Airport Management in a Multi-Airport Region: The case of transfer of flights at Belo Horizonte

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Abstract

This paper analyzes the demand of flights at Belo Horizonte, Brazil multi-airport region after a restriction in the downtown airport, which transferred most of flights the international airport. The transfer of flights began in 2005, downtown airport was saturated and the international was underutilized at that time. Policies limited the central airport, and most flights were transferred to a more distant airport. An econometric study is used to identify what happened with the demand due to the transfer. The access time for customers increased after transfer because the international airport is 40km from downtown, this can reduce the customers' interest. However, after the study performed, it was proved that there was increase in demand, particularly for long-haul flights. We also believe that people and airline companies need time to get used to this change, so the post-transfer demand grows more intensively over the years. Triennium dummies were used to identify what happens with the demand in a three consecutives periods of three years after transfer, with that was possible to identify the increase of demand over the time. Distance ranges interact with the triennium variables was implemented in the model, so we were able to see that for long-haul flights, growth was higher. The use of triennium variables was interesting, because explained better what happens with the demand instead of only one dummy of transfer, and is better to visualize than year dummies. The interaction with dummies had a great result, and helped to achieve the conclusions about the impact at the long-haul flights. Our study showed that a restriction, which has increased the access time to passengers, in that case was beneficial to the region's demand, contradicting other studies in the literature.

Keywords: Multi-airport, restrictions, transfer of flights, triennium dummies, distance ranges, econometric study.

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Introduction

The objective of this paper is to evaluate the demand after a flight transfer policy of a downtown airport (Pampulha Airport) to another international (Confins Airport) located at about 40 Km from the downtown. There was an increase in access time, but increased the number of flights and destinations available, so one of the objectives of this study is to analyze the impact of the transfer in the demand for flights in the region. Another objective is to analyze what happened with the demand over time, as it is believed that people and the airlines will get used to the changes over time, so if there was an increase, this increase would not be linear. We will also analyze what happened with the demand for different distance ranges, as for short-haul flights, it is believed that customers could choose to travel by car or other means of transport, the international airport also includes more flights and longer destinations then it is expected that the higher the distance range, the higher is the increase. For this analysis will be implemented an econometric study, with a logit model.

The transfer of flights occurs in some ways, freely, without political intervention, like price, flight availability, access time, etc. or by policy. Policy interventions usually take place to ensure the development of the region and options for costumers. They are usually applied in downtown airports that are saturated in order to develop one or more secondary airports. These interventions are usually restrictions on downtown airport, such as perimeter rule, airport use limited to specific times, the model aircraft can be operated, etc..

The airport of Confins was created in 1984, but by 2005 was considered a "white elephant" until a new law prevented planes with more than 75 passengers to operate in Pampulha. That policy transfer the most of the flights from Pampulha to Confins. At 2011 the airport was already saturated, making the government decided to privatize it in 2013, in 2014 the BH Airport, formed by CCR and Flughafen Zürich AG, starts to manage it (Vieira, 2014).

The transfer of flights began in 2005 but only in 2007 it was completed after the end of the construction of the “green channel”, a highway that connected Confins airport to the center of the city, which improved the connection between Confins and Belo Horizonte. Pampulha airport it is located at 6 Km from Belo Horizonte downtown approximately and have a limitation of 3 million annual PAX, Confins airport is about 40 Km from BH and with 10 million annual PAX it is saturated. After the transfer of flights, a lot of things change in this region, especially with the demand of flights of the region, so this paper aims to analyze what was the impacts of the transfer in this region, try to find the positive and negative sides using an econometric study to test our hypotheses and try to reveal what the transfer brought to the region.

A similar case is that of Dallas multi-airport region, where the downtown airport suffered restrictions for other, international and more robust could develop, there was a perimeter rule to the downtown airport (Love Field) known as the Wright Amendment, and was questioned for many people, in this case the majority was against the restriction, recently this restriction was removed, which according to the literature was good for the region.

A multi-airport region is one where two or more airports serving the same metropolitan area, for example, the metropolitan area of London, which has 5 airports, Heathrow, Gatwick, Stansted, Luton and London City. With the development of cities and globalization, the metropolitan areas are increasingly becoming more congested and larger, causing airports from neighboring towns, with certain proximity and easy access to the metropolitan area are considered in the same airport system, or a multiple airports region. A multiple airport region can be created to attend the growing demands of saturated airports, with the implementation of new airports or the use of

neighboring airports. Airports in metropolitan areas are used for the transport of persons, usually for tourism and business, and cargo for import and export, so they are essential to those regions, ensuring their development.

However, in the case of creation of new airports or improvements of one already undertaken, should be discussed well before implementation, particularly as regards the demand as they can be built underutilized airports, generating losses. For example, the case of the Montreal / Mirabel airport, which was built to receive 6 million to 10 million passengers / year, but after 20 years of its construction, received only 3 million, according to Carr, 1994.

