

Application of the markup pricing method as an alternative to the non-cost-based model for airport charges

Aplicação do método markup de precificação como alternativa do modelo não baseado em custo para as tarifas aeroportuárias

Reinaldo Moreira Del Fiaco¹ , Paulo Afonso Lopes da Silva¹ 

¹Instituto Militar de Engenharia – IME, Programa de Pós-graduação em Engenharia de Transportes, Rio de Janeiro, RJ, Brasil. E-mail: fiaco@ime.eb.br; pauloafonsolopes@uol.com.br

How to cite: Del Fiaco, R. M., & Silva, P. A. L. (2021). Application of the markup pricing method as an alternative to the non-cost-based model for airport charges. *Gestão & Produção*, 28(1), e4788, <https://doi.org/10.1590/1806-9649.2020v28e4788>

Abstract: The experience of developed countries shows that airport managers seek to increase their profitability, while regulatory agencies aim to guarantee quality, investments and fair charges. This study presents an application of the Tornqvist Index and the markup pricing method to find the market price opportunity for airfares and one of the specific objectives is to present a methodology for comparing the financial results of airports based on ANAC Resolution No. 350/14, which allows a 100% increase in aeronautical charges concerning the tariff ceiling. To predict passenger demand with new airport fares, the least-squares method was used based on empirical equations and the concept of elasticity. The scenario used was the Campinas / Viracopos Airport from January 2014 to March 2017. The results showed that it is possible to increase the price of the domestic aeronautical charges and the revenue from the airport, with the counterpoint of falling demand. This method, based on cost and market opportunity, but on which the financial statement should be audited, is shown to be promising to increase airport revenue.

Keywords: Pricing; Charging; Concessions; Airports; Aeronautics.

Resumo: A experiência de países desenvolvidos mostra que os administradores aeroportuários procuram aumentar sua lucratividade, enquanto que as agências reguladoras objetivam garantir qualidade, investimentos e tarifas justas. Este estudo apresenta uma aplicação do Índice de Tornqvist e do método de precificação *markup* para encontrar a oportunidade de preço de mercado das tarifas aéreas, tendo como objetivo apresentar uma metodologia de desenvolvimento de um modelo para comparar os resultados financeiros dos aeroportos com base na Resolução n°350/14 da ANAC, a qual permite uma majoração de 100% das tarifas aeronáuticas em relação ao teto tarifário. Para a previsão de demanda de passageiros com esses novos preços das tarifas aeroportuárias, utilizou-se o método dos mínimos quadrados a partir de equações empíricas e do conceito de elasticidade. O cenário utilizado foi o do Aeroporto de Campinas/Viracopos no período de janeiro de 2014 até março de 2017. Os resultados evidenciaram ser possível aumentar o preço da tarifa de embarque doméstico e a receita do aeroporto, com o contraponto de queda na demanda. Esse método, baseado em custo e na

Received May 31, 2018 - Accepted Nov. 19, 2018

Financial support: The authors would like to thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior for the support provided during the research.



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oportunidade de mercado, aliado à fiscalização do demonstrativo financeiro, evidenciou ser promissor para aumentar a receita dos aeroportos.

Palavras-chave: Precificação; Tarifação; Concessões; Aeroportos; Aeronáutica.

1 Introduction

A national aviation system must be able to have intermodality, establish responsibilities among its agents, regulate operations and establish policies that foster its development (TRB, 2010). All transportation activities generate revenue and costs which, inserted in a market, must remunerate the capital invested by shareholders and produce value for the company.

In Brazil, from 2011 to 2017, five rounds of airport concessions were made, from three government programs. The same period was marked by the applicability of two types of tariff regulations and the repeal of the Airport Tariff Additional Law, both to increase airport revenue, whose sources of revenue depend on the laws and regulations of each country. State-owned companies, such as the Brazilian Airport Infrastructure Company (INFRAERO), can use the Union's resources to cover financial deficits but, in other countries, market risks are from the airport administrator herself (Vojvodic, 2008). However, according to Tadeu (2011), the ideal is that airports can be financially self-reliant.

The concession contract of airports requires a high financial contribution of investment of corporate companies in infrastructure and operation. The forecast for the following years of 2011 was an increase in passenger and cargo movement, but there was a slowdown in the Brazilian economy, which resulted in stable demand for air transportation after 2013 (Cappa & Souza, 2017), and the difference between projected and real resulted in the drop in the financial results of the concessionaires because they invested at a time considered low economic risk.

To survive to these risks, the concession contract of the airports of Brasília / DF (SBBR), Guarulhos / SP (SBGR) and Viracopos /SP (SBKP) establish clauses for unfavorable scenarios, and in one of these, it is established that, in the last review of the Marginal Cash Flow, ANAC should recompose the balance-financial to generate revenue to the concessionaire to cancel the Negative Net Present Value (ANAC, 2015a).

As ANAC regulates the price of airport fare, then the risk is associated with the amount determined by the governmental agency, and if ANAC allows airport administrators to decide on their own, the profitability of investment and competition in the sector can be stimulated. This one-way measure could release ANAC from the task of recommitting the economic and financial balance of the concession if the latest review of the Marginal Cash Flow reveals unfavorable outcomes for the airport.

The theme proposed in this article falls within a moment that of legislative transition between the former Brazilian Aeronautics Code (CBA), Law No. 7,565/86, with the new wording proposed by the Committee of Specialist of the Reform of the Brazilian Aeronautics Code (CERCBA) in the House of Representatives, still being evaluated and debated in the Federal Senate by the Special Committee aimed at examining the Senate bill 258/2016 (CEAERO).

Art. 26, proposed in the new CBA text, establishes that the burden stemming from the services provided for the use of airspace are subject to the payment of air navigation tariffs, while, on the land side, art. 29 assigns the regulatory agent the performance to maximize market efficiency, as well as ensure interaction between service providers

and passengers. With the new CBA, the Government wants to stipulate the quantity and quality in airport services to ensure free competition (item III) and tariff freedom in the provision of regular air services (item VIII) (Brasil, 2016b).

