Exploring causality between economic growth and air transport demand for Argentina and Uruguay

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Abstract: This paper investigates the effects in the long-term between air transportation and the economic growth in Uruguay and Argentina. Employing annual data from 1970 to 2011, the study uses cointegration analysis to consider the existence of a long-run relation between real GDP and the number of air passengers in each country. Results show that for both considered countries, the series are cointegrated and it is possible to estimate an error correction model (ECM). The Granger causality test shows that causality goes unidirectionally from GDP to air-transport for both countries. The elasticity and impulse-response function analysis shows that the effect of a GDP shock on the number of passengers is higher in Uruguay than in Argentina, which is consistent with the characteristics of the air market and the geographical conditions of each country. The results suggest different policy and planning implications.

Keywords: economic growth; air transport; cointegration; Granger causality; Argentina; Uruguay; passengers; impulse-response; shock; error correction; long-run.

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1 Introduction

The second half of the 20th century saw the development of global air and telecommunication networks in conjunction with economic globalisation (Bowen and Rodrigue, 2013). The set of activities that collectively make this unprecedented mobility possible is known as air transportation. While maritime transportation is the physical paradigm of globalisation, air transportation supports the accelerated mobility of passengers and specialised freight (Rodrigue, 2013).

Air travel is growing faster, with total revenue passenger kilometres (RPKs) growth of 5.9% in mid-2014, the best since 2011, moving above the 5.5% trend of the past 20 years [International Air Transport Association (IATA), 2014]. Further, air transportation is an important factor for the economic development of a region (Graham and Guyer, 2000) and conversely, economic development may encourage a region to provide increased and better air transportation.

Economic growth depends on increases in capital and labour inputs and in total factor productivity. Air transport is an important channel of economic growth. The effects can be direct, through investment in transport infrastructure, vehicles and logistics systems and increasing physical capital; or indirect through the impact that more efficient air transport can have by inducing greater efficiency in the way that other sectors use their own inputs (Leung, 2006). Improvements in air transport infrastructure imply a reduction of the costs of long-distance trade and make markets more integrated. It must be noted that air transport and the economy have a two-way connection; changes in the supply of air transport affect the level of economic activity and vice versa. This demand for air transport is a direct consequence of an increase of economic and social activities. In particular, the acquisition of goods by end users requires products to be transported and the demand of air transport for passengers rises from different cultural, tourist and social needs. From a theoretical perspective, four different causality relationships between transport activity (in particular air transport) and economic growth are possible (see Hakim and Merkert, 2016). First, air transport activity is a crucial factor of economic growth and supports it. Second, growth in the demand for travel depends on economic growth. Third, the causality is bi-directional in the sense that each factor has an effect on the other. Finally, there is no relationship between the two variables.

In the new global economy, economic opportunities are related to the mobility of people, goods and information. In economies where the air transport infrastructure is highly developed and connected, economic and social benefits result in positive multipliers (Bowen and Rodrigue, 2013; Fernandes and Pacheco, 2010). On the one side, air transport is a significant foreign exchange earner facilitating the growth of international trade, tourism and investment; thus, contributing to capital goods that can be used in the production process (see Van De Vijver et al., 2014). In addition, air transport stimulates other economic industries as well as supporting the generation of employment and the rise in incomes (Özcan, 2013). Lastly, but not least, air transport causes positive economies of scale, helping to boost a country's competitiveness.

Contrarily, the economic growth of a country can also lead to significant effects on air transport by the development of hard infrastructures such as airports. A growing country needs to be connected with the global economy; firms need to be linked with potential foreign markets. In turn, airport infrastructures give the opportunity to promote export activities, including tourism, enhance business operations and productivity and influence company location and investment decisions (Halpern and Bråthen, 2011). On the other hand, when there is economic prosperity, unemployment rates trend downward while household income increases. This implies that people have more discretionary income and then, they can afford more air trips (Vasigh et al., 2013). Consequently, different effects will occur on regions they reach. In addition, increased economic activity contributes to generate employment, which ultimately causes an increase in business travel, the most important segment of travellers for airlines (Vasigh et al., 2013).

The precedent relationships reveal a typical strong correlation between air traffic and economic growth; however, the causation between both variables is not entirely clear. Therefore, considering that the type of causality differs from one country to another (Fernandes and Pacheco, 2010), this paper is written as a contribution to a better understanding of the air transport behaviour within a cointegration analysis and Granger causality framework, taking and comparing the cases of Argentina and Uruguay. Cointegration analysis and the estimation of an error correction model (ECM) allow determining long-term relationships between the variables of interest. Meanwhile, Granger causality is a statistical methodology applied in the economic context to test the relationship between two or more variables. Moreover, it is a technique for determining whether one time series is useful in forecasting another.

The structure of the paper is as follows: Section 2 presents a review of the related literature. Section 3 describes the main characteristics of air transport in both countries.

Section 4 introduces data and the methodological econometric framework. The following section presents the empirical results. The final sections present a general conclusion, policy implications and future perspectives.