A management of airports and good planning are of great importance when dealing with multiple airports regions, so there is no planning errors and can ensure the needs of the regions. Generally downtown airports are near from populated residential areas and therefore have environmental and safety issues, especially when there is a need for expansion.

Neufville (1995) says that to airports are considered as part of multiple metropolitan area airports in a system, they should have flow which migrate to the same region, not only are close. São Paulo, Rio de Janeiro, Belo Horizonte are examples of Brazilian regions with multiple airports. In the case of Belo Horizonte, airports that are part of multiple airports region are Pampulha and Confins, the second one was initially created to attend the demands not supported by Pampulha.

The paper it's presented into four sections, theoretical framework, empirical model development, results and robustness checks. The theoretical framework has a review of the literature and presentation of the conceptual model. The second section presents the application, the database, the empirical model and estimation strategy.

1. Theoretical framework

Generally the flight transfer impacted the demand, as there was a change in the main airport of the region, the closest airport in the city is now less used, with some limitations. The main airport is now the most distant, but more modern, support larger and heavier aircrafts and can process a larger amount of people. Knowing this, the work seeks to analyze what will be the behavior of the demand, if it will increase or decrease due to the transfer, and if increase. In the most cases at the literature, the demand decreases after a restriction, but might increase over the years. If increase it will increase linearly or exponentially, also it is believed that people and airlines take time to get used to changes, so it is very possible that this increase is not linear over time.

Another point to be considered here are the impacts on demand by each distance range of flights, as the airport is further out of town, so it is believed that for short distances, passengers could choose to go by car or other means of transportation, but the frequency of flights increased due to capacity of a bigger airport, in the most of the cases the demand for short-haul flights decreases, but for long-haul increases.

It's not so common to see policies like these in the literature, when the demand its forced from downtown airport to an international airport, usually this is done more succinctly, with some rates an tax, placing slots, etc..

1.1. Literature review

Richard De Neufville (1995) highlights the importance of studies on the management and creation of airports in multiple regions airports, in this article he brings situations that were poorly planned, mainly due to erroneous demand forecasts, citing the cases of Edmonton, London, Montreal, Osaka, Washington. According to him, airlines tend to focus the main demands in primary airports, causing secondary more volatile to demand changes, making the creation of new more attractive

facilities for longer periods of time, but more risky for short periods. He says that dynamic strategies are generally most suitable for those cases, for example, incremental and flexible investments. In incremental and flexible, the changes are carried out in parts, according to the increase of demand; airports must have strategies which involve future changes. According to him, the passengers' point of view, secondary airports will be interesting when providing the services desired by customers, such as availability flights and total time expend to go from where you are to where you want to go, if the time to the final destination at secondary airport is less than the waiting time to get a flight at the primary, passengers tend to choose the secondary. From the standpoint of the airlines companies they prefer to concentrate their routes, to raise your Market share and gain competitiveness, preferring airports with higher demand and sometimes leaving aside the secondary. According to the author, when secondary airports have more than 50% of total traffic, is usually for policies related to distribution traffic, or due to oversaturation of the airports, in cases of very large demands, or for technical reasons of the airports. Deregulation increases the volatility of secondary airports, making the regulation into an alternative to the control demands in airports, thus aiding in its administration.

Hess and Polak (2005) conducted a study about the passenger choices in a multi-airport region, specifically in the San Francisco Bay area. The authors say that there are differences between the passengers' interests, preferences or individual passenger segments. For this study, they used a multinomial logit model, which is widely used in the area and can be often seen in the literature, to make comparisons and evaluations of the airline industry markets. The database they used was a survey of MTC (Metropolitan Transport Commission) 1995, containing information from 21000 respondents passengers. In this case, after selected passengers with significant relevance to the calculations, the passengers were segmented into four options: business residents; leisure residents, business visitors and leisure visitors. The attributes that influence consumers were fare, frequency, access time, cost of access, flight time, number of airlines, aircraft size, and punctuality at each airport. And according to the authors, only rate, frequency and access time had significant results, it was not possible to identify great significance between the effects of tariff on business visitors, it was concluded also that business visitors tend to prefer lower access times even paying a higher rate, while for residents, the price is more important, even when compared to visitors to ride. This study shows the importance of access time in a multi-airport region, in our case access time will increase as the flights were transferred to a further airport.