To ensure these items, the responsibility for pricing tariffs should be the airport administration and not the regulatory agency. Art. 2º, item IV, proposed by CERCBA, safeguards the tasks of the code itself and the legislation complementary to the figure of the airport authority to carry out the administration of the airport (CERCBA, 2016). For Adjekum (2015), this administrator must observe internal and external market movements so that she can develop her strategies. The legislation, when milder, allows companies to be freer to generate competitiveness for innovation in the sector (Calmanovice, 2011), which would lead to a change in the text of Law No. 6009/73, by which airport tariffs must be approved by ANAC, as well as the text of Law No 13,319/16, which extinguishes ATAERO.

Examples of international regulations show that it is possible to withdraw from the regulatory agency the responsibility for the adjustment of airport tariffs and, consequently, the management of the financial viability of the airport as a consideration. Authors such as Czerny (2006), Biggar (2012), Yang & Fu (2015), Czerny & Zhang (2015) use optimization methods to determine the fare value, while Fadlaoui (2012) uses multiple linear regressions for the same goal. In Brazil, each concession round, from 2011 to 2017, received a different method of calculating the airport tariff, all of which are not based on costs, but using as variables the Euclidean distances of competitors, the Broad Consumer Price Index, as well as factors of production and quality (ANAC, 2011a, 2014, 2015b).

As of 2011, ANAC Resolution No. 180 (ANAC, 2011) allowed fares to be increased by up to 20% above the ceiling set by the same agency, i.e. airport administration has the freedom to increase the price of the tariff or use prices below the ceiling. With Resolution No. 350/14, airport tariffs had a high percentage of up to 100% of the tariff ceiling value set by ANAC (2014).

Using this information, the objective of this study is to develop a model of pricing of aeronautical tariff based on airport costs, in addition to providing information to review the non-cost-based pricing, to compare fare values after the application of the *markup* method and to verify the impacts of changes in fare prices on passenger demand and airport revenue and the influence of demand within the margin of extrapolation d and 100% of the tariff ceiling.

Section 2 reviews the methods of pricing fares practiced by airport concessions in Brazil from 2011 to 2017, 3 develops an empirical model based on the *markup* method, section 4 there is an application of this empirical model, using the operational and economic historical series of Campinas/Viracopos International Airport (SBKP) and, finally, section 5 presents discussions, conclusions, and recommendations.

2 Brazilian regulations on airport tariffs

INFRAERO was created by Law No. 5,862/72 to deploy, manage, operate and operate the airport infrastructure in the country industrially and commercially. Law No. 6,009/73 provides that airport charges to be charged for the use of areas, buildings, facilities, equipment, facilities and services offered at airports are identified as boarding, landing, permanence, storage, foreman and connection tariffs (Brasil, 1973).

Vojvodic (2008), Tadeu (2011) and Young & Wells (2014) clarify that airport revenues are divided into non-operational and operational. Interest on financial

investments, consultancies, and training, while operating revenues are divided into aeronautics and non-aeronautics. Aeronautical revenues are the tariffs alluding to landing, boarding, permanence, foreman and storage operations, and non-aeronautical rates for rental commercial spaces and the promotion of advertising, and can also be charged profit sharing, parking lots, check-in counters, rental of maintenance areas, hangars and offices.

Law No. 6,009/73 allows annual adjustments to be made on the ceiling of airport tariffs and, as it considers aeronautical revenues (a name used by the authors) as airport tariffs (Brasil, 1973), this focus is the one adopted for this article.

The CBA was sanctioned by Law No. 7,565/86, being the main regulations on aeronautics in the country, concerning infrastructure, airspace and the responsibilities of operators, whose objectives are to prevent competition ruinous and ensure the best economic performance of the sector (Brasil, 1986).

To reserve cash for improvements, reform, expansion, and amortization of depreciation of airport facilities, the Airport Tariff Additional (ATAERO) was created in 1989 to charge 50% more on airport charges (Brasil, 1989). ATAERO was considered a cross-subsidy fund because it collected funds from airport fares, air navigation and concessions to cover expenses of airports that were not economically self-sustaining (Brasil, 2011a; Cappa & Souza, 2017). With Law No. 8,399/92, which deals with the development of regional aviation and new airports, the Federal Airport Assistance Program (PROFAA) was established, and 25% of ATAERO's collection was allocated to meet the needs of expansion of regional airports (Brasil, 1992).

The airport sector did not cause concern to the State regarding cost balance. This perception changed in the mid-1990s when the Government realized that the sector should be self-sustaining, and measures began to be taken in this direction (Tadeu, 2011). With Law No. 9,825/99, the international boarding fee and its additional tariff began to be charged. Between 1999 and 2003, the State will use ATAERO's resources, related to international boarding fees, for the amortization of federal real estate government debt (Brasil, 2011b; Tadeu, 2011).

The economic release of Brazilian aviation, or post-deregulation, allowed partnerships through privatizations, strategic alliances, technological innovations, structural and concentration of aeronautical services in the markets of higher demand (Bendinelli, 2016). The control through pricing is free and done by airlines, and airport fares are controlled by the regulatory agency. According to ANAC (2015b, p. 6) "[...] the setting of tariffs did not follow a regulatory model but done sporadically and according to the needs of INFRAERO or public policies".

ANAC updated in 2011 the regulatory model for airport shipping fares, landing and permanence through Resolution No. 180/11, in which ANAC clarifies that the methodology for finding the ceiling value of the tariff was developed according to INFRAERO's operational data since 95% of all passenger and cargo traffic in Brazil occurred in the 66 airports administered by it in 2011 (Brasil, 2011c; INFRAERO, 2012). From that time on, the regulation is based on the average airport costs of the three years before the collection period, using the Broad Consumer Price Index (IPCA) for the annual adjustment of the tariff.

Article 3 of Resolution No. 180/11 states that airports can apply discounts without discrimination, based on requirements such as quality of services, schedules, days and seasons. The same Resolution allowed fares to be increased by up to 20% above the ceiling set by ANAC. If surplus satisfying amounts were identified, administrative measures would then be taken to favor tariff modesty (Brasil, 2011c).