2 Literature on causality relationship in the air transport

Aviation research has made significant progress during the last 15 years (Zhang and Czerny, 2012). It has been observed that economic growth worldwide is getting a significant boost from air transport, explaining why many countries have understood this sector as a competitive advantage (ACI, 2004; Button and Taylor, 2000). Then, different issues need to be addressed when assessing the impacts of this industry on national economies. For instance, accessibility is essential for the growth of air transport. In a study of Japanese airports, Yamaguchi (2007) shows significant productivity gained from improvement in air transport accessibility, mostly in agglomerated areas such as the Tokyo metropolitan region. Recent issues have also favoured the positive impact of air transport. This is the case of the emergence of the so-called 'new economies' (such as high-tech) which may encourage more international trade, thus, increasing further air travel demand (Button and Taylor, 2000; Graham, 2000). A study by Button and Taylor (2000) examined the link between international air service and economic development. Using data for 41 metropolitan areas in the USA, the authors statistically analysed the link between 'high-tech' employment and the number of direct routes to Europe offered by airports in the region. The analysis found that there was a strong and significant relationship between employment and air services to Europe, such that increasing the number of European routes served from three to four. Approximately, 2,900 'high-tech' jobs were generated.

Cooper and Smith (2005) examined the contribution of air transportation to tourism, trade, location/investment decisions and productivity. The study estimated that the net contribution of air transportation to trade (i.e., export minus imports) was €55.7 billion in 2003 across the 25 current EU members or approximately 0.6% of GDP.

Recently, Tinoco and Sherman (2014) in their empirical research study found evidence of positive influences of air transport and airline consortia to the local economic development. Overall, Coto-Millán et al. (2013) show that 1% increase in performance logistics index generates an increase of world economic growth of more than 0.011%.

In relation to studies from international organisms, it is also found a permanent interest in analysing the impact of the air transport sector on national economies. The study led by the World Bank (Arvis and Shepherd, 2011) provides a robust tool to incorporate in future research about transport and international trade such as the air connectivity index (ACI). The authors proved for a great number of worldwide airports (211) that liberalisation of air transport markets and the share in international production networks is closely correlated with the measure of connectivity.

Despite the mentioned impacts of air transport on economic development and the strong correlation between air transport demand and economic growth, there are few studies addressing the causal relationship between these variables (Green, 2007). This kind of body of literature has emerged in the last years. Regarding air cargo demand, Chang and Chang (2009) analyse the relationship between air cargo expansion and economic growth in Taiwan under a Granger causal framework. Their results indicate that air cargo traffic and economic growths are cointegrated, showing that in the short and in the long-run there is bidirectional causality. Using panel data, Mukkala and Tervo (2013) conduct an empirical analysis based on data for 86 regions and 13 countries at the European level. Their results show the existence of causality from air traffic to regional growth in peripheral regions, while for the core regions the causality is less evident. On the other hand, Chi and Baek (2013) analyse both the short and long-run relationships between economic growth and the movement of air passenger and cargo using the ARDL dynamic model for the case of the USA. The issue of how some external shocks have effects on the air transport demand is also examined by the authors. Main results indicate that in the long-run, air passenger and cargo demands tend to increase with economic growth. Finally, in more recent studies, Hu et al. (2015) examine 29 provinces in China from 2006–2012. Main conclusions show evidence of a long-run equilibrium relationship between economic growth and domestic air passenger traffic. They also found a long-run bidirectional Granger causal relationship between the two variables.

Reviewing those studies addressing Latin American cases, some investigations with dissimilar results are found. On the one side, Fernandes and Pacheco (2010) and Marazzo et al. (2010) investigate the relationship between air transport demand (using domestic route passenger-kilometres data as proxy of air demand) and economic growth (GDP as proxy) in Brazil. Both studies found a cointegration between the mentioned variables and the existence of a unidirectional equilibrium relationship. From 2015, a modest increase on this topic in the region of Latin America can be seen. For example, in Rodríguez-Brindis et al. (2015), authors take Chile as case of study. They applied an impulse-response analysis in order to evidence that an increase in the magnitude of air transport expansion in Chile produces a positive effect on economic growth in the country.

On the other hand, in Rodríguez-Brindis (2015) and Brida et al. (2016b), authors arrive to the same results for the case of Mexico.

And more recently, Pacheco and Fernandes (2017) go deep on how passenger movement behaves in Brazil analysing the relationship between air transport and macroeconomic indicators such as trade openness and the purchasing power of the main trade currency (USD). Their results show that changes in international trade indicators favour a long-run relationship with changes in international air passenger movement.

From the brief review, it can be argued that studies in this area are still scarce. Especially in the context of Latin America where studies addressing the dimensions of air transport sector are important to evidence the need of developing specific public policies (Pacheco and Fernandes, 2017). This paper examines the dynamic relationship between air transport (measured as the number of aircraft passengers) and economic growth within the regional economic context, which is briefly described in the next section in order to answer the following questions. First, is there a long-run equilibrium relationship between air transport industry and economic growth in Argentina and Uruguay? Second, if a stable long-run relationship exists, what is the direction of the causal relationship between these two variables?

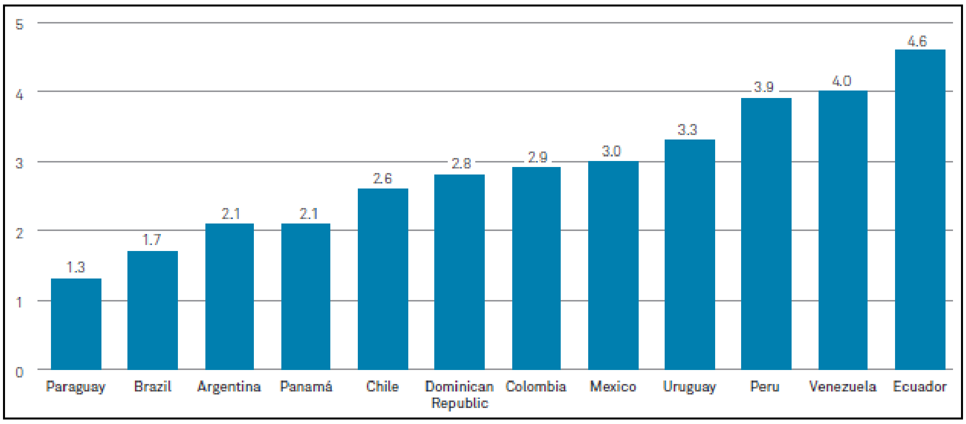
3 Argentina and Uruguay: a brief background of the economy and air transport performance in the context of MERCOSUR

