Dynamic relationship between air transport and economic growth in Italy: a time series analysis

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Abstract: This paper studies the causal relationship between air transport demand and economic growth in Italy for the period 1971–2012. Johansen cointegration analysis shows the existence of one cointegrated vector between real GDP and air transport (represented by aircrafts movements) where the corresponding elasticities are positive. The Granger Causality test shows that causality goes unidirectionally from air-transport to GDP. The results imply that Italy can improve its economic growth performance by strategically harnessing the contribution of the air transport industry and improving their governance performance. Although air transport industry has grown significantly in Italy, there are no empirical analyses, to our knowledge, regarding European region as an entire case of study, neither the particular case of Italy. Therefore, the value of this work is that it deals with the dynamics between the air transport sector and the Italian economy.

Keywords: air transport demand; economic growth; Granger causality; Johansen co-integration; Italy.

**1 Introduction**

Airports and aviation are essential elements of today’s national economy and transportation system. They provide a quick, efficient, and safe method to move people and goods, and they improve the quality of life of every citizen: The aviation industry facilitates greater global travel, economic links and trade, making possible to connect a country to the global economy. It helps to improve productivity levels to the benefit of an economy (Smyth and Pierce, 2007). Thus, air transport is a strategic factor and can play a key role in facilitating economic development, particularly in developing countries, and in enhancing long-term economic growth (Chang and Yu, 2014; Chang and Chang, 2009).

Positive effects of air transport on economic growth can be obtained through different channels. First, air transport is a significant foreign exchange earner within the increasingly globalised world economy, facilitating the growth of international trade, tourism and international investment, thus, contributing to capital goods that can be used in the production process (Van De Vijver et al., 2014). Second, air transport has an important role in stimulating investments in new infrastructure and competition. Third, given the complex mix of transport-related sectors and interest groups that operate, regulate and interact in it (Page, 2003), air transport stimulates other economic industries by direct, indirect and induced effects. Fourth, air transport contributes to the generation of employment and the rise in incomes (Özcan, 2013). Fifth, air transport causes positive economies of scale, and then, it also can help to boost a country’s competitiveness. Finally, air transport is an important factor in the diffusion of technical knowledge, the stimulation of research and development and the accumulation of human capital. Conversely, the economic growth of a country can also have significant effects on air transport expansion. This is the case of the development of hard infrastructures such as airport ones. A growing country needs to be connected to the global economy; firms need to be linked with potential sales markets. In turn, airport infrastructures give the opportunity to promote export activities including tourism, enhance business operations and productivity (Halpern and Bråthen, 2011). A clear related example is the air freight
volumes which continue to show solid gains supported by economic improvements in some regions (IATA, 2014a) Phenomena such the growth of digital economy has led to the appearance of new business transactions by facilitating the interchange of goods around the world. Consequently, air cargo movement has also undergone a revolution in which its differing demand patterns have driven the separation of cargo and passenger transportations networks, each optimised around their own demand-based resource allocation systems and allowing passenger aircraft to be designed to accommodate more people (IATA, 2011).

The correlation between economic growth and air transport has been examined, among others, using statistical methods such regression analysis. This is the case of Dobruszkes and Van Hamme (2011) who analysed how the global economic crisis has impacted the airline industry by regressing change in airline supply on GDP growth through multiple linear regressions for a set of 181 countries. On the other hand, Kasarda and Green (2005) examine the relationship between air cargo and economic growth whilst also analysing how factors such aviation liberalisation, quality of customs and degree of corruption condition its impact. In addition to research initiatives coming from the academic sector, the International Air Transport Association – IATA – has developed a detailed statistical analysis of the relationship between a country’s connectivity to the global air transport network and its level of productivity (IATA, 2014b).