Using the same database that Hess and Polak (2005) Ishii et al (2006) also conducted an interesting study showing some existing trade-off and also the influence of the entrance of a LCC in market competitiveness. They focused attention to only 4 destinations in or near Los Angeles, causing managed to outline a more specific market, also made the use of more specific targets, such as, flights at peak hours, or flights at non-peak hours. They analyzed the effect of the entrance of the low cost company Southwest and the impacts that it has caused, the trade-off that consumers would be willing, and the changes made by competitors who dominated airports. For a case of a multi-airport region, this study is very important because it identifies factors that can increase the demand on secondary airports, thus decreasing the volatility of these airports and facilitate its management.

In the paper of Takebayashi (2012), he comes to the conclusion that the restrictions, in this case a perimeter rule brings benefits for airlines and passengers. According to him, in a multi-airport region the longest flights should be allocated to more distant airports. He also carried out his research in an multi-airport region, in Japan. He used a “bi-level air

transport market model" to reach these conclusions.

Murça and Correia (2013), made a comparison between several articles that referred to the regions of multiple airports, analyzed the approach of methods used to process the data and drew some conclusions about the trends of studies airports from these regions. According to the authors, most studies using discrete choice models and the majority converges to the evidence that the attributes that have more significance for passengers are: rate, frequency and access time.

Bendinelli and Oliveira (2015) conducted a study of demand impacting on the Confins airport, and from a database from the INFRAERO, ANAC, and IPCA IBGE, hypotheses have been raised about what factors are most closely linked to changes in demand in the airport. After the best methods were tested, it was concluded that certain factors has high elasticity and significance in relation to demand for Confins, for example, the average consumer income. This article is very relevant to the case of multiple airports regions by dealing with the demands of the Confins airport, which may be associated with the volatility of the airport, which should always be observed for better management and planning of the airport.

1.2. Conceptual model

In regions of multiple airports, demand have a important significance for the airports, particularly in secondary airports, where volatility is higher, so each change must be thoroughly analyzed before being deployed, to avoid mistakes and problems, like financial losses. There are also relationships between those airports that alter the frequency of flights each other, these effects may be related to policies, tickets price, distance ranges, etc..

The transfer of flights from an airport already saturated to another, unsaturated and with higher capacity, both in physical spaces like airport terminals and check-in areas to operational areas such as runways and courtyards, is expected to demand grow due to the increase of flights and destinations available. However, according to the literature access time is inversely proportional to demand, so that decreases demand after the transfer of flights to a more distant airport. For a case of an airport that was saturated, it`s expected demand increase after the transfer, because it would eliminate a bottleneck.

H1: Demand increases due to the transfer.

In the literature we can find several works that show the effects of a policy conducted in demand, but often it is presented in a linear method, which may not correspond to reality, because it is believed that after a change, it takes a while for the environment responds, and in this case, the transfer of flights from one airport to another, the impact on demand is believed to be exponential, as people and airlines will get used to the new environment over the time.

H2: Post-transfer demand changings it`s not linear over the years.

Another point that has been discussed in the literature is what happens with the demands for each distance ranges after a transfer of a closest airport to the metropolitan area to another more distant. Generally it is expected that for smaller distances occur a decrease in demand, and for long-haul, as the international could include a greater number of flights and destinations, it is expected to occur an increase.

H3: After transfer, demand increases for long-hauls and decreases to short-haul.

In this diagram we can visualize the demand impactful, and the consequences for the airports and costumers, and also the relationships between them.

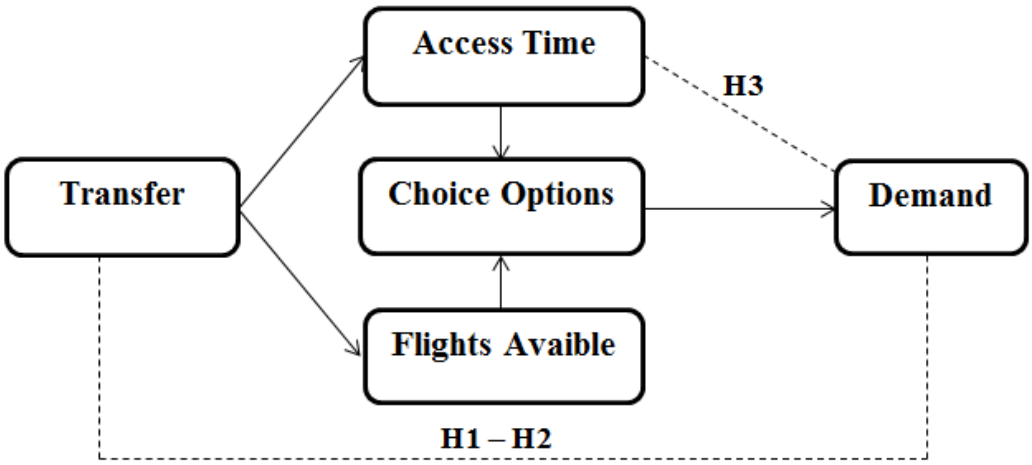

FIGURE 1 – DIAGRAM

Analyzing the diagram, we can check that transfer interfere the access time and the number of flights available, and both have an impact on passengers choice options, resulting in a demand change. Our hypotheses 1 and 2 measure the impact of a restriction, with caused the transfer of flights, on the demand in the region, hypothesis 3 evaluate what happen with demand for each distance ranges, so it's expected that for shorter flights, the access time have greater importance.