This study has considered two Latin American countries: Argentina and Uruguay. These two countries are full members of MERCOSUR (Southern common market), one of the largest regional trade blocs in Latin America and the principal ones in South America. Argentina, together with Brazil, represents the largest economies, while Uruguay and Paraguay, the smallest ones. In the case of Uruguay and Paraguay, the trade shares with Brazil and Argentina account for approximately 30%–55% of total trade during 2006–2016.

In some South American countries, air transport has performed an important growth despite global economic issues (for example, global financial crisis in 2008–2009). This is the case of Argentina, Brazil and Uruguay, where traffic grew at high rates, especially, attributed to the commodities boom between 2002–2014, that boosted local consumption according to a recent S&P (2016) study. The firm's study shows that air passenger traffic growth rates were roughly the triple the real GDP growth, which averaged 2.7% between 2006 and 2016.

In Figure 1, it can be observed the elasticity between both variables varied from 1.3x for Paraguay to a peak of more than 4x for Ecuador, with the bulk in the 2.5x–3.5x range.

Figure 1 Elasticity between GDP growth and traffic performance 2006–2016 (see online version for colours)



An interesting pattern to note is that the domestic passenger traffic has performed a key role in the few past years (2009–2016) as a consequence of factors such as the rising middle class, greater access to financing and the arrival of low-cost carriers in the region. This is the case of Argentina, Uruguay and Brazil (MERCOSUR full members) where traffic continued growing at high single or double-digit rates.

With an open economy integrated into the world markets, Argentina is one of the largest economies in Latin America. It has a leading role in advocating the region's policy stance, as it is one of the two countries representing South America region at the G-20. Since 2003, Argentina has exhibited an outstanding economic performance with high growth rates. From 2003 to 2011, GDP grew at an average annual rate of 7.6% (World Bank, http://www.worldbank.org/en/). Notwithstanding the impact of the international economic crisis, the Argentine economy bounced back rapidly. During 2010, the economy grew 9.2% compared to 2009, experiencing an 8.9% growth during 2012 and a 2.9% growth during 2013 (World Bank, http://www.worldbank.org/en/).

For a country such as Argentina, air connectivity with the major markets is essential for the productive capacity of the economy and for the long-term economic development.

During the period 2002–2009, the country connectivity increased 12%. In the same line, air traffic grew at a compound annual growth rate (CAGR) of 6% in 2006–2016 (S&P, 2016), despite wide fluctuations in economic performance.

Air transport not only directly contributes to the country's GDP by generating wages, profits and tax payments, but also supports jobs and value-added in the wider economy through its supply chain. In 2008, the industry supported 36,148 jobs (direct, indirect and induced) and contributed in US $2,713 million (0.8%) to Argentine GDP, according to the IATA (2010).

On the other side, Uruguay is a market-oriented economy in which the state has played a noteworthy role. National economy has achieved the longest period of growth in history, registering annual average growth rates of over 5.5% during the last 11 years (World Bank, http://www.worldbank.org/en/). This expansion has been accompanied by a growth of the GDP per capita, which grew from US $10,000 in 2005 to almost US $17,000 in 2013, allowing Uruguay's economy to stand out as having the highest GDP per capita in Latin America (Uruguay XXI, http://www.uruguayxxi.gub.uy).

In 2015, the total international air passenger traffic to/from Uruguay exceeded 2 million passengers (DINACIA, http://www.dinacia.gub.uy/). Uruguay's largest airport is Carrasco 'General Cesáreo L. Berisso' International Airport, serving the capital Montevideo, which handled over 80% of Uruguay's international traffic. The other major airport with international traffic is 'Capitan Corbeta CA Curbelo' International Airport in Laguna del Sauce (Punta del Este), which serves especially to countries at Southern Cone region of South America. It is important to note that given the small size of the country and relatively flat terrain, domestic air traffic is almost inexistent.

The airline *Primeras Líneas Uruguayas de Navegación Aérea* (Pluna) was the national airline of Uruguay with a 25% state-owned until its operation cessation in July 2012.

However, Pluna's bankruptcy brought positive implications for the small but fast-growing intra-regional international market within MERCOSUR region since Pluna controlled 47% of the market. Specifically, the left routes were rapidly replaced by competitors which allowed traffic to be recovered completely by the end of 2013 (S&P, 2016).

The major international origin/destination (O/D) market for Uruguay is Argentina, followed by Brazil and other countries from different regions (InterVISTAS, 2009). This interdependence relationship is coherent with the economic context described previously.

4 Data and methodology

The selected variables to be considered are the number of passengers and the GDP. The first variable is obtained from the World Bank database and is defined as the total of air passengers carried, arriving or departing, by both domestic and international air carriers registered in the country. The GDP series is obtained from the Penn World Table (Feenstra et al., 2013) and it is expressed in purchasing power parity, eliminating the effect of prices distortions between countries. The considered period is 1970 to 2011 for the case of Argentina and 1970 to 2009 in the case of Uruguay, due to the lack of data for the passengers variable for the years 2010 and 2011.