Despite the mentioned impacts of air transport on economic development and the strong correlation between air traffic (from both passengers and freight 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 transportation traffic, 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 co-integrated showing that in the short and in the long run there is a bi-directional causality. From a different geographic sphere, Fernandes and Rodrigues Pacheco (2010) and Marazzo et al. (2010) investigate the relationship between air transport demand (using passenger kilometre data as proxy of air demand) and economic growth (GDP as proxy) in Brazil. Both studies found a co-integration between the mentioned variables and the existence of a unidirectional equilibrium relationship them. In a recent work, Chi and Baek (2013) analyse both the short and long run relationships between economic growth and air transport (representing by air passenger and cargo movements) using the ARDL dynamic model (autoregressive distributed lag) for the case of US. Authors also examine how some external shocks have effects on the air transport demand. Main results indicate that in the long run, air passenger and cargo demand tends to increase with economic growth. On the contrary, in the short run, air passengers movements are negatively affected by some external shocks (SARS epidemic and 9/11 event), however, these shocks have little effect on cargo demand.

Although air transport industry has grown significantly in Italy, to the best of our knowledge there are no empirical analysis regarding European region as an entire case of study neither the particular case of Italy. Consequently, this paper examines the dynamic relationship between the Italian air transport sector (from the perspective of airport’s movement and air freight movement) and economic growth, in order to answer the following questions. First, is there a long-run equilibrium relationship between air transport industry and economic growth in Italy? Second, if a stable long-run relationship exists, what is the direction of the causal relationship between these two variables?
The structure of the paper is as follows: in the next section, we briefly describe the main characteristics of air transport in Italy. Section 3 describes the data. The subsequent section presents the methodological econometric framework. Section 5 gives the empirical results. Finally, the last section discusses the results, offers concluding remarks, and indicates directions for future developments in this field.

2 Air transport in Italy

Currently, Italian airport system is composed of 112 operational airports, of which 90 are exclusively for civilian traffic use; 11 are military airports open to civil traffic as well, and the remaining 11 are exclusively of military use (ENAC). Moreover, From the 112 airports, 31 airports are of relevance for the industry during the next years. Of these airports, 10 are part of the UE core network, 13 operate a volume of over one million passengers per year, and 6 airports manage over a half million passengers per year (Masutti and Colucci, 2013). Italian airports are significant generators of revenues, wages, and jobs for the country. Not only do the airports themselves generate economic benefits, but also many other non-aviation employers who rely on the airport system to support their daily business activities also contribute to building the economy of Italy. With a market share of 9.5% within European air transport, Italian airport system is the fifth largest in the EU by number of passengers carried according to the National Institute of Statistic (ISTAT, 2014). As well as the passenger services, airfreight movements is an important part of the global transport network.

Figure 1  Trade relationship of Italian air freight (tons) (see online version for colours)

Source: Oxford Economics (2011) on behalf of IATA
Figure 1 illustrates the scenario for the Italian case. It can be seen that in terms of tonnage carried to and from Italy, 41% is traded with the Asia Pacific region with a further 15% linked to trade with the North American region. Freight shipments within the European region equate to 36% of the total while a smaller proportion of 7% is linked to the Middle East and Africa. As for the movement of both passengers and airfreight to Italy, the greatest risk comes from a slowdown in the growth of wealth being as well as the contraction in economic activity in international and EU level (Oxford Economics, 2011). Regarding airport traffic, during the period of the present analysis, aircraft movements grew from 293 thousands (of landings and take offs) to 1.4 million with a weak performance between 2008 and 2012, as can be noted in Figure 1.

**Figure 2**  Air transport and GDP (see online version for colours)

On the other hand, regarding low cost phenomenon, this market segment experienced the strongest current value growth in transportation in Italy with value sales of overall transportation grew by 2% with low cost airlines recording growth of 8% in 2012, reaching €4.1 billion (Euromonitor, 2013). The mentioned behaviour has left an important footprint in the Italian economy. Thus, the industry in 2009 has supported 0.8% of Italian GDP and 195,000 jobs or 0.8% of the Italian workforce (Oxford Economics, 2011). If the sector’s contribution to the tourism industry is included, these figures
rise to 1.5% of Italian GDP and 382,000 jobs, or 1.7% of the workforce (Budd and Goetz, 2014).

