curation, Writing – original draft, Visualization, Investigation, Supervision, Validation, Writing – review & editing.

Acknowledgement

This paper summarizes some of the major results of the first economic regulation applied to the Mexican rail concessions by ARTF in 2020. Cesar Rivera Trujillo is a Director of Transport Economics at the Regulatory Agency of Rail Transport (ARTF) in Mexico City. He has a multidisciplinary background: a master's and Ph.D. degrees in transport economics from the Institute for Transport Studies University of Leeds, a master degree in transport systems from the University of Queretaro and a bachelor degree in transport engineering from the National Polytechnic Institute. He has more than 20 years of experience in the public sector.

References

Agencia Reguladora del Transporte Ferroviario. (2019). *Tarifas ferroviarias de Carga*. https://www.gob.mx/artf/documentos/tarifas-ferroviarias-de-carga.

Agencia Reguladora del Transporte Ferroviario. (2020). *Resolutions on rail rate regulation by ARTF: Public versions*. https://www.gob.mx/artf/documentos/resoluciones-en-materia-de-regulacion-economica.

Agencia Reguladora del Transporte Ferroviario. (2021). *Anuario estadístico Ferroviario 2020. Ciudad de México*. https://www.gob.mx/artf/documentos/anuario-estadistico-ferroviario-2020.

Agencia Reguladora del Transporte Ferroviario PULSO del Sistema Ferroviario Mexicano, Diciembre 2021. (2021). In *Ciudad de México*. https://www.gob.mx/cms/uploads/attachment/file/694120/PULSO_Noviembre_2021_V4.pdf.

Christopher Decker. (2015). *Modern economic regulation, an introduction of theory and practice*. Cambridge University Press.

COFECE Paper. (2020). Proposals on economic competition to support the recovery of the Mexican economy, Competition Advocacy Papers. https://www.cofece.mx/wp-content/uploads/2020/12/reactivacion_eng.pdf.

COFECE-004-2020. (2020). *COFECE issues resolution on lack of competition in 20 routes of freight railway transportation of chemical and petrochemical products originating in southern Veracruz*. Mexico City https://www.cofece.mx/wp-content/uploads/2020/02/COFECE-004-2020.pdf.

Department of Business Innovation & Skills. (2011). *Principles for economic regulation*. BIS. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/31623/11-795-principles-for-economic-regulation.pdf.

Glaister, S. (1981). *Fundamentals of transport economics*. Oxford: Basil Blackwell.

Handbook on railway regulation: concepts and practice. (2020). *Matthias finger. 15. Railways and railways regulation in the United States: Surely you don't want jones back?' russell Pittman1*. Edward Elgar Publishing.

Instituto Federal de Telecomunicaciones. Cálculo del WACC para los modelos de interconexión 2020. http://www.ift.org.mx/sites/default/files/contenidogeneral/politica-regulatoria/wacc2020.pdf.

Law on the Regulation of Rail Services. https://www.diputados.gob.mx/LeyesBiblio/pdf/209_061120.pdf.

LINEAMIENTOS generales que deben observarse para desarrollar los modelos de costos que se aplicarán para resolver los procedimientos suscitados dentro del Sistema Ferroviario Mexicano, respecto de lo dispuesto en los artículos 35, 36, 36 Bis y 47 de la Ley Reglamentaria del Servicio Ferroviario,2020,https://www.dof.gob.mx/nota_detalle.php?codigo=5585427&fecha=04/02/2020#gsc.tab=0.

OECD. (2020). *Regulatory governance of the rail sector in Mexico*. Paris: OECD Publishing. https://doi.org/10.1787/c21203ee-en

Richard, G., & Martín Rodríguez, P. (1999). *Ressetting price controls for privatized utilities, A manual for regulators*. Economic Development Institute of The World Bank.

Rivera-Trujillo, C. (2004). *Measuring the productivity and efficiency of railways: An international comparison*. PhD Thesis. University of Leeds.

Russell, P. (2002). *Chinese railway reform and competition:vertical or horizontal restructuring*. Antitrust Division US Department of Justice.

Russell, P. (2010). Against the stand-alone-cost test in U.S. freight rail regulation, 3. In *Journal of regulatory economics* (Vol. 38, pp. 313–326). Springer, 2010.

Strasser, K. A., & Kohler, M. F. (1989). *Regulating utilities with management incentives: A strategy for improved performance*. Quorum Books.

Surface Transportation Board STB, "NOTICE docket No. EP 689 (sub-No. 13) simplified standards for rail rate cases— 2020 RSAM and R/VC>180 calculations decided: February 7, 2022".

Surface Transportation Board STB. (2019). Rate reform task force, report to the Surface transportation board. https://www.stb.gov/wp-content/uploads/Rate-Reform-Task-Force-Report-April-2019.pdf.

Vickers, J., & Yarrow, G. (1988). *Privatization: An economic analysis*. Cambridge, MA: MIT Press.

Wilson, W. W., & Wolak, F. A. (2018). *Benchmark regulation of multiproduct firms: An application to the rail industry*. NBER Working Paper No. w25268, Available at: SSRN: https://ssrn.com/abstract=3286889.

Robert E, G., & Louis, W. (2004). Menk professor of economics, when is competition not good? The case of compelles acces and maximum rate regulation for railroad "captive shippers.