2. Empirical model development

2.1. Application

The region of Belo Horizonte is a very important region for the country, and is characterized by being one of the main economic centers of the country, also has tourist and cultural importance, so there is a great demand for airline travels in the region, especially for business travellers, these kind of people have some peculiarities, the time factor is very important for them, so they usually travel by plane. Therefore, factors like availability of flights, total departure and arrival times and proximity to the economic centers is essential.

The transfer of flights performed in the region of Belo Horizonte changed the main airport in the region, from Pampulha(downtown) to Confins(international). It passed from a closer to downtown but saturated, to another underutilized but farther from the center. The following is a plot of the annual demand for passengers over the years.

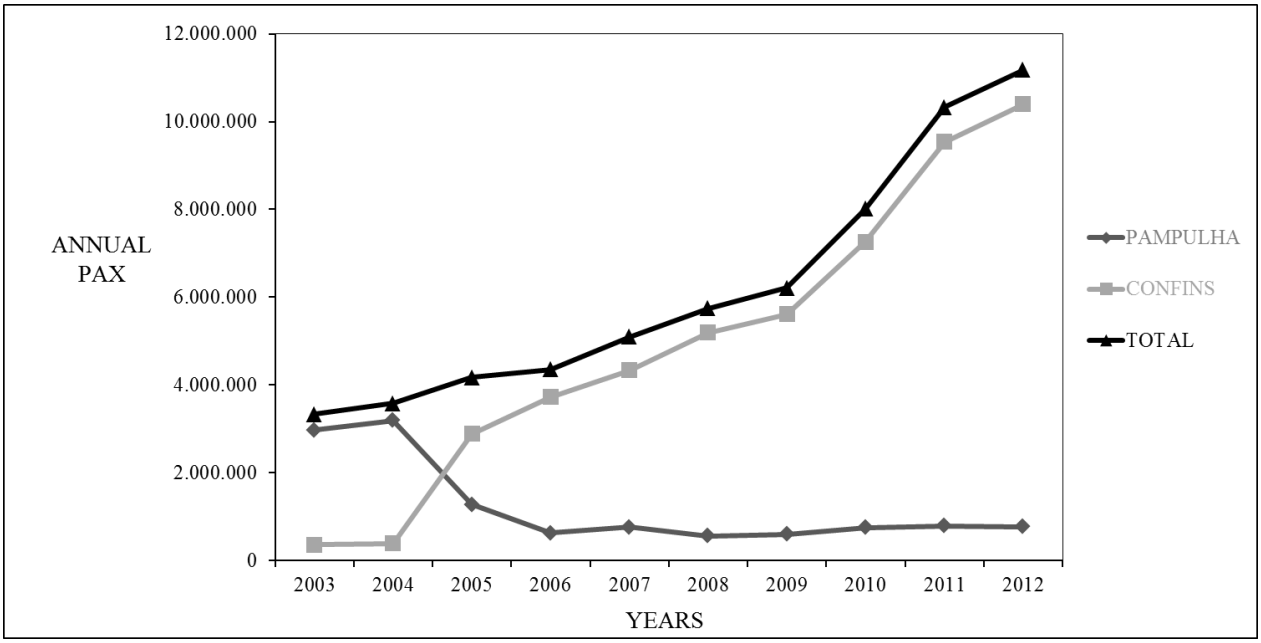

FIGURE 2 – Annual PAX x Years

The transfer of flights was held in 2005, it is possible to see from the chart the difference between the demands of each airport and the sum of them, immediately after the transfer, the annual passenger demand in Pampulha falls and remains virtually constant at approximately one million annual passengers, instead of that, the demand of Confins has a momentary growth and continues to grow exponentially over the years. The increase caused by Confins made the total demand in the region increased exponentially as well, directly following the increases in Confins. Another fact that has made the growth was even greater, was the entry of LCC AZUL in 2009, as can be seen in the chart.

This paper analyzes the direct impact of the transfer of flights in demand in the region, and how this impact occurred over the time, and also some other factors that may have contributed to changes in demand. For the result be as faithful as possible, will be held an econometric study, with variables known in the literature and some peculiarities of the region.

It is already known, that analyze the demand in a region of multiple airports is of paramount importance, because it is related to regions with a high demand, but rather peculiar, with very demanding customers. There are projects for future expansions and improvements at airports in these region, projects that require large investments, so a good analysis is important, to does not incur unnecessary expenses or lack of options due to lack of planning.