3 Data

Data applied in this study to represent economic growth are annual time series, from 1971 to 2012, of real gross domestic product (GDP). In addition, annual time series, from 1971 to 2012 corresponding to the number of aircraft movements (the total of take-off and landing of an aircraft at an airport) and air cargo (tonnes of freight and mail carried on aircraft flying to, from or within Italy) movements are used to represent air transportation dynamics. Data from air transport are provided by the library of the national aviation authority Ente Nazionale Aviazione Civile (ENAC) through its library manager. The real GDP series was obtained from OECD Stats. Figure 1 presents the series used in levels, although for the empirical analysis we use the variables in their logarithmic transformation, lnGDP, lnMOV and lnCARGO for the GDP, aircraft movements and airport cargo respectively.

4 Methodological framework

Before testing any causal link between air transport and GDP for the case of Italy we must first establish that there is a long-run relationship between those two variables. In this section, we develop the methodology used in the analysis of the variables, which relies in the econometric time-series literature.

4.1 Unit root testing

In the context of time series analysis, a stationary test is important to establish the estimation of the right model. While some economic series may be stationary, i.e., I(0), it is common to find non-stationary macroeconomic variables, in general presenting one unit root, i.e., first order integrated series (I(1)). As Granger (1988) pointed out, it is not possible for a I(1) variable to have a long run relationship with a I(0) variable, in that case, it is said that the equation does not ‘balance’. An equation balances when all the variables considered have the same order of integration. Thus, the first step of our empirical strategy implies performing a unit root test on the series.

Unit root testing was carried out using the Augmented Dickey-Fuller test (ADF) (Dickey and Fuller, 1979). The ADF test involves fitting the model:

$$\Delta Y_t = \mu + \beta T + \gamma Y_{t-1} + \sum_{j=1}^{k} \phi_j \Delta Y_{t-j} + \epsilon_t$$

(1)

where $Y_t$ and $\Delta Y_t$ are respectively the level and the first difference of the series, $\mu$ is a drift term which captures a possible stochastic trend and $T$ is a time trend variable. The $k$ lagged difference terms control for serial correlation in the residuals (with the number of lagged terms usually selected based on some information criterion) and $\epsilon_t$ is a white noise error term. After fitting the model, the test implies contrasting the null hypothesis
$H_0: \gamma = 0$, i.e., the series has a unit root, to the alternative hypothesis $H_1: \gamma \neq 0$, i.e., the series does not have a unit root.

4.2 Cointegration

After checking that the series are both I(1), we must check that an economically meaningful relationship between the variables exists and discard the spurious regression problem. When two I(1) variables present a long-run relationship they are said to be cointegrated. Formally, cointegration between two I(1) variables $(Y_t, X_t)$ implies that there is a linear combination of $Y_t$ and $X_t$ that is I(0). Conceptually, it means there is a long-run equilibrium linking the variables, i.e., they move together over time and although temporal shocks may drift them apart, in the long run they return to their common path.

Engle and Granger (1987) proposed a two-step method to check for cointegration between $Y_t$ and $X_t$ that involves running the regression:

$$Y_t = \mu + \beta X_t + u_t$$

and check the order of integration of the residuals $u_t$. This can be performed using the ADF test. If the residuals are I(0) then $Y_t$ and $X_t$ are cointegrated. A more general approach to cointegration was proposed by Johansen (1988) and Johansen and Juselius (1990) which consists of using a vector error correction model (VECM) specification:

$$\Delta Y_t = \mu + \prod Y_{t-1} + \sum_{j=1}^{k-1} \Gamma_j \Delta Y_{t-j} + \epsilon_t$$

where

$$\prod = \sum_{j=1}^k A_j - I_N,$$

$$\Gamma_j = - \sum_{j=1}^k A_j,$$

$A_j$ are $N \times N$ matrices of parameters, $Y_t$ is a $N \times 1$ vector containing the variables of interest, $\mu$ is a vector of constant terms analogous to equation (1), $N$ the number of variables; and $\epsilon_t$ is the usual error term, which allows us to control for factors omitted by the deterministic part of the model. Matrix $\prod$ conveys information about the long-run relationship between the $Y$ variables. The rank of $\prod$ expresses the number of cointegrating relations; that is, the number of linearly independent and stationary linear combinations of the variables. The tests for cointegration rely on placing restrictions on the rank of $\prod$ and are called the trace test and maximum eigenvalue test. As the test results are sensitive to the number of $k-1$ lags used in the specification of the model, information criteria are usually used to select the best model. If the tests show the existence of cointegration, then it is helpful to re-write equation (3) in the following way:

$$\Delta Y_t = \mu + \alpha \beta' Y_{t-1} + \sum_{j=1}^{k-1} \Gamma_j \Delta Y_{t-j} + \epsilon_t$$

(4)
where $\alpha$ is a $N \times r$ matrix of parameters known as the *adjustment coefficients* that show the speed at which each variable comes back to equilibrium after suffering a shock. $\beta'$ are the parameters of the cointegrating vectors, i.e., the parameters that characterise the long-run relationship between the variables, $\Gamma_i$ are the short run parameters and $r$ is the number of cointegrating relations.