For increasing airport revenue, Law No. 12,648/12 reduced, at ATAERO, from 50% to 35.9% (Brasil, 2012a) the highest charged in fares. Adding taxes, ATAERO and other fees, the gross percentage of revenue from tariff revenue for airports was 32.55%, passing this percentage under total gross revenue to 46.65% from the 2012 law.

In 2011, the airport concession program began, starting with São Gonçalo do Amarante/CE (SBSG). The second round was held in 2012, in which the private sector was granted those of Brasília (SBBR), Guarulhos (SBGR) and Campinas (SBKP). With the Logistics Investment Program (PIL), the airports of Galeão (SBGL) and Confins (SBCF) were delivered to concessions, whose auctions took place in 2012 and the subscriptions of contracts in 2013. In 2015, a new stage was announced for complying with the fourth round of concessions, and the concession of the airports of Fortaleza (SBFZ), Salvador (SBSV), Porto Alegre (SBPA) and Florianópolis (SBFL) was planned. However, in 2016, the Government announced the Grow Project and these four airports were auctioned in 2017 (ANAC, 2017a).

For those granted, the regulation chosen was non-cost-based, in force through ANAC Resolution 350/14, and which guided the concession model made to São Gonçalo do Amarante. With the experience that ANAC and INFRAERO experienced in the early years of concession airports, both opted for a change of approach from INFRAERO, also to non-cost-based regulation, which led to Resolution No. 350/14, by which airport fares could be increased by up to 100% of the value of the tariff ceiling set by ANAC (2014).

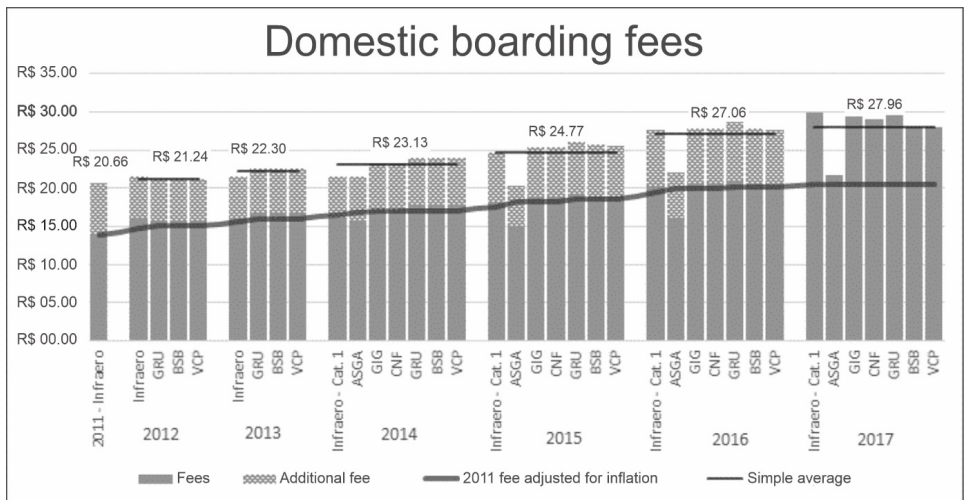


Figure 1. Evolution of the value of domestic boarding fees. Source: ANAC (2017b).

Figure 1 shows the advance in the value of domestic embargo rates for the INFRAERO Network with more than one million PAX, embarkation, and landing, per year and concession. It is observed that the inflation correction line (IPCA) from 2011 to 2017 follows the average tariffs, an increase of 35.3% in six years.

With the values in Reais for the year 2017, consider the conversion rate of R\$ 1.68 in 2011, R\$ 1.96 in 2012, R\$ 2.16 in 2013, R\$ 2.36 in 2014, R\$ 3.34 in 2015, R\$ 4.01 in 2016 and R\$ 3.17 until October 2017. It is concluded that, from 2011 to 2016, the value of the dollar rose 88% and the domestic boarding fee decreased by 30%. Moreover, when analyzing the IPCA, whose increase was 41%, there is the devaluation

of the Real (IPEA, 2017), that is, the average increase in tariffs was 52.7% lower than the appreciation of the dollar.

To assist airports administered by INFRAERO and concessions to remain financially, Provisional Measure (MP) No. 714/16 was proposed, converted into Law No. 13,319/16 (Brasil, 2016a), which extinguished ATAERO and determined that revenue from the adjustment of *ofortuária* airport tariffs be reverted to the airport administrator until the time of the economic and financial balance of concessions.

PROFAA, until 2016, was maintained with 20% of the total ATAERO (Tadeu, 2011); with Law No. 13,319/16, the percentage of gross profit from aeronautical tariffs increased to 82.55% and, after 2016, with the extinction of ATAERO, PROFAA and FNAC began to be financed with resources arising from the payment of concessions from concession airports.

2.1 Methodology for pricing non-cost-based regulation

Non-cost-based regulation applies to INFRAERO network and concession airports (ANAC, 2015b), and each concessioned airport can operate under the rules defined by contract with ANAC (ANAC, 2014), whose pricing methodology depends on predetermined revisions in the contract of each concession.

Decree No. 7,624/11 establishes, in art. 7, that “[...] in the operation of aerodromes granted, airport tariffs will be applied according to the tariff regime established by ANAC” (Brasil, 2011a).