2.2. Data

The database used is from:

- INFRAERO(Brazilian Airport Infrastructure Company)
- ANAC(National Civil Aviation Agency)
- IPCA(National Index of Consumer Prices Wide)
- IBGE (Brazilian Institute of Geography and Statistics)

From the years 2005 to 2012 data.

The data were adjusted by economic, geographic and local factors.

2.3. Empirical model

After analyzing the literature and discussion of what may have effect on demand in the

region, the chosen variables were: yield, income per capita, connections on the route, presence of LCCs, presence of budget carriers, small regional carriers, the codeshare Varig-tam and dummies after transfer. It was also used monthly dummies and origin-destination to control endogeneity.

Below are the models:

$$\begin{aligned} ln\, pdew_{kt} = {} & \beta_0 + \beta_1\, ln\, yield_{kt} + \beta_2\, ln\, income\, pcap_{kt} + \beta_3 ln\, conn\, share_{kt} \\ & + \beta_4 After\ Transfer_{kt} + \beta_5 preslcc_{kt} + \beta_6 presbud_{kt} + \beta_7 majors_{kt} \\ & + \beta_8 presreg_{kt} + \gamma_0 k + \gamma_1 RM + \varepsilon_{kt}, \end{aligned} \tag{1}$$

$$\begin{aligned} ln\, pdew_{kt} = {} & \beta_0 + \beta_1\, ln\, yield_{kt} + \beta_2\, ln\, income\, pcap_{kt} + \beta_3 ln\, conn\, share_{kt} \\ & + \beta_4 First\ Triennium\ AT_{kt} + \beta_5 Second\ Triennium\ AT_{kt} \\ & + \beta_6 Third\ Triennium\ AT_{kt} + \beta_7 preslcc_{kt} + \beta_8 presbud_{kt} + \beta_9 majors_{kt} \\ & + \beta_{10} presreg_{kt} + \gamma_0 k + \gamma_1 RM + \varepsilon_{kt}, \end{aligned} \tag{2}$$

$$\begin{aligned} ln\, pdew_{kt} = {} & \beta_0 + \beta_1\, ln\, yield_{kt} + \beta_2\, ln\, income\, pcap_{kt} + \beta_3 ln\, conn\, share_{kt} \\ & + \beta_4 T1\ Dist\ 300_{kt} + \beta_5 T2\ Dist\ 300_{kt} + \beta_6 T3\ Dist\ 300_{kt} + \beta_7 T1\ Dist\ 600_{kt} \\ & + \beta_8 T2\ Dist\ 600_{kt} + \beta_9 T3\ Dist\ 600_{kt} + \beta_{10} T1\ Dist\ 900_{kt} \\ & + \beta_{11} T2\ Dist\ 900_{kt} + \beta_{12} T3\ Dist\ 900_{kt} + \beta_{13} T1\ Dist > 900_{kt} \\ & + \beta_{14} T2\ Dist > 900_{kt} + \beta_{15} T3\ Dist > 900_{kt} + \beta_{16} preslcc_{kt} \\ & + \beta_{17} presbud_{kt} + \beta_{18} majors_{kt} + \beta_{19} presreg_{kt} + \gamma_0 k + \gamma_1 RM + \varepsilon_{kt}, \end{aligned} \tag{3}$$

where:

- pdew (passengers daily each way) is the amount of daily passengers arriving or departing from Belo Horizonte;
- yield is the medium price of the tickets charged at each travel, adjusted for distance;
- income pcap is the average income per capita of the regions of origin an destiny of the each flight adjusted by gini coefficient;
- conn share is the higher percent of connections between origination and destination airports.
- After Transfer is a single dummy variable post-transfer;
- preslcc is a dummy for the presence of LCCs;
- presbud is a dummy of presence of budget carriers;
- majors is a dummy of presence of the codeshare Varig-Tam;
- presreg is the presence of small regional carriers;
- (First, Second, Third) Trienniun AT are dummy variables of trienniuns post-transfer
- T(1,2,3) Dist(300, 600, 900, >900) are the interactions between the trienniuns dummies with distances ranges(miles) [3].
- k is fixed effects of each route
- RM is seasonality effects of the region for each month
- ε is the error term, which are related to unobservable factors and potentially related to variable yield, it will be controlled for autocorrelation and heteroskedasticity.

In Brazil, we had another important fact in the period, which was the rise of the new middle class, so this variable was also tested, the results was not relevant, so we did not consider it to the model, the results with this variable can be found at the appendix:

- midclass is a dummy of presence of the new middle class.

All hypotheses can be tested by the models, with transfer dummy and post transfer triennium dummies will be possible to examine whether there was an increase due to transfer and how this growth was. With the interaction with dummies it will be possible to assess the assumptions related to distance ranges, like the access time.