When a long-run equilibrium relationship among the variables is detected, exogeneity must be tested in order to avoid misinterpretation in the meaning of the estimated parameters (McCallum, 1984). Following Johansen and Juselius (1990) and Johansen (1995), weak exogeneity of the variable $n$ in the cointegrating equation can be tested by applying zero restrictions on the relative rows of matrix $\alpha$. In this test, the null hypothesis is of weak exogeneity and consists of testing $H_0: \alpha_n = 0$. If the null hypothesis cannot be rejected then variable $n$ is said to be weakly exogenous in the estimation of $\beta$.

The first step is therefore to apply unit root tests to study time series stationarity. In the case of non-stationarity, we apply the Johansen cointegration test (Johansen, 1988; Johansen and Juselius, 1990) to detect long-run relationships in the data. Weak exogeneity and a modified version of the Granger causality test are then applied to analyse causality between the variables. In order to detect causality between air movements and economic growth, we refer to the methodological framework of Granger (1988), which is based on a ‘weak’ concept of causality (Granger, 1969). According to this perspective, one variable causes a second variable if the second variable can be better predicted with all the available information on it and the past history of the first variable, than without using the past history of the first variable. Therefore, this particular notion of causality is related to prediction and not necessarily to actual predetermination (Ahmad, 2001).

Lastly, the robustness of the results with respect to the model assumptions – that is, autocorrelation, non-normality and conditional heteroscedasticity in residuals – is tested, to check whether the VECM is a proper representation of the phenomenon under study.

5 Empirical results

5.1 Unit root testing, VECM and cointegration analysis

Table 1 and 2 present the results for the ADF test of the series. The former shows the results for the variables taken in their first difference, while the latter shows the results in ADF test performed in the series in levels. It is important to stress that the specification of the ADF test given by equation (1) is not trivial; meaning that unnecessarily including the drift and/or time trend parameters as well as their exclusion may lead to disturbances in the power and size of the test. Because of this, visual inspection of the series is important to establish the proper specification of the model. As the differenced series (omitted from the paper) do not show a growing pattern, we decided to include only a drift term in the model.

The results in Table 1 show that we can reject the null hypothesis of unit root at 1% confidence level, thus providing evidence that the analysed series are not I(2). Next step is to contrast the I(1) vs. I(0) hypothesis by performing the ADF test in the series in levels. In this case the analysis of the series in shows a growing pattern in all three variables, therefore, in order to avoid biases in the test result we included both drift and time trend in the model. According to the results shown in Table 2 we cannot reject the
null hypothesis of the existence of a unit root at any of the standard confidence levels, suggesting that all the variables are first order integrated processes I(1). Having established that we have a balanced equation to estimate we should proceed to test for a cointegrating relationship between lnGDP, lnMOV and lnCARGO. Following the methodology, we estimate a VECM to model the long-run relationship between the variables, using lnGDP as the dependent variable. Based on the minimum Akaike Information Criterion (AIC) we established a lag length of one in the specification of the model. Results shown in Table 3 show the existence of one cointegration relation between lnGDP, lnMOV and lnCARGO according to the trace test.