To compose the initial pricing of tariffs, the calculation of Total Factor Productivity (PTF) is considered, using the value of tariffs previously found by INFRAERO’s internal methodology (ANAC, 2015b) or *torqvist* index, Equation 1, index that can be calculated both by Equation 2 and Equation 3 (ANAC, 2011b). According to ANAC (2013), the difference between equations is the segregation of the number of inputs and cost, and Equation 1 can be applied if there are no variables necessary for the use of Equation 2.

$$\ln\left(\frac{PTF_t}{PTF_{t-1}}\right) = \frac{1}{2} \sum_{i=1}^n (S_{it} + S_{it-1}) \times \ln\left(\frac{Y_{it}}{Y_{it-1}}\right) - \ln\left(\frac{C_t}{C_{t-1}}\right) \quad (1)$$

in that Y_i : product quantity i

S_i : participation in product i revenue in total revenues and

C_t : total cost of airport activities.

$$\ln\left(\frac{PTF_t}{PTF_{t-1}}\right) = \frac{1}{2} \sum_{i=1}^n (S_{it} + S_{it-1}) \times \ln\left(\frac{Y_{it}}{Y_{it-1}}\right) \times \frac{1}{2} \sum_{j=1}^n (E_{jt} + E_{jt-1}) \times \ln\left(\frac{X_{jt}}{X_{jt-1}}\right) \quad (2)$$

in that Y_{it} : product quantity i in time (t)

X_{jt} : the amount of input j in time (t)

S_{it} : product i revenue share in total revenue in (t) and

E_{jt} : participation of the cost of the input j in the total cost in (t) .

In the specific case for SBSBG, ANAC used cluster analysis to determine the Euclidean distance (d) between SBSBG and 49 airports. This analysis included the sum between the Revenue Profile (d_{pe}) and Product Participation in the Amount of

movement (d_{po}), described according to Equation 3 (ANAC, 2011b), whose objective was to price the effect of the competition, but this methodology was not implemented in the other airports.

$$d_{pe} + d_{po} = \left[\sum_{i=1}^6 (S_{qi} - S_{ni})^2 \right]^{0,5} + \left[\sum_{i=1}^6 (y_{qi} - y_{ni})^2 \right]^{0,5} \quad (3)$$

where

S_{qi} : revenue share i in total revenues

S_{ni} : product i revenue share in total SBSG revenues

y_{qi} : participação do produto i no total da movimentação e

y_{ni} : product i participation in total SBSG drives.

The result of d_{pe} e d_{po} is multiplied by the PTF to find the marginal cost of an airport product. To correct this value for the other years, ANAC, in 2012, established that it should follow the variation of the IPCA. Paragraph 2 of art. 7 of Decree No. 7,624/11 states that "tariff values will be adjusted annually, through a consumer price index", Equation 4.

$$Tarifa_{t0} = Tarifa_{t-12} \times \left(\frac{IPCA_{t-1}}{IPCA_{t-13}} \right) \times (1 - X) \quad (4)$$

in which $Tarifa_{t0}$: tariff value for the period t_0

$IPCA_{t-1}$: IPCA value in the month before the adjustment and

$IPCA_{t-13}$: IPCA value in the month before the adjustment in the previous year.

Paragraph 1 of Decree No. 7,624 states that the gains from tariffs should be used to provide operational efficiency and quality in the services provided by the concessionaire, and as an instrument of evaluation and pricing, the indicators of efficiency (Factor X) and quality of services (IQS) are used, the latter obtained through the Permanent Survey of Satisfaction of Passengers of the Civil Aviation Secretariat.

After calculating the VARIATION of the IPCA, the concession agreements define the methodology of calculating Factor X, according to Equation 5. Adjusting the fare value considers the investment in the passenger terminal air (TPAX) and aircraft parking positions (ANAC, 2012), being a reduction in the fare value. SBBR, SBGR, and SBKP airports adjust tariffs with the reference base value 2.06%, and SBGL and SBCF use 1.42%, ANAC's values indicated in the concession contract.

$$fator X = 1,0206 \times (1 - (TPAX + PE)) \quad (5)$$

Factor Q is the result of the analysis of The Quality of Services Indices (IQS), divided into three areas: direct services, availability of equipment and installations on the airside. The IQS are composed of 29 performance factors, however, the concession contract, ANAC considers only 15 of them, each with a decrease factor, which is not explained in concession contracts. The adjustment of Factor Q may vary by at least 2% and at most 7.5%, depending on the contract (ANAC, 2011a).

3 Development of the empirical model

The development of the model proposed by the authors was divided into three parts: the first, description of the data, which presents the variables of the macro and microeconomic panels, the movement of the airport and the operational history of flights; the second part addresses the development of the empirical model with the proposed delimitations and, finally, the statistical restrictions considered for the analysis of the robustness of the model.

3.1 Description of data

For the development of the proposed model, macroeconomic, microeconomic, operational and tax values on tariffs are required.

Table 1 shows the definition of the model input and output variables. The index i refers to the aeronautical tariff (1 for boarding and 2 for connection) and j for the destination, 1 for domestic and 2 for international.

Table 1. Model Input and Output Variables.

Acronyms		Settings
Input	Output	
$REDBRUT_{ij}$	$redbrut_{ij}$	Gross operating revenue*
RED_{ij}	red_{ij}	Net operating revenue*
CT_{ij}	ct_{ij}	Total airport cost or total cost of ij^* product
CSP	–	Cost of services provided*
DGA	–	General and administrative expenses*
CTM_{ij}	–	Average total cost*
–	ptf_{ij}	Total factor yield
$PAXPG_{ij}$	$paxpg_{ij}$	Sum of pax paid
$PAXGR_{ij}$	–	Free pax sum
$QPAX_{ij}$	$qpax_{ij}$	Paxpg and PAXGR sum
ASS	–	Number of seats offered by airlines
$VMPT$	–	Weighted average fare value*
$TEMB_{ij}$	$temb_{ij}$	Boarding Fee*
$VMPTT_{ij}$	$vmptt_{ij}$	Weighted average value of the total fare*
–	$Eass_{ij}$	Elasticity of seats relating to $VMPTT_{ij}, ASS_{ij}$
–	$Epaxpg_{ij}$	Elasticity of passengers paid relating to the $VMPTT_{ij}$

*Values in real.

The macroeconomic variables to be used in the model should be selected from the previous experience of the researcher and the review of the technical-scientific literature. After, the variables whose results can influence the aviation market (Vasigh et al., 2013) should be compared to identify possible mutual influences

(Gujarati & Porter, 2008; Vega, 2012). In this case, the correlation matrix is determined to obtain a proximity range between them, empirically defining that, for an amplitude greater than or equal to 0.5, the variables can be considered correlated.