A simple model was run with the variables of the empirical model without control of endogeneity and not robust to heteroskedasticity and autocorrelation problems. Analyzing this initial model is possible to note that the signals are consistent with the expected, the transfer dummy and LCC presence had relative relevance and statistical significance and the results are in the appendix.

The table 1 shows some descriptions of the continuous variables of our data.

[3] Ranges: 300 is from 0 to 300 miles; 600 is from 300 to 600 miles; 900 is from 600 to 900 miles; >900 is more than 900 miles.

Table 1 – Descriptive statistics of continuous variables

Variable	Obs	Mean	Std. Dev.	Min	Max
pdew	4723	472.4636	787.8628	30	5400.064
yield	4723	.7503662	.3963561	.1877413	2.433059
income pcap	4723	999.3253	337.3337	392.7746	2225.597
conn share	4247	.1137415	.0791459	.0306557	.5688199

2.4. Estimation strategy

Tests were conducted to check problems in the models.

2.4.1. Stationarity and cointegration

Also in the empirical model, stationary tests were held, for unit root, the test was performed for all continuous variables of the model, yield, income pcap, conn share. The Augmented Dickey-Fuller test (ADF) was used, with a deterministic trend, and with a number of lagged first differences. For all variables, the calculated ADF exceeded the critical value of 5% level of significance, not rejecting the unit root hypothesis for the variables, making them non-stationary. However, the variables could be cointegrated if exists any linear combination between them, making it stationary, if cointegrated, there is a long-term stability or equilibrium relationship between them. The Pedroni's test method was used to see if there is cointegration. It was performed with a linear deterministic trend, an intercept included in cointegration, one selected lag order 2, Suggested by the majority of the range. At 5% level of significance, the null hypothesis of no cointegration was rejected and the hypothesis of only one cointegration equation was not rejected for any of the variables

2.4.2. Multicolinearity, heteroskedasticity, autocorrelation

It was used the Variance Infltafor Factor (VIF) to measure the level of inflation of the variances, by a multicolinearity issue. The mean VIF of the model was 3.42. Only the variable income pcap presented a VIF higher than 10.5, it was found a VIF of 14.96 for it. So that could inflate it is estimation of standards errors and the interpretation of it is results should be interpreted with attention.

Tests were also performed to heteroskedasticity and autocorrelation. The implemented tests was Pagan-Hall, White/Koenker and Breusch-Pagan/Godfrey/Cook-Weisberg heteroskedasticity using alternative specifications of levels, squares, cross products of regressors and also fitted values of the regressand. The tests reject the hypothesis of homoskedastic disturbances. For autocorrelation , the Cumby-Huizinga test was made, and suggested the presence of autocorrelation of order 15.

The procedure of Newey-West was used to adjust the standard errors estimation.

2.4.3. Endogeneity and instrumental variables

Analyzing the literature, we have the variable yield is closely linked to demand and potentially linked to other unobservable factors such as promotions, etc.. The variable yield is strongly related to the term of error, resulting in an endogeneity problem. This problem could bring problems to the estimations, like bias, and damage our propositions, to such instrumental variables were used to correct this problem.

Our choice of instrumental variables was based in exogenous yield shifters, the instruments chosen was “average unit cost of fuel per ask”, “average unit cost adjusted for

distance and average stage of landing fees per ask", "average unit cost of navigation fees per ask", "average unit cost of aircraft insurance per ask"[4].

Tests were used to validate the relevance and quality of instrumental variables, to check overidentifying problems; we used the Hansen J. test. In all cases, the chi-square statistic was above 2, not rejecting the orthogonality of the instruments[5]. To underidentifying, the test used was Kleibergen-Paap rk LM statistic (KP), and also rejected the hypothesis of underidentifying.

2.4.4. Estimator

After the instruments were selected, the method employed was the equation-by-equation two-step feasible efficient generalized method of moments (2SGMM) estimator with statistics robust to arbitrary heteroskedasticity and autocorrelation. The limited information maximum likelihood (LIML) was also used as a crosscheck.

3. Results

Table 2 shows the coefficients obtained and their relevance for 2SGMM model.

[4] For comparison purposes, we present the results of OLS estimation in the Appendix.

[5] Note that the Hansen J test has a non-conservative a null hypothesis, as it assumes orthogonal instruments. It is non-conservative because is it well known in the literature that good instruments are typically hard to find. To increase the power of the test and thus avoiding Type II error - acceptance of a false null -, we adopted a significance level of 25%. Even with stricter significance levels - in this case, a broader critical region -, we could not reject the null in any situation.