**Table 1**  
I(2) vs. I(1) test

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF test specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnGDP</td>
<td>–4.54***</td>
</tr>
<tr>
<td>lnMOV</td>
<td>–3.86***</td>
</tr>
<tr>
<td>lnCARGO</td>
<td>–3.89***</td>
</tr>
</tbody>
</table>

Notes: t-statistic reported  
Notes: Significance level: ***Rejection of the null hypothesis at 1%

**Table 2**  
I(1) vs. I(0) test

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF test specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnGDP</td>
<td>–0.41</td>
</tr>
<tr>
<td>lnMOV</td>
<td>–2.75</td>
</tr>
<tr>
<td>lnCARGO</td>
<td>–1.43</td>
</tr>
</tbody>
</table>

Notes: t-statistic reported  
Lag length selected based on Schwarz Information Criterion (SIC)

**Table 3**  
Unrestricted cointegration rank test (trace) using lnGDP, lnMOV and lnCARGO

<table>
<thead>
<tr>
<th>Hypothesised number of cointegrating relations</th>
<th>Eigenvalue</th>
<th>Trace statistic</th>
<th>0.05 critical value</th>
<th>P-value**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None *</td>
<td>0.587</td>
<td>4.769</td>
<td>2.979</td>
<td>0.0002</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.258</td>
<td>1.224</td>
<td>1.5494</td>
<td>0.1455</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.007</td>
<td>0.296</td>
<td>3.841</td>
<td>0.5863</td>
</tr>
</tbody>
</table>

Notes: *Denotes rejection of the null hypothesis at the 0.05 level  
**MacKinnon-Haug-Michelis (1999) p-values

However, looking at the cointegrating equation given in (5) (in parenthesis below the coefficients) we see that the coefficient associated with lnCARGO is not significant from zero. In our opinion, cargo demand does not have a significant relationship with GDP in Italy because most of the cargo transport in this country is done by other means of transport.
This indicates that the underlying long-run relationship between the three variables actually resembles the relation between lnGDP and lnMOV. Therefore, we proceed to estimate a VECM relating only lnGDP and lnMOV.

$$\ln GDP = 11.09 + 0.38 \ln MOV - 0.17 \ln CARGO$$

(5)

Table 4 shows the results for cointegration test between lnGDP and lnMOV. Trace test indicates the existence of one cointegrating relation between the variables. In this case, the selected lag length was two, based on minimum AIC. As we know that the lnMOV parameter is significant from zero in equation (5), we proceed with the weak exogeneity test. This test consists in testing the restriction that the adjustment parameter associated with lnMOV is equal to zero. The null hypothesis of the test is of weak exogeneity, i.e., $\alpha_{\ln MOV} = 0$. We fail to reject the null hypothesis at standard confidence levels with a Chi-square (1 d.f.) statistic of 1.31 and a p-value of 0.25, thus establishing that lnMOV is weakly exogenous.

Table 4  Unrestricted cointegration rank test (trace) using lnGDP and lnMOV

<table>
<thead>
<tr>
<th>Hypothesised number of cointegrating relations</th>
<th>Eigenvalue</th>
<th>Trace statistic</th>
<th>0.05 critical value</th>
<th>P-value**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None*</td>
<td>0.585</td>
<td>37.074</td>
<td>15.494</td>
<td>0.0000</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.045</td>
<td>1.850</td>
<td>3.841</td>
<td>0.1738</td>
</tr>
</tbody>
</table>

Notes: *Denotes rejection of the null hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The following step is to estimate the restricted model where $\alpha_{\ln MOV} = 0$ to obtain the proper long-run equation given by equation (6).

$$\ln GDP = 11.7 + 0.17 \ln MOV$$

(6)

As equation (6) shows, there exists a positive relationship between air transport, given by the airport movements and GDP in Italy. As the variables are in logarithms, we can interpret the coefficient of lnMOV as the long-run elasticity of the GDP respect to the airport movements. According to our estimation, an increase in 100% in air transport is associated with an increment of 17% in the GDP of Italy.