The microeconomic input variables, presented in Table 1, can be found in the financial statements of airports. For the determination of these values, you have:

a) Average Total Cost, Equation 6.

$$CTM_{ij} = \frac{CT_{ij}}{Y_{ij}} \quad (6)$$

in that Y_{ij} : quantity of product ij .

b) Value of the Weighted Average of the Tariff (VMPT), Equation 7:

$$VMPT_{ij} = \frac{\sum_{n=1}^n \text{Tarifa}_{ij} \times \text{Assentos}_{ij}}{\text{Assentos}_{ij}} \quad (7)$$

Operational variables can be found in the electronic portals of airport administrators, regulatory agents, and the Ministry of Infrastructure (Young & Wells, 2014). PaxPG $_{ij}$, PAXGR $_{ij}$, and QPAX $_{ij}$ values are required for domestic and international traffic destinations.

Section 3.2 addresses tariff regulation in Brazil, considering taxes at the federal, state and municipal levels, and each unit of the Federation can charge tax rates for each tax (Brasil, 1988). Fees on financial transactions between airlines and airports can also be deducted from the amount collected with boarding fees.

3.2 Description of the empirical model

To find the cost of each airport service, the Tornqvist index issued, also applied by ANAC, justified use if the airport does not appropriate the cost of its services (ANAC, 2011b). However, equation (8), obtained from Dumagan & Ball (2009), was used due to the amount of data available for the application of the case of this article.

$$\frac{ptf_{ijt}}{ptf_{ijt-1}} = \prod_{i=1}^n \left(\frac{Y_t}{Y_{t-1}} \right)^{\frac{1}{2} [S_{it} + S_{it-1}]} \quad (9)$$

where Y_{ijt} : quantity of product ij at a certain time (t); and

S_{it} : participation of the revenue of the product ij in the total revenues in the t .

The result of the Tornqvist index is multiplied by the absolute value of the total cost of the airport, to determine the cost of the unit produced from the service, according to Equation 10.

$$ct_{ij} = ptf_{ij} \times |CT| \quad (10)$$

With the values of ct_{ij} found, we seek the result of elasticity between the supply of seats (ASS) and the VMPTT to define the price per *markup*, the percentage that the entrepreneur can generate gross profit (Vasigh et al., 2013). The *markup* is mainly used by airlines for pricing and their fares (Vasigh et al., 2013).

Equation 11 shows the calculation of the elasticity arc. According to Vasigh et al. (2013, p. 82), “[...] the arc of elasticity is the average of elasticities concerning a specific series of values, while the point of elasticity is the exact value of a specific price”. The result, which can be equal to 1, is classified as elastic when greater than 1 and inelastic if less than 1.

$$E_p = \frac{\Delta ASS_{ln}}{\Delta VMT_{ij}} \times \frac{VMT_{ij2} + VMT_{L1}}{ASS_{ln2} + ASS_{ln1}} \tag{11}$$

Vasigh et al. (2013) state that the model will correspond to values that are more suitable for the market if the result is elastic or unitary. The result is that 1 indicates that supply has decreased and that strategies to attract passenger demand, seat supply and cost-cutting can be considered as an option by the airport administrator (Vega, 2012; Vasigh et al., 2013).

The action Equation12 determines the price per *markup* (Vasigh et al., 2013, p. 337). If the result of elasticity is negative, then the calculation should consider the optimal *markup* formula, Equation 13.

$$Markup\ price(temb_i) = CTM \times \left(1 + \frac{E_p}{1 + E_p} \right) \tag{12}$$

$$Optimal\ markup = CMT \times (E_p / 1 + E_p) \tag{13}$$

To verify the impact of the tariff price change, after determining the next step is to calculate demand (y_{ij}), gross result and net revenue. In this case, a conditional analysis will be considered, using the ordinary least square method (OLS) and the calculation of demand elasticity. $temb_{i,qpax_i}$

The calculation of the is done by multiplying the by $rebrutad_{i,qpax_i,temb_i}$.

Net revenue from domestic boarding (red_i) considers the multiplied by the tax percentage or other $redbrutad_i$ tariffs.

Hill et al. (2010) consider the calculation through OLS, because economic theory applies exogenous variables using different statistical parameters to obtain the results. In Equation 14, the endogenous variable of the amount of demand is identified by y , the exogenous variables of price per p and the macroeconomic variables per Z .

$$y_{ijd} = \beta_0 + \beta_1 p_{ij} + \beta_{...} Z_{ij} + \varepsilon \tag{14}$$

The variation in the price of the boarding fee will be considered to the limit of a 100% increase of the ceiling, as determined by ANAC, applying the equation obtained by OLS and calculating the elasticity of demand.

3.3 Statistical restrictions

The layout of the output of the statistical data according to the variables is in Table 2, adapted from Vose (2008), Hill et al. (2010), Wooldridge (2010) and E-views (2017).

Table 2. Statistical data output layout.

Variables	Coefficients	Standard Error	Test-t	P-Value
C	$(x'x)^{-1} x'y$	$\sqrt{\frac{\sum_i (x_i - \bar{x})^2}{n-1}}$	$(b_k - \beta_k) / \text{ep}(b_k)$	$\frac{\bar{x} - \mu_0}{\sigma / \sqrt{n}}$
B			* or $(b_k - \beta_k) / \sqrt{\text{var}(b_k)}$ ** Γ	
R ²	$\frac{\sum_{i=1}^n (y_i^e - \bar{y})^2}{\sum_{i=1}^n (y_i - \bar{y})^2}$	Standard dependent var		$\sqrt{\text{var}(y)}$
\bar{R}^2	$1 - \frac{(1 - R^2)x(n-1)}{n-k-1}$	Var dependent on Standard Deviation		$\sqrt{\frac{n}{\sum_{i=1}^n (y_i - \bar{y})^2}} / (n-1)$
SQR	$\sqrt{\frac{\hat{\epsilon}'\epsilon}{n-k}}$	Akaike Information Criterion		$\frac{2(k+1)}{n} - \frac{2\ln(l)}{n}$
SQE	$\sum_i (y_i - x_i'b)^2$	Schwarz Criterion		$\frac{(k+1)\ln(n)}{n} - \frac{2\ln(l)}{n}$
Log Verossimi-lhança	$-\frac{n}{2}\ln(2\pi) - \frac{n}{2}\ln(\hat{\sigma}^2) - \frac{(y-x\hat{\beta})(y-x\hat{\beta})}{2\hat{\sigma}^2}$	Hannan-Quinn Criterion		$\frac{2(k+1)\ln(\ln(n))}{n} - \frac{2\ln(l)}{n}$
F-test	$\frac{\left(\frac{RSS_1 - RSS_2}{p_2 - p_1}\right)}{\left(\frac{RSS_2}{n - p_2}\right)}$	Durbin-Watson Statistics		$\frac{\sum_i (\hat{\epsilon}_n - \hat{\epsilon}_{n-1})^2}{\sum_i \hat{\epsilon}_n^2}$
Prob (test-F)	$\frac{SQR/p}{SQE/(n-p-1)}$			