As mentioned above, a cointegration analysis and an ECM will be run, following the methodology proposed by Engle and Granger (1987). At the same time, the direction of the relationship between the variables under consideration will be determined using a Granger causality analysis.

As first step, the order of integration of the series is identified by applying the augmented Dick and Fuller (ADF) unit root test following the technique of Dolado et al. (1990). To improve analysis of stationarity, it is possible to differentiate the tendency and the cycle of the series using the Hodrick-Prescott (HP) filter. When there are two or more non-stationary series, it is possible to find a linear combination that is stationary. In this case, it is said that the series are cointegrated. To check if the series are cointegrated, it is necessary to apply cointegration tests.

If it is found that the series are cointegrated, that means that their time paths are influenced by the extent of any deviation from long-run equilibrium. After all, if the system is to return to long-run equilibrium, the movement of at least some of the variables must respond to the magnitude of the disequilibrium. The dynamic model related with these characteristics is called ECM. In an ECM, the short-term dynamics of the variables in the system are influenced by the deviation from equilibrium (Enders, 2003).

Considering two cointegrated series X and Y, it is possible to define the short and long-run relation estimating the ECM, as:

$$\Delta Y_t = \lambda + \alpha_1 \Delta Y_{t-1} + \ldots + \alpha_i \Delta Y_{t-i} + \beta_1 \Delta X_{t-1} + \ldots + \beta_j \Delta Y_{t-j} + \phi z_{t-1} + \varepsilon_t \quad (1)$$

$$\Delta X_t = \lambda + \alpha_1 \Delta Y_{t-1} + \ldots + \alpha_i \Delta Y_{t-i} + \beta_1 \Delta X_{t-1} + \ldots + \beta_j \Delta Y_{t-j} + \phi z_{t-1} + \varepsilon_t \quad (2)$$

where λ is a constant, both i and j are the number of lags sufficient to cause the disturbance term ε_t to be I(0), z_{t-1} is the cointegration vector. Inclusion of z_{t-1} in the ECM acts as error correction term. The coefficients β in equation (1) reflect the immediate response of Y to a change in X and the coefficients α reflect the immediate response of X to a change in Y. The EC term represents the long-run equilibrium among the variables and the coefficient ϕ represents the speed of adjustment to short-run equilibrium in relation to long-run equilibrium.

In the context, it is possible to test the sense of the causality through applying the Granger causality test. Granger causality implies that a temporal variable X_t causes another temporal variable Y_t if the past information provided by X_t improves the predictions about Y_t that can be done by just using the past information of Y_t (Marazzo et al., 2010). Note that, since the test is based on an improvement in prediction from past values, it is often mentioned as a test of 'temporal relations' (Granger and Newbold, 1977) rather than of pure causality.

The existence of Granger causality at the presence of stationary series as in a VAR model can be analysed considering if some parameters of the model are zero in a context of an F-test procedure. However, Toda and Phillips (1993) show that when the series are not stationary, the test statistic does not have a standard distribution (Rambaldi and Doran, 1996).

In this context, it is necessary another test to consider the causality. The solution is the VEC Granger causality/block exogeneity Wald test for exclusion of the lagged independent variables proposed by Toda and Yamamoto (1995). This test considers if the lags of one variable Granger cause any other of the variables in the system, restricting all lags of one variable to zero in the equations of the other variables. The likelihood ratio of this test has a χ^2 distribution (Enders, 2003). This test determines, in this way, whether an endogenous variable can be treated as exogenous.

After estimating an ECM, it is also possible to check the effect of a shock in one variable on the other variables. The impulse-response functions show the response of the contemporary endogenous variables to a perturbation in one of them, assuming that this perturbation disappears in subsequent periods and new perturbations do not occur.

5 Results

Table 1 shows the results of the ADF test applied to the selected series, expressed in logarithm in order to obtain later the elasticities. We consider the possible existence of trend and intercept for each series. The number of residuals in the test is automatically determined according the Schwarz info criteria and it is showed in Table 1. We can see that both series (log passengers and log GDP) for the considered countries are integrated of order 1.

Table 1 ADF tests (log passengers and log GDP series) – Argentina and Uruguay

Argentina GDP	*Level*	*First differences*	*Uruguay GDP*	*Level*	*First differences*
Trend and constant	–2.604	–3.998*	Trend and constant	–3.032	–3.571*
	(0.280)	(0.016)		(0.136)	(0.004)
	Lags: 2	Lags: 0		Lags: 1	Lags: 0
No trend, constant	–0.312	–4.042*	No trend, constant	–1.102	–3.597*
	(0.913)	(0.003)		(0.705)	(0.010)
	Lags: 1	Lags: 0		Lags: 1	Lags: 0
No trend, no constant	2.259	–3.165*	No trend, no constant	1.106	–3.405*
	(0.093)	(0.002)		(0.927)	(0.001)
	Lags: 1	Lags: 0		Lags: 1	Lags: 0
Argentina pass	*Level*	*First differences*	*Uruguay pass*	*Level*	*First differences*
Trend and constant	–2.516	–6.816*	Trend and constant	–3.934*	–6.055*
	(0.319)	(0.000)		(0.002)	(0.000)
	Lags: 0	Lags: 0		Lags: 1	Lags: 0
No trend, constant	–1.810	–6.816*	No trend, constant	–2.046	–6.124*
	(0.370)	(0.000)		(0.266)	(0.000)
	Lags: 0	Lags: 0		Lags: 0	Lags: 0
No trend, no constant	1.384	–6.506*	No trend, no constant	0.643	–6.128*
	(0.956)	(0.000)		(0.851)	(0.000)
	Lags: 0	Lags: 0		Lags:	Lags: 0