Table 5  Diagnostic tests for estimated VECM

<table>
<thead>
<tr>
<th>Test</th>
<th>Autocorrelation</th>
<th>Non-normality</th>
<th>Heteroscedasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test statistic</td>
<td>3.51</td>
<td>7.30</td>
<td>42.52</td>
</tr>
<tr>
<td>Distribution</td>
<td>$\chi^2(4)$</td>
<td>$\chi^2(4)$</td>
<td>$\chi^2(42)$</td>
</tr>
<tr>
<td>p-value</td>
<td>0.47</td>
<td>0.12</td>
<td>0.45</td>
</tr>
</tbody>
</table>

To check the adequacy of this modelling framework, we conducted some diagnostic tests for residual autocorrelation, non-normality and heteroscedasticity. In particular, in order to check the first problematic effect, we performed a Portmanteau test specified with three lags. Non-normality is diagnosed by the multivariate Lomnicki–Jarque–Bera-based test proposed by Lütkepohl (1991). The third violation of assumption is detected by a standard White heteroscedasticity test. In all three tests the null hypothesis is that the model is correctly specified, i.e., there is no autocorrelation, non-normality or
heteroscedasticity in the residuals. The results are listed in Table 5, which shows that the in all cases the null hypothesis cannot be rejected, thus implying that the model assumptions hold and that the VECM can properly represent the underlying data-generating process.

5.2 Granger causality and impulse-response function

The existence of a significant stable long-run relation between lnMOV and lnGDP is a necessary but not sufficient condition for causality between the two variables. In other words, we still need to determine which variable is the cause and which is the effect. In this paper, we apply the VEC Granger Causality/Block exogeneity Wald Test in order to assess the direction of the causality between both variables. The test involves checking whether an endogenous variable can be treated as exogenous by excluding the first difference term of the variable from the VECM equation (4). If a variable is correctly excluded from the model then it does not Granger causes the other variable. The null hypothesis of the test is of non-Granger causality, i.e., the $n$-th variable is correctly excluded from the VECM equation. Rejection of the null hypothesis is interpreted as evidence of $n$-th variable Granger-causing the other. Results in Table 6 show that we cannot reject the null hypothesis that the lnGDP does not Granger-cause lnMOV, but we reject the null hypothesis that lnMOV does not Granger-cause lnGDP. Thus, we find evidence of uni-directional causality from air-transport to GDP. The results imply that a change in the rate of economic growth does cause a significant expansion in air transport with a confidence level of 95%. It is worth noting that this result does not imply that economic growth has no impact on air transport growth. It just indicates that the level of GDP at any point is not a reliable predictor of the amount of economic activity in the air transport sector at a later point in time.

The outcomes obtained from this study are consistent with those in the study of Brida et al. (2016), Tinoco and Sherman (2014) and Coto-Millán et al. (2013) where they found evidence of positive influences of air transport, and airline consortia to the local economic growth and development. However, these results are not consistent with those of Chang and Chang (2009) and Hu et al. (2015) where they found bidirectional causality among economic growth and air transport expansion, nor with those of Chi and Baek (2013), Fernandes and Rodrigues Pacheco (2010) and Marazzo et al. (2010) where they found unidirectional causality from air transport to economic growth. The unidirectional causality relationship from air-transport to GDP implies that air transport expansion would be beneficial for economic development. The fact that causality from economic growth to air transport cannot be inferred, implies that it is not necessary an expansion of the economy to develop the air transportation sector. That is, the air transport industry can have an expansion even when the overall economy is not growing.

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>Chi-square statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnGDP does not Granger cause lnMOV</td>
<td>0.05</td>
<td>0.975</td>
</tr>
<tr>
<td>lnMOV does not Granger cause lnGDP</td>
<td>7.773</td>
<td>0.02**</td>
</tr>
</tbody>
</table>

Note: **Denotes rejection of the null hypothesis at 5% confidence level
To identify the time-span of the impact of air transport demand on GDP we compute the impulse response function, (see, for example, Lütkepohl, 2006 and 2004), which shows, ceteris paribus, how GDP reacts over time after a positive shock in the number of airport movements. Figure 3a shows the impulse-response analysis for a shock occurred in the period $t$ for a ten year horizon in a year by year approach, while Figure 3(b) shows the accumulated impact of air-transport on GDP.

Figure 3  Response to Cholesky one S.D. innovations (see online version for colours)

We find that $\lnGDP$ responds fairly quickly to a shock in $\lnMOV$ with the maximum impact taking place after three years ($t + 3$). We also find that the level of the shock is permanent on the GDP as it maintains the same from the third to the tenth year of analysis. Figure 2b shows the long run impact of $\lnMOV$ on $\lnGDP$. We find that after ten years, a positive shock on air transport causes an increase in GDP by approximately 10%. Thus, the impact of air transport expansion on economic growth is very significant. Our findings show the long term positive effects of the development of the aviation sector on the development of the economy, stressing the importance of the air transportation sector.