Source: Eviews (2017), Hill et al. (2010), Wooldridge (2010). *Applicable for simple regression; **Applicable for multiple regressions.

These are decision criteria: the R-square coefficient of determination (> 0.25), R-square-adjusted (\leq R-square), p-value (≤ 0.05), Akaike Criterion (CIA) (close to zero), the Hannan-Quinn Criterion (< 20 does not reject, > 20 or < 40 does not penalize and > 40 rejects) and the Durbin-Watson indicator ($> R^2$, < 4).

To verify that there are omitted exogenous variables that can cause linearity errors, the Ramsey RESET test (called regression specification error test or model stability) is used, proposed by Ramsey (1969), the abbreviation of "Regression Specification Error Test" (or, in Portuguese, specification error test in regression). RESET is a general test for specification errors that can have multiple sources, such as omitted independent variables, incorrect functional form, measurement errors in variables, concurrency errors, and inclusion of outdated values of the dependent variable when the residuals have a serial correlation.

4 Model application

As the Metropolitan Region of Campinas has 20 municipalities, representing 2.7% of the national GDP (Cappa & Souza, 2017), this was one of the reasons why the scenario chosen was the Campinas/Viracopos International Airport (SBKP) for attracting a large volume of passenger traffic, motivated by the blue airlines *hub*. However, the highest revenue of the airport originates from the movement of cargo, because it is the polo region of industrial, agroindustrial, aeronautical and educational attractiveness (Cappa & Souza, 2017). From 2014 to 2016, the highest revenue from SBKP was cargo business (60.4%), followed by business with airlines (22.2%) and commercial revenues (10.6%). According to Cappa & Souza (2017), the demand of 14 million passengers was expected for 2014, and in the planning of the concession for 2018, R\$ 22 million. However, the movement (boarding/disembarkation/connection) of passengers in 2014 was only 9.84 million, 5 million paying of the domestic boarding fee in group I (VIRACOPOS, 2015).

The application of the model consisted of using the demand and cost of domestic boarding of scheduled flights, to find the best price for the corresponding aeronautical fare, using the *markup* method from 2014 until the first quarter of 2017. The *markup* method is employed to determine the opportunity price of the airport fare, depending on the objective of this work.

4.1 Obtaining data

Economic, financial and operational values were organized by monthly frequency. The National Civil Aviation Agency (ANAC), the Central Bank of Brazil (BCB) and World Bank have a data repository that directs the user from their networks to different databases, and therefore it is necessary to differentiate this information. Table 3 shows the variables searched, the time extension of the series, the name of the database, and the references.

Table 3. Data structure and references.

Variables	Extension	Freq.	Database	References
RED _{ij} ; CT _{ij} ;	Jan./2014- Mar./2017	Quarterly	Corporate Governance	VIRACOPOS (2017)
PAXPG _{ij} ; PAXGR _{ij} ; ASS _{ij} ;	Jan./2000-2017	Month	Statistical Air Transportation Database	ANAC (2017c)
QEAE _{ij} ; VMPT _{ij} ;	Jan./2002-2017	Month	Commercialized AirFare Microdados	ANAC (2017c)
TEMB _{ij} ;	Jan./2010- Dec./2011	Month	Tariff	ANAC (2017c)
CRPF; CRPJ;	Mar./2007-2017	Month	Credit Indicators	Banco Central do Brasil (BCB, 2017)
DOLLAR;	Nov./1984-2017	Day	Exchange Rate	Banco Central do Brasil (BCB, 2017)
IPCA; INPC; PIB;	Feb./1992-2017	Month	Monetary Indicators	Banco Central do Brasil (BCB, 2017)
POUP;	Jul./1994-2017	Month	Financial and capital markets	Banco Central do Brasil (BCB, 2017)
BRENT.	Aug./2002-2017	Month	Commodity Price Data	World Bank (2017)

Table 4 displays the operational values. The sample released by the VMPT airlines corresponds to 45% of the total PAXPG that moved Aram SBKP in 2014, an increase or reduction of 36% compared to 2015 and 28% compared to paying passengers in 2016 (ANAC, 2017c).

Table 4. Demand, supply and tariff values at Viracopos Airport.

Period	PAXPG ₁₁	PAXGR ₁₁	QPAX ₁₁	ASS*	VMT**	VMTP***	TEMB ₁₁ *
2014.1	1.172.437	49.069	1.221.506	1.609.627	455,41	324,17	16,49
2014.2	1.179.020	47.509	1.226.529	1.572.685	441,05	323,43	16,49
2014.3	1.221.422	51.323	1.272.745	1.518.275	474,95	323,98	16,49
2014.4	1.247.247	51.610	1.298.857	1.646.262	502,26	360,15	17,68
2015.1	1.204.579	47.088	1.251.667	1.645.790	443,46	307,88	17,68
2015.2	1.106.233	45.109	1.151.342	1.624.014	460,34	337,06	17,68
2015.3	1.173.601	45.976	1.219.577	1.482.040	524,45	397,57	19,02
2015.4	1.125.890	49.623	1.175.513	1.564.928	551,38	415,56	19,02
2016.1	1.067.199	44.249	1.111.448	1.528.946	508,93	383,39	19,02
2016.2	971.811	43.628	1.015.439	1.468.110	534,14	407,31	19,02
2016.3	1.072.785	46.507	1.119.292	1.311.289	568,72	414,62	20,36
2016.4	1.083.976	53.057	1.137.033	1.394.242	581,04	442,90	20,36
2017.1	1.083.724	47.779	1.131.503	1.439.904	537,63	381,23	27,67

