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# Air passenger transport and economic activity

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ABSTRACT

In the present paper we analyze whether a correlation exists between air passenger transport and economic activity at world level and for the various geographical areas of the world. Econometric models are calibrated and the coefficient of determination is calculated for each case. The whole analysis permits an estimation of a plausible evolution of air passenger transport activity and of its growth rates that can be expected.

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## 1. The relationship between air passenger transport and economic activity

It is often argued that the air passenger transport activity (measured as number of either air transport passengers or revenue passenger-kilometres) is closely related to the economic activity (reflected in the Gross Domestic Product (GDP) of the region under consideration). This general viewpoint is analyzed in this paper and we demonstrate a causal relationship between air passenger transport activity and GDP.

In the past, air transport demand was correlated with economic activity by many researchers. Chin and Tay (2001) showed that air traffic growth rates are positively associated with GDP growth rates. Similarly, Ishutkina and Hansman (2009) explored the relationship between air transport passengers and GDP. Marazzo et al. (2010) concluded that PAX (air passenger-kilometres) and GDP are co-integrated, while Chi and Baek (2013) suggested that in the long-run, both air passenger and freight services tend to increase with economic growth; however, in the short-run, only air passenger service is responsive to economic growth.

In the present analysis, we investigate the degree of correlation between air passenger transport demand and GDP at world level but also for the various geographical areas of the world according to the classification of the World Bank: North America, Europe and Central Asia, East Asia and Pacific, South Asia, Latin America and Caribbean, Middle East and North Africa, Sub-Saharan Africa. The analysis shows that such correlations are more solid for mature air markets and can be used for the long-run estimation of the air passenger transport activity. The present analysis suggests for the coming 15 years a growth rate of air passenger transport activity worldwide at the level of 3.8%, which is very close to that of 4.1%, as suggested by Boeing (2013).

The econometric relationships established permit (under the assumption that all present determinants of the air passenger activity will remain the same and with the same degree of impact) the estimation for the growth rate of air transport for the various geographical areas of the world. This finding is essential for the management of airlines and airports, fleet planning, etc.

## 2. Degree of correlation between air passenger transport and GDP

The whole analysis is conducted both at world level but also for the various geographical areas of the world, as mentioned previously. For each case we surveyed whether a causal relationship can be established between the number of air trips per 1000 inhabitants and per capita GDP of the area under consideration, based on the published annual data by the World Bank for the period 1980–2013 (World Bank, 2015), (GDP expressed in purchasing power parity (PPP) US$, constant 2011 prices). Table 1 gives the descriptive statistics of the various data, whereas Fig. 1 illustrates the results of our analysis concerning the form of correlation (a logarithmic one) and the coefficient of determination ($R^2$) for each case.

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**Table 1**
Descriptive statistics concerning per capita GDP and number of air trips per 1000 inhabitants.

| Geographical area | North America (NA) | | Europe & Central Asia (ECA) | | East Asia & Pacific (EAP) | | South Asia (SA) | | Latin America & Caribbean (LAC) | | Middle East & North Africa (MENA) | | Sub-Saharan Africa (SSA) | | Word (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | GDP[a] | Air trips[b] | GDP | Air trips | GDP | Air trips | GDP | Air trips | GDP | Air trips | GDP | Air trips | GDP | Air trips | GDP | Air trips |
| Number of data (annual 1980–2013) | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34.00 | 34 | 34 | 34 | 34 |
| Maximum | 50,494 | 2383.14 | 26,738 | 858.80 | 13,353 | 391.34 | 4846 | 55.90 | 14,588 | 373.30 | 17,466 | 472.37 | 3270 | 49.78 | 13,884 | 424.35 |
| Minimum | 28,862 | 1191.66 | 16,741 | 165.91 | 3250 | 57.28 | 1369 | 12.12 | 9522 | 137.84 | 10,182 | 139.77 | 2204 | 23.61 | 7614 | 141.86 |
| Mean | 40,692 | 1894.23 | 21,118 | 440.20 | 6861 | 161.50 | 2555 | 24.30 | 11,242 | 186.15 | 12,931 | 207.54 | 2563 | 31.79 | 9947 | 249.18 |
| Median | 40,243 | 1945.12 | 19,817 | 412.59 | 6371 | 149.50 | 2261 | 18.59 | 10,876 | 163.26 | 12,170 | 175.31 | 2443 | 30.85 | 9372 | 243.75 |
| First quartile | 35,465 | 1690.05 | 18,618 | 238.78 | 4538 | 85.32 | 1763 | 16.68 | 10,032 | 144.26 | 11,479 | 155.52 | 2301 | 26.57 | 8534 | 187.61 |
| Third quartile | 47,646 | 2232.52 | 24,177 | 591.59 | 8597 | 211.08 | 3148 | 24.87 | 11,920 | 191.30 | 14,344 | 198.88 | 2700 | 34.41 | 11,359 | 301.30 |
| Skewness | −0.13 | −0.46 | 0.51 | 0.41 | 0.73 | 0.97 | 0.87 | 1.50 | 0.99 | 1.89 | 0.86 | 2.06 | 0.94 | 1.32 | 0.66 | 0.59 |

[a] GDP: Per capita GDP, purchasing power parity in US$, constant 2011 prices.
[b] Air trips: Air trips per 1000 inhabitants, referring to both domestic and international trips produced by registered air carriers of the specific geographical area.

With reference to Fig. 1, we can note the following regarding the relationship between the number of air trips per 1000 inhabitants and