6 Conclusions

The aim of this study is to contribute to the understanding of the impacts of air transport on the growth of the Italian economy. We have studied the relationship between air transport, modelled as airport movements and air cargo volume, and economic growth in Italy under two perspectives. From one side, given that variables included in the model are not stationary and present a unified root, Johansen techniques were applied to investigate the long-run relationships between the variables previously mentioned. The empirical evidence obtained suggests the existence of a cointegration relationship between aircraft movements and GDP indicating a long run relationship between them. On the other hand, the Granger causality test reveals the existence of a unidirectional causality going in a positive direction from air transport to GDP. These results indicate that air transport expansion plays a crucial role in promoting economic growth in Italy. This is in line with the results of Beyzatlar et al. (2014) who found statistically significant
Granger-causality running from transportation (in general, not only for air transport) to GDP for the case of Italy in an analysis of several EU countries. Italy is not an exception with the unidirectionality: this result is also found for Ireland, Spain and Portugal, in which the authors suggest that constitutes evidence that middle-low income countries show unidirectional causality from air transport and GDP whilst high-income countries display bi-directional causality or running from GDP to transport. This could be also an explanation for the empirical results of unidirectional causality for Italy obtained in this study.

In particular, the study shows that, a positive shock on air transport causes a significant increase in GDP. Precisely, after ten years, a positive shock on air transport causes an increase in GDP by approximately 10% during three years. With respect to airport cargo demand, it appears to be a non-significant relationship in the long run with GDP. Italy can improve its economic growth performance by strategically harnessing the contribution of the air transport industry and improving their governance performance. Since airports are important engines of local development, it seems to be necessary to increase domestic traffic in order to have more decentralisation of local development caused by such activity. The overall conclusion is that, within limits, more air transportation is likely to stimulate further growth in the Italian economy. Formal incentives should be given to the air transport sector to increase its macroeconomic contribution to growth.

The positive unidirectional relationship of causality can be attributed to direct and indirect effects of the air transport sector. Direct effects include transportation of passengers. Indirect benefits include benefits that accrue to other industries through backward and forward linkages of the air transport sector multiplying the effects and increasing the economic activity and hence growth.

Policy and management implications could be drawn from the empirical findings. First, the study reaffirms the idea of the need to avoid constraints in the development of the civil aviation sector in order to boost the nation’s competitiveness. This would lead to an increase of domestic and foreign investments, as well as the development of economies of scale (Marazzo et al., 2010). Second, this research suggests that in the long run the national economy would be enhanced by improving its level of connectivity by the development of the air transport sector. This will give opportunities to means enhancing links within and between businesses and accessing to international capital markets (IATA, 2014a). In addition, it will support the development of remote regions. Also, policy makers should note that providing the conditions for better air transport in the present will have a long run impact on the GDP. The empirical results of this study show that air transport policy in Italy is an important tool to the socioeconomic development of the country and policy makers should take account of the significant income elasticity of the sector and its multiplier effect on the market.

Based on the present study, more questions arise as follows. What are the relationships between the air transport sector and other economic sectors, in particular with the tourism sector? The growth of the air transport sector is affecting the willingness to travel of higher-yielding travellers, so that the overall GDP contribution of tourism may be diminished – and then the contribution of the air transport sector to the overall economic growth? Can the growth of the air transport sector be always thought as sustainable? These questions give rise to opportunities of future research in this topic. In addition, further investigations need to be carried out in order to analyse the link between air transport expansion, economic growth and sustainability that can give adequate
indications to policy-makers who have to shape present development without compromising future growth. Finally, future research can include the study of the contribution to economic growth of different cargo segments, e.g., courier and express, vs. bulk, given that their respective growth contributions may be significantly different.

The present work shows the need to further expand the validation of the empirical results not only with the use of innovative methodological approaches and alternative variables to represent the air transport sector, but also taking into account of a possible nonlinear relationship between the expansion of the air transport sector and economic growth. This is also material for future research.

References


**Notes**

1. It is important to remember that we work with their series taken in natural logarithms.