*Number of available seats. **Values in Randal. *** Weighted Average Rate Value. Source: Adapted by the author (ANAC, 2011c, 2017c)

To obtain tax amounts, it was identified that, from 2012 to December 2016, ATAERO was applied, which corresponded to 35.9% of the shipping fee (Brasil, 1989). From 2017, the collection of ATAERO was extinguished until the moment of recovery of the economic and financial balance of the concession, according to Law No. 13,319/16 (Brasil, 2016a). In Campinas-SP, the Tax on Services of Any Nature (ISSQN) corresponds to 5% of the amount charged for airport services, according to Decree No. 25,508 of January 19, 2005 (Prefeitura Municipal de Campinas, 2005). The Ordinance of DAC No. 602/GC-5 September 2000 stipulated that airlines for collecting the collection of aeronautical fares for passengers could retain 3% of the amount of this tariff, as well as a percentage of 7.05% should be withheld from the fare under Normative Instruction No. 1,234/12 of the Brazilian Internal Revenue Service (Brasil, 2012b).

4.2 Results

Table 5 presents the results of the Tornqvist index for each period, and the, according to Equations 9 and 10.

Table 5. Tornqvist index application result.

Period	ptf_{11}	ct_{11}^*	Period	ptf_{11}	ct_{11}^*
2013.4	-	-	2015.3	0.164181	-31,982,546
2014.1	0.173761	-53,179,305	2015.4	0.158906	-42,201,807
2014.2	0.180207	-54,820,041	2016.1	0.145267	-35,090,874
2014.3	0.178204	-52,919,506	2016.2	0.094217	-3,808,536
2014.4	0.177955	-118,388,518	2016.3	0.124462	-30,048,157
2015.1	0.169242	-29,782,498	2016.4	0.152058	-14,221,861
2015.2	0.146245	-28,424,972	2017.1	0.165661	-2,262,291

*Values in real.

The results of the elasticity of the number of ASS and VMTP, the ctm_{11} markup price and are presented in Table 6. With cost-based prices, the total range of tariffs is R\$ 126.71. The averages of and the $vntp_{11}TEMB_{11}$ $temb_{11}$ are R\$ 18.99 and R\$ 48.61, and that of R\$ 32.70, and then the airport may have a prize ctm_{11} of R\$ 15.91 from the present application of the *markup* method.

The result of the average elasticity is greater and approximately equal to 1, and the average price found for the domestic boarding fee is R\$48.62, 2.5 times higher than the average established by ANAC which is R\$19.10. The price for the first period of 2017 is R\$28.94, this is 4.58% higher than the ceiling established by ANAC ().

To find the impact on demand generated by the change in the price of the boarding fare, as described in the methodology, OLS develops, according to Equation 14.

Table 6. Price application result by *Markup*.

Period	Ep	ctm_{11}^*	$temb_{11}^*$	$vntp_{11}^*$	Period	Ep	ctm_{11}^*	$temb_{11}^*$	$vntp_{11}^*$
2013.4	-	-	-	-	2015.3	0.981	26.22	39.78	437.35
2014.1	0.834	43.54	63.57	387.74	2015.4	1.069	35.90	54.58	470.15
2014.2	0.852	44.70	65.00	388.43	2016.1	1.084	31.57	48.51	431.90
2014.3	0.832	41.58	60.63	384.61	2016.2	1.157	3.75	5.82	413.14
2014.4	0.845	91.15	132.53	492.68	2016.3	1.236	26.85	41.71	456.33
2015.1	0.831	23.79	34.69	342.57	2016.4	1.240	12.51	19.26	462.16
2015.2	0.845	24.69	36.92	373.97	2017.1	1.173	18.79	28.94	410.17

*Values in real.

$$paxpg_{11} = \beta_0 + \beta_1 VMTP_{11} + \beta_2 PF + \beta_3 PJ + \beta_5 IPCA + \beta_6 INPC + \beta_6 PIB + \varepsilon \tag{14}$$

The result of the application of Equation 14 and the statistical tests are presented in Table 7.

Table 7. Regression result and statistical demand test by Markup.

Variables	Coefficients	Standard Error	Test-T	P-Value
C	439178.5	1058144	0.415046	0.6925
VMPTT	-243.3219	684.3448	-0.355555	0.7343
PF	23.27758	47.30421	0.492083	0.6401
PJ	-8.260585	19.68553	-0.419627	0.6894
IPCA	2544.177	2639.032	0.964057	0.3722
INPC	-2705.325	2396.309	-1.128013	0.3024
PIB	2.376763	1.715570	1.385408	0.2152
R ²	0.834272	Standard dependent var		1131533
\bar{R}^2	0.668545	Var dependent S.D.*		76824.45
SQR	44229.49	Inf. Akaike's Criterion		24.53590
SQE	1.17E-10	Schwarz Criterion		24.84011
Log-Likelihood	-152.4834	Hannan-Quinn Criterion		24.47338
F-test	5.033996	Durbin-Watson stat		3.331864
Prob (Teste-F)	0.034953			

*Variable dependent with standard deviation.

Durbin -Watson's statistic (3.33) is higher than the R² value (0.83), thus rejecting the hypothesis of spurious regression, but the value greater than 2 shows that there is a dispersion in the actual correlation. The estimated angular coefficients (T-Test) are greater than 1, in addition to the difference between coefficients and standard error. Test F indicates that there is a linear relationship between the endogenous variable and the exogenous variables. On the other hand, p-values are higher than the significance level of 0.05, not rejecting the null hypothesis. The RESULT of the CHQ, above 20, indicates that there are a larger number of explanatory variables that the model is not identifying. According to the Schwarz Criterion, above 10, there is a relationship between the degrees of freedom of the variables used.