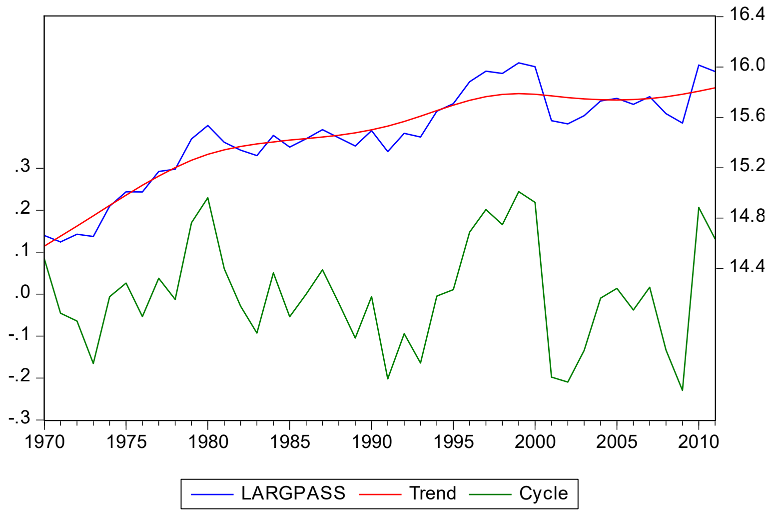
Notes: *Denotes rejection of the hypothesis at the 0.05 level. P-values expressed in brackets.

Source: Own calculations

Although at first sight there seems to be doubts about the degree of integration of the logarithm of passengers of Uruguay variable, when eliminating the trend and/or the constant, it is verified that the result of stationarity of the series in levels is not robust.

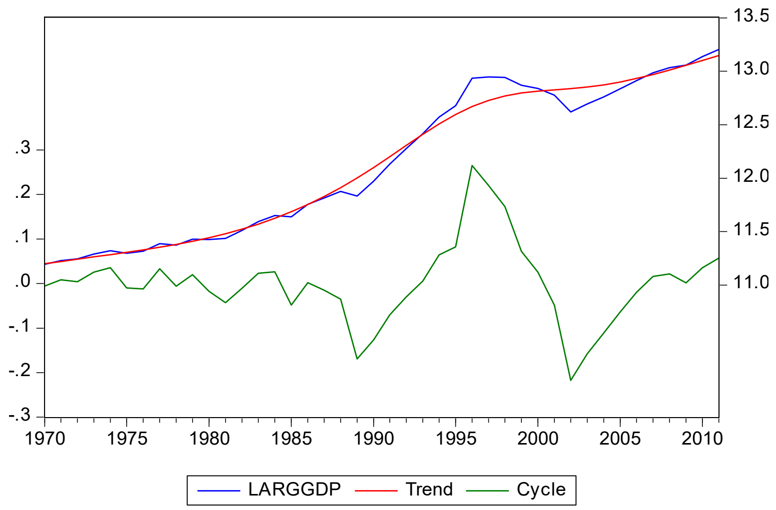
However, the result of stationarity of the series in differences is robust, which confirms that the series is integrated of order 1.

Figure 2 HP filter applied to log passengers series – Argentina (see online version for colours)



Source: Own calculations

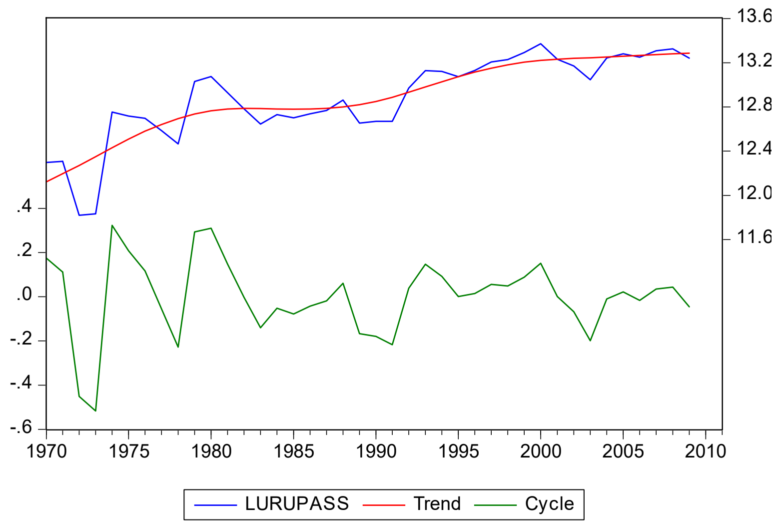
Figure 3 HP filter applied to log GDP series – Argentina (see online version for colours)