Table 1 - Estimation results (2SGMM)6

	(1)GMM	(2)GMM	(3)GMM
ln yield	-0.4669**	-0.7470***	-0.6952***
ln income pcap	0.7289**	-0.1684	-0.0905
ln conn share	0.0106	-0.0343	-0.0305
After Transfer	0.1327**		
First Triennium AT		0.2788***	
Second Triennium AT		0.4145***	
Third Triennium AT		0.5439***	
T1 Dist 300			0.1901***
T2 Dist 300			0.3659***
T3 Dist 300			0.4493***
T1 Dist 600			0.2705***
T2 Dist 600			0.4335***
T3 Dist 600			0.5567***
T1 Dist 900			0.4275***
T2 Dist 900			0.1517
T3 Dist 900			0.6298***
T1 Dist>900			0.5412***
T2 Dist>900			0.6623***
T3 Dist>900			0.7339***
preslcc	0.3390***	0.3018***	0.3108***
presbudget	0.0210	0.0017	0.0023
majors	0.0296	0.0590***	0.0625***
presreg	0.0402	0.0600**	0.0565**
Adjusted R^2	0.9425	0.9381	0.9422
RMSE	0.2961	0.3073	0.2975
F	325.778	298.719	313.590
N_Obs	4247	4247	4247

[6] Results produced by the two-step feasible efficient generalized method of moments estimator (2SGMM); statistics robust and efficient to arbitrary heteroskedasticity and autocorrelation; figures are representative of the estimated elasticities calculated at the sample mean; P-value representations: ***p<0.01, ** p<0.05, * p<0.10; results generated by alternative estimators presented in the Appendix.

Observing this table, we are able to see some occurrences:

Income per capita will lose significance when the triennium dummy variables and the interaction of triennium and distance ranges are used, it may be related to the fact that income per capita has grown over the years, as well as dummies, causing it loss of statistical significance.

The triennium dummies had higher rates than a single dummy transfer as dividing it into periods, it can better explain what happened to the demand, causing its coefficients have greater relevance.

There is an increase in the coefficient of the triennium dummies over the time, which shows that the influence of transfer of flights in demand was getting bigger every triennium. Reforms and increased Confins capacity were gradually increasing demand over time. The custom of the people and the airline companies to use the airport may also have influenced, over time people will get used to the another airport.

As for dummies of distance ranges interacted with the trienniums, we can see that for longer distances, the coefficients are also higher, indicating that there was an increase in long-haul flights after the transfer. The expansion of the Confins airport and the creation of new routes and longer, meant that the coefficients were higher for longer distances. It has a growth in the short-haul flights also, which was not expected.

The presence of LCCs on all models showed great impact on demand, the Varig-TAM codeshare and small regional companies also had significance in many of the models, but with lower impact on demand. The presence of Budget companies was not statistically significant. The airline's entry Azul in Confins may be related to the high coefficient of the presence of LCCs.

4. Robustness checks and limitations

Table 3 - Estimation results (2SGMM) and (LIML)7

	(1)GMM	(1)LIML	(2)GMM	(2)LIML	(3)GMM	(4)LIML
ln yield	-0.4669**	-0.5300**	-0.7470***	-0.7808***	-0.6952***	-0.7010***
ln income pcap	0.7289**	0.6476*	-0.1684	-0.1806	-0.0905	-0.0638
ln conn share	0.0106	-0.0083	-0.0343	-0.0517	-0.0305	-0.0383
After Transfer	0.1327**	0.1466**				
First Triennium AT			0.2788***	0.2800***		
Second Triennium AT			0.4145***	0.4116***		
Third Triennium AT			0.5439***	0.5420***		
T1 Dist 300					0.1901***	0.1846***
T2 Dist 300					0.3659***	0.3593***
T3 Dist 300					0.4493***	0.4315***
T1 Dist 600					0.2705***	0.2644***
T2 Dist 600					0.4335***	0.4241***
T3 Dist 600					0.5567***	0.5399***
T1 Dist 900					0.4275***	0.4200***
T2 Dist 900					0.1517	0.1144
T3 Dist 900					0.6298***	0.6142***
T1 Dist>900					0.5412***	0.5351***
T2 Dist>900					0.6623***	0.6372***
T3 Dist>900					0.7339***	0.7201***
preslcc	0.3390***	0.3314***	0.3018***	0.2917***	0.3108***	0.3049***
presbudget	0.0210	0.0162	0.0017	-0.0013	0.0023	0.0030
majors	0.0296	0.0345	0.0590***	0.0625***	0.0625***	0.0636***
presreg	0.0402	0.0428	0.0600**	0.0653**	0.0565**	0.0572**
R^2Ajustado	0.9425	0.9417	0.9381	0.9373	0.9422	0.9421
RMSE	0.2961	0.2982	0.3073	0.3094	0.2975	0.2977
F	325.778	316.291	298.719	291.949	313.590	312.073
N_Obs	4247	4247	4247	4247	4247	4247

[7] Results produced by the two-step feasible efficient generalized method of moments estimator (2SGMM) and limited information maximum likelihood (LIML); statistics robust and efficient to arbitrary heteroskedasticity and autocorrelation; figures are representative of the estimated elasticities calculated at the sample mean; P-value representations: ***p<0.01, ** p<0.05, * p<0.10; results generated by alternative estimators presented in the Appendix.