The Ramsey RESET test presented the P-value of the F-Test (0.6101) greater than 0.05 when including variables omitted by OLS, indicating that the null hypothesis cannot be rejected for the significance level of 95%.

Table 8 shows the result of the estimation of demand), gross revenue of the domestic tariff () and net revenue per month) from the values of $temp_{11}$ ($paxpg_{11}redbrut_{11}(red_{11})$). This was developed using Equation 14 and the values of the coefficients arranged in Table 7.

Table 8. Demand, gross and net revenue per markup.

Period	$paxpg_{11}^*$	$redbrutad_{11}^*$	red_{11}	Period	$paxpg_{11}$	$redbrutad_{11}^*$	red_{11}^*
2013.4	-	-	-	2015.3	1,133,723	45,097,218	22,120,185
2014.1	1,171,821	74,496,761	36,540,661	2015.4	1,132,801	61,831,444	30,328,323
2014.2	1,164,195	75,675,370	37,118,769	2016.1	1,040,626	50,484,110	24,762,456
2014.3	1,192,682	72,314,429	35,470,228	2016.2	1,046,810	6,096,859	2,990,509
2014.4	1,226,028	162,485,444	79,699,110	2016.3	1,022,785	42,662,265	20,925,841
2015.1	1,181,780	40,999,021	20,110,020	2016.4	1,082,962	20,859,279	10,231,477
2015.2	1,144,380	42,246,276	20,721,798	2017.1	1,075,992	31,136,188	26,450,192

*real values.

The total was 14,709,924, and the regression model result was 14,616,584. With the average value being 2.5 times higher than the ceiling established by ANAC, the estimated value was R\$367,469,569.98, tariff values that resulted in a reduction of 0.07% in demand, according to $PAXPG_{11}temb_{11}red_{11}$ regression results.

The average value of elasticity of and was unitary, that is, for every 1% of the increase in the value of the tariff there is a 1% increase in demand. During the period analyzed, there were moments of inelasticity according $PAXPG_{11}VMTP_{11}$ to the increase in the price of airfare. Figure 2 shows the behavior of the estimated demand for the period 2017.1, considering the unitary elasticity, according to the increase in the domestic boarding fare, comparing the regression results in the OLS method with the elasticity of the demand.

The regression result (paxpgRg) showed that demand drop is estimated when there is an increase in the price of airfare. Paid passenger elasticity (paxpgEp) demonstrates the effect of demand elasticity on unitary ratio. The point of intersection between the straights was just below the ceiling value defined by ANAC, and the *markup* price presents a lower estimate of demand using regression. With the increase of the tariff ceiling by 100%, the elasticity is 104,000 paxpg less than estimated by regression.

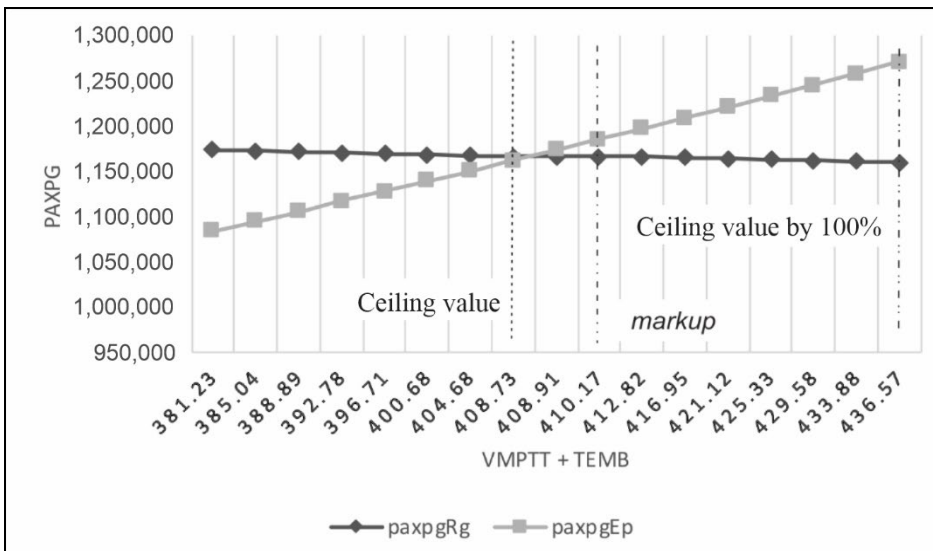


Figure 2. Demand behavior for the period 2017.

5 Conclusions and recommendations

The method for pricing aeronautical tariffs apportions the operating costs of each service through the Tornqvist index; after, the cost multiplied by the elasticity of the seat supply applies and total weighted average fare value paid by passengers, the latter method called *markup* pricing. To calculate the impact of the change in the price of the aeronautical tariff, the ordinary least squares method is used to obtain a regression equation and empirical estimation regarding the quality of the analyzed data and, finally, the elasticity of demand.

The Tornqvist index has as its advantage the accounting facility for updating the share of the cost of a service at full cost, and the *markup* pricing model stands out because it is known for airlines that want to profit from market opportunities, and it is

possible to obtain more predictable results when using the offer as an elasticity criterion for adjusting airfare prices.

The scenario used was Campinas airport from 2014 to March 2017. The cost found of the domestic boarding operation was - R\$ 21,262,291.19 for the first quarter of 2017, a figure representing 16% of the total cost of the airport. When applying the *markup* method the value found of the tariff was R\$ 28.94, and the ceiling value determined by ANAC of R\$ 27.67. The average shipping fee amount by the *markup* model in the period was 2.5 times higher than ANAC's tariff ceiling average, showing that from the Tornqvist index the cost of the operation of this service is not covered by actual revenues.

When analyzing the price results of the *markup* model and financial statements, it is concluded that, at times when construction costs are higher. The rate value accompanies this trend. In order not to make major differences in the fare amount to the passenger, airport administration can distribute, on time, infrastructure spending and other actions for cost management.

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