Source: Own calculations

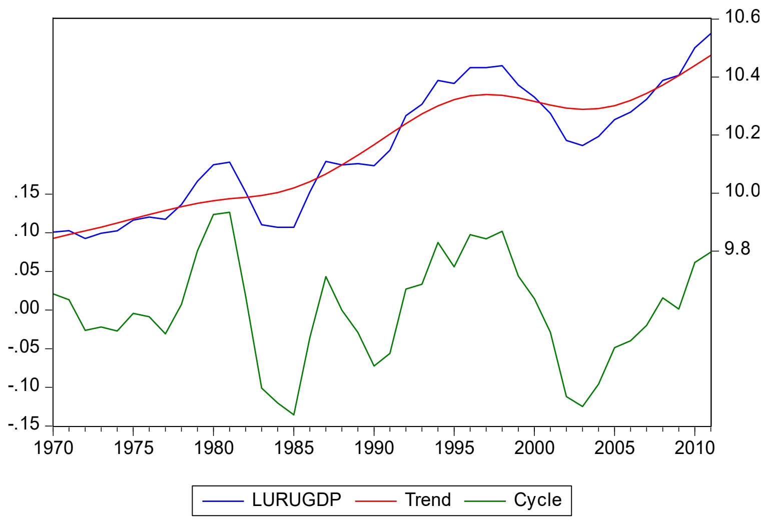
An additional element that can be included to improve the analysis is the application of the HP-test to differentiate graphically the tendency and the cycles in the series. Figure 2 shows the decomposition of the passengers series according to the HP filter for Argentina, while Figure 3 shows this analysis for the GDP in the same country. Figures 4 and 5 repeat the analysis for Uruguay. These figures suggest that both series show a very similar trend in the long-run for each country. At the same time, the cyclic series are stationary and also comparable, although it is possible to identify considerable peaks.

Figure 4 HP filter applied to log passengers series – Uruguay (see online version for colours)



Source: Own calculations

Figure 5 HP filter applied to log GDP series – Uruguay (see online version for colours)



Source: Own calculations

If two or more series are non-stationary but are integrated of order one, the next step consists in establishing whether there is a linear combination of the series that is stationary, indicating that they are cointegrated. Tables 2 and 3 show the results of the Johansenn cointegration test for each country.

Table 2 Johansen cointegration test – Argentina

Trace test		
Hypothesis	*Trace statistic*	*Critical value*
None*	16.834	15.494
At most 1	1.102	3.841
Maximum eigenvalue		
Hypothesis	*Max-eigen statistic*	*Critical value*
None*	15.731	14.264
At most 1	1.102	3.841

Notes: *Denotes rejection of the hypothesis at the 0.05 level.
Observations: 37; trend assumption: linear deterministic trend; lags interval: 2 to 4.

Source: Own calculations

Table 3 Johansen cointegration test – Uruguay

Trace test		
Hypothesis	*Trace statistic*	*Critical value*
None*	35.004	15.494
At most 1	0.773	3.841
Maximum eigenvalue		
Hypothesis	*Max-eigen statistic*	*Critical value*
None*	34.231	14.264
At most 1	0.773	3.841

Notes: *Denotes rejection of the hypothesis at the 0.05 level.
Observations: 36; trend assumption: linear deterministic trend; lags interval: 2 to 3.

Source: Own calculations

In order to perform this test, it is necessary to make some assumptions. In the first place we are going to suppose the existence of a deterministic tendency, which is compatible with the characteristics of the data. Second, we must also assume some behaviour of the variables for the choice of lags: there will be a lag in the impact of a change in one variable over the other, so we will start from the second lag. At the same time, seeking to capture past effects, we include up to the fourth lag. In the case of Uruguay, being the shortest series, we consider from the second to the third lag. Results show that for both considered countries, the series are cointegrated.

As there are two cointegrated series for both countries, it is possible to estimate the long-run relation between the variables through the ECM. Table 4 shows the results of the estimation of the cointegration relation for Argentina, while Table 5 shows the estimation for Uruguay. In both cases, we include two lags by defect. To simplify the presentation of results, we avoid in the tables the coefficients of the lagged variables for each model.

Table 4 ECM – Argentina

Error correction	*D(log(Pass))*	*D(log(GDP))*
z_{t-1}	–0.539	–0.097
	(0.138)	(0.083)
D(LARGPASS(–2))	–0.081	–0.073
	(0.171)	(0.103)
D(LARGPASS(–3))	–0.053	–0.187
	(0.171)	(0.103)
D(LARGPASS(–4))	–0.142	–0.017
	(0.176)	(0.106)
D(LARGGDP(–2))	0.132	0.314
	(0.317)	(0.191)
D(LARGGDP(–3))	0.251	0.146
	(0.325)	(0.195)
D(LARGGDP(–4))	0.540	0.066
	(0.325)	(0.195)
C	–0.008	0.032
	(0.027)	(0.016)
R squared	0.401	0.238
Adjusted R squared	0.256	0.054
Log likelihood	28.927	47.738

Note: Observations: 37; lags interval: 2 to 4.

Source: Own calculations

Table 5 ECM – Uruguay

Error correction	*D(log(Pass))*	*D(log(GDP))*
z_{t-1}	–0.876	–0.071
	(0.127)	(0.053)
D(LURUPASS(–2))	–0.042	0.006
	(0.111)	(0.047)
D(LURUPASS(–3))	–0.123	–0.077
	(0.100)	(0.042)
D(LURUGDP(–2))	–0.141	0.381
	(0.439)	(0.186)
D(LURUGDP(–3))	–1.184	–0.416
	(0.473)	(0.200)
C	0.059	0.016
	(0.021)	(0.008)
R squared	0.694	0.280
Adjusted R squared	0.643	0.160
Log likelihood	27.537	58.490

Note: Observations: 36; lags interval: 2 to 3.

Source: Own calculations

A very important aspect is to determine the sense of the causality between the variables under consideration. In this context, the appropriate methodology is, as mentioned, the VEC Granger causality/block erogeneity Wald test for exclusion of the lagged independent variables.