According to the literature, LIML model has less problems of bias, however, with less accurate statistics compared to the model 2SGMM. So to make a good comparison both models are presented together.

Both models showed very similar results, most of the signs are in line with expectations and with the literature, only income PCA and conn share had exchanged signals, but when it occurred, the significance was low therefore have no relevance.

Conclusion

It was concluded that, after the restriction, the demand has increased due to the transfer of flights from Pampulha to Confins, and that growth it was higher over the time and to longer distances. Our results shows something not expected, like the increase on short-haul flights, it was expected a decrease according to the literature. The decreased demand on Pampulha airport, led to an increase in the demand of Confins, but the increase in Confins was greater than the decrease in Pampulha, making the total demand increase.

Takebayashi (2012), said that government restriction, in that case the perimeter rule has been good for passengers and airlines. In our case the downtown airport restriction also brought benefits, such as increased demand in the region.

Grouping years after transfer in trienniums was important because it showed that after a restriction, the changes do not occur linearly, in this case the demand has been growing exponentially over time. The result can explain better than a single dummy, because better represents the effects of a restriction. This grouping of dummies in periods could be used in future studies with similar characteristics.

According to Hess and Polak (2005) study, the access time is important for the passenger, so an increase in the access time would bring demand decrease, but in our study neither for short-haul flights was decreased demand.

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Appendix

Table 4 - Estimation results – Empirical model (OLS)

	(1)OLS	(2)OLS	(3)OLS
ln yield	-0.2452***	-0.2336***	-0.1600***
ln income pcap	1.0413***	0.7393***	0.8485***
ln conn share	0.0337*	0.0129	0.0315*
After Transfer	0.0739***		
First Triennium AT		0.1297***	
Second Triennium AT		0.1807***	
Third Triennium AT		0.3421***	
T1 Dist 300			-0.0025
T2 Dist 300			0.0622*
T3 Dist 300			0.1855***
T1 Dist 600			0.1529***
T2 Dist 600			0.2434***
T3 Dist 600			0.3733***
T1 Dist 900			0.3362***
T2 Dist 900			-0.0311
T3 Dist 900			0.4914***
T1 Dist>900			0.5310***
T2 Dist>900			0.5975***
T3 Dist>900			0.6610***
preslcc	0.3530***	0.3108***	0.3222***
presbudget	0.0515***	0.0677***	0.0555***
majors	0.0163	0.0249**	0.0288**
presreg	0.0422***	0.0615***	0.0428***
Adjusted R^2	0.9438	0.9448	0.9489
RMSE	0.2927	0.2904	0.2797
F	767.989	764.489	754.456
N_Obs	4247	4247	4247

Table 5 - Estimation results with midclass variable (GMM)

	GMM
ln yield	-0.5197*
ln mean(income pcap)	1.0568***
ln max(conn share)	0.0212
Midclass	-0.1356
majors	0.0107
preslcc	0.3342***
presbud	0.0243
presreg	0.0343
Adjusted R^2	0.9417
RMSE	0.2981
F	311.320
N_Obs	4247

Table 6 - Estimation results – (LIML)

	(1)LIML	(2)LIML	(4)LIML
ln yield	-0.5300**	-0.7808***	-0.7010***
ln income pcap	0.6476*	-0.1806	-0.0638
ln conn share	-0.0083	-0.0517	-0.0383
After Transfer	0.1466**		
First Triennium AT		0.2800***	
Second Triennium AT		0.4116***	
Third Triennium AT		0.5420***	
T1 Dist 300			0.1846***
T2 Dist 300			0.3593***
T3 Dist 300			0.4315***
T1 Dist 600			0.2644***
T2 Dist 600			0.4241***
T3 Dist 600			0.5399***
T1 Dist 900			0.4200***
T2 Dist 900			0.1144
T3 Dist 900			0.6142***
T1 Dist>900			0.5351***
T2 Dist>900			0.6372***
T3 Dist>900			0.7201***
preslcc	0.3314***	0.2917***	0.3049***
presbudget	0.0162	-0.0013	0.0030
majors	0.0345	0.0625***	0.0636***
presreg	0.0428	0.0653**	0.0572**
R^2Ajustado	0.9417	0.9373	0.9421
RMSE	0.2982	0.3094	0.2977
F	316.291	291.949	312.073
N_Obs	4247	4247	4247