Table 6 Wald test for exclusion of the lagged independent variables – Argentina

	χ^2	*Probability*
Dependent variable: D(log(Passengers)) D(log(GDP))	5.930	0.115
Dependent variable: D(log(GDP)) D(log(Passengers))	3.719	0.293

Source: Own calculations

Table 7 Wald test for exclusion of the lagged independent variables – Uruguay

	χ^2	*Probability*
Dependent variable: D(log(Passengers)) D(log(GDP))	8.018	0.018
Dependent variable: D(log(GDP)) D(log(Passengers))	3.503	0.173

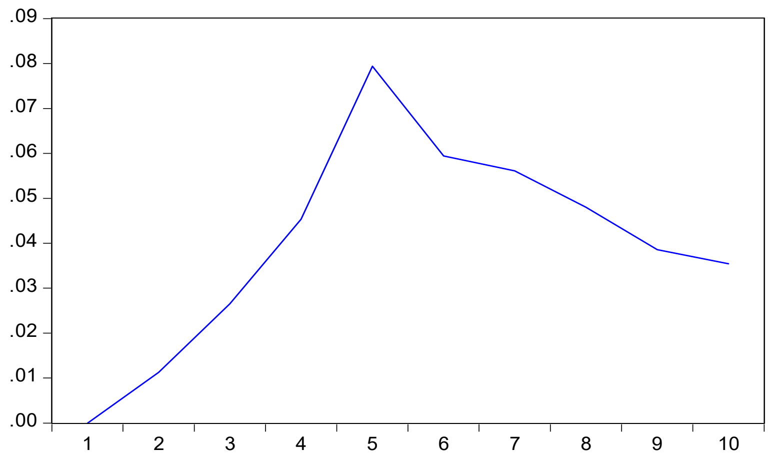
Source: Own calculations

As shown in Tables 6 and 7, the test suggests two interesting results. First, it offers the possibility to treat some of the endogenous variables as if they were exogenous. Second, it determines causality in the Granger sense between the variables.

The results of the Wald test for exclusion of the lagged independent variables for both countries show that GDP can be treated as an exogenous variable, having a relationship in advance or causality in the Granger sense regarding the number of passengers.[1]

This mentioned causal link can be analysed by considering, from the impulse response functions, the effects of an exogenous shock (an increase) on GDP on the number of passengers.

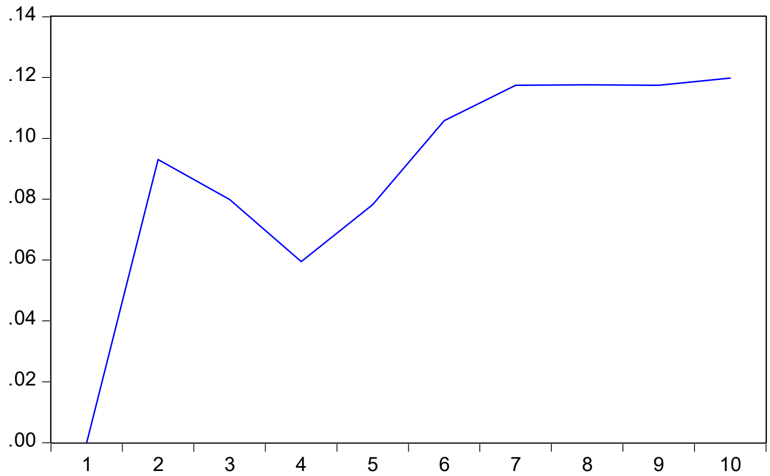
Figure 6 Impulse response function (shock in log GDP on log passengers) Argentina (see online version for colours)



Source: Own calculations

As shown in Figure 6, in the case of Argentina, there is an increasing effect for an extended period of time, reaching a maximum after five times and then it begins to decline. On the other hand, Figure 7 shows that for Uruguay the effect is different, from the existence of a strong initial effect that persists over time.

Figure 7 Impulse response function (shock in log GDP on log passengers) Uruguay (see online version for colours)



Source: Own calculations

Table 8 Normality test for residuals – Argentina

Test	*Chi-sq (joint)*	*P-value*
Skewness	0.010	0.917
Kurtosis	0.006	0.936

Notes: Orthogonalisation: Cholesky (Lutkepohl).
Null hypothesis: residuals are multivariate normal.
Observations: 37.

Source: Own calculations

Table 9 Normality test for residuals – Uruguay

Test	*Chi-sq (joint)*	*P-value*
Skewness	1.559	0.458
Kurtosis	0.186	0.911

Notes: Orthogonalisation: Cholesky (Lutkepohl).
Null hypothesis: residuals are multivariate normal.
Observations: 36.

Source: Own calculations

An additional analysis that is carried out to verify the validity of the ECM models is the check of the normality of the estimation residuals. Tables 8 and 9 show the results of these tests for both countries. The normality of the residuals is verified in both cases.

The cointegration equation shows the long-run relationship between the variables. Equation (3) shows the relation for Argentina, while equation (4) introduces the relation for Uruguay. Standard deviation is included in brackets.

$$\log(\mathit{Passengers}) = 12.066 + \underset{(0.065)}{0.283}\log(\mathit{GDP}) \tag{3}$$

$$\log(\mathit{Passengers}) = 0.452 + \underset{(0.132)}{1.317}\log(\mathit{GDP}) \tag{4}$$

The coefficients of log (GDP) can be interpreted as the elasticity of GDP respect to the number of passengers. It means that an increase in 1% in the GDP elevates the number of passengers in 0.28% in the case of Argentina and 1.317% in the case of Uruguay.

The different magnitude of these coefficients can be explained by the following aspects. In the case of Uruguay, as previously contextualised, due to the small size of the country and its relatively flat terrain, domestic air traffic is almost inexistent. Consequently, most of the air passenger's movements are international ones and in its turn, those are mainly tourism-motivated. Hence, this is congruent with the outstanding economic performance of the country in the last decade that has allowed Uruguayans to improve their welfare. Thus, as evidenced within the literature, international tourism trips have a higher sensitivity to income than a normal good (income elasticity higher than unity). In particular, tourism is a key factor for the Uruguayan economy by creating value-added, employment and income (Brida et al., 2010). For the case of Argentina, the demand for domestic air travels is strong; being the proportion of domestic travels on total air travels about 42% (Ministry of Tourism, http://desarrolloturistico.gob.ar/estadistica/indicadores-de-turismo-en-argentina). There are regions, especially in the area of Patagonia, where access is difficult by other means than air. All these features make air transport demand very inelastic, presenting a low response to changes in GDP.

6 Conclusions and policy implications

As one of the fastest growing aviation markets worldwide, the LAC region has successfully overcome numerous challenges and it is expected to continue expanding (S&P, 2016). This article focuses on the importance that air transport has for the economies of Argentina and Uruguay. Therefore, the relationship between the aircraft passengers' movement and economic growth is analysed. The study indicates a need to rethink policy and it may serve as a point of reference for other developing countries.

Regarding the two concerns at the beginning of this study, it can be affirmed that: first, there exists long-run cointegration between air passenger traffic and economic growth in Argentina and Uruguay. In this sense, the result is in line with that found for the case of Brazil (Marazzo et al., 2010; Pacheco and Fernandes, 2017), Mexico (Brida et al. 2016a), Czech Republic (Mehmood and Shahid, 2014), USA (Chi and Baek, 2013), Australia (Baker et al., 2015), Tunisia (Achour and Belloumi, 2016), European countries (Mukkala and Tervo, 2013), SAARC countries (Hussain et al., 2017), Turkey (Artar et al., 2016), Nigeria (Saheed and Iluno, 2015) and China (Hu et al., 2015). This suggests that this kind of tests jointly with sophisticated forecasting techniques can be strategic methodologies for stakeholders' decisions related to the management, planning and economic performance of air transport operations.

Second, regarding the direction of the causality, Granger causality tests show that there is long-run unidirectional causality between air transport expansion and economic growth. Contrary to the existing literature, we do not find a long-run bi-directional causality which could be a consequence that spatial dimensions and context matter, but this result is in line with the recent paper (Hakim and Merkert, 2016) that examines the causal relationship between air transport and economic growth in the South Asian context. This is also the case of the paper (Brida et al., 2016b) for Mexico. The absence of Granger causality from air transport to GDP could be explained by the fact that air transport sector is still growing in South America region. In fact, it could be argued that there is significant room for growth, which will depend primarily on economic growth, but also on a wide combination of variables, including an efficient air traffic control system, adequate investment climate, tourism development (Serebrisky, 2012) and the increasing arrivals of low-cost carriers. In addition, and more importantly, the development of infrastructure to handle the expected traffic growth in the longer-term.

Third, the study of the dynamic interactions of the variables, through the impulse-response analysis, indicates for Uruguay a strong and continuous reaction of air passenger traffic to an increase in GDP. Similarly, Argentina shows a strong reaction but with a short duration effect over time.

Policy and management implications could be drawn from the overall empirical findings. First, the study provides strong evidence that GDP can be a key driving force by increasing the demand for air travel in the long-run for the analysed countries. For the case of Uruguay, after its economic recovery and current outstanding performance, it is likely to increase outbound travel flows. In the case of Argentina, the spectrum of positive effects reaches both domestic and international air transport flows. The causality direction found for Argentina suggests that current travel restrictions policies have little adverse or no effect on economic growth.

As further implications for the Uruguayan case, the results can offer critical inputs for regional and international airlines, which can find an attractive target in the Uruguayan market. For government and national aviation authorities, the current conjuncture is a positive moment to boost the air transport sector throughout new bilateral agreements. These allow increasing foreign passengers' flows (Button and Taylor, 2000) and recovering the lost connectivity after the demise of the national carrier, Pluna.

If the previous implications are put into practice, this would naturally yield the feedback effect for the development of the air travel industry and bidirectional causality relationships between the two variables.

7 Limitations and further perspectives

Uruguay is a small country with almost null air domestic market but, as pointed previously in this paper, the national market of Argentina is a significant portion of the overall air transport market. Thus, it would be useful to obtain data regarding regional level in order to obtain a more accurate analysis of the dynamic relationship between the air transport demand and economic growth. These data are not yet available. A regional perspective of the present exercise would offer more accurate tools for decision makers in the sector.

There are still important aspects of regulation to be addressed in Argentina. Many of the air service agreements to which Argentina is a signatory remain restrictive in nature, setting many limits on capacity, designated airports and, in some cases, approved airlines and pricing (IATA, 2010). Therefore, further liberalisation actions could boost international traffic. Then, if the mentioned restrictions were overcome, it would be necessary to upgrade the analysis provided here in order to assess the impact under new panorama.

Future research can also include the study of other Latin-American countries to be compared with the results of this paper or the introduction of alternative econometric methodologies to study the Granger causality in this context, that allow to consider the presence of nonlinearities in data. Finally, as suggested by one of the reviewers of this paper, an interesting line of research could be to take into account international and domestic air transport demand or to consider regional versus non-regional air transport demand, extending the period of analysis.

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Notes

1 In the case of Argentina, the p-value is 0.11. As this value is near the 10% of error, the null hypothesis can be rejected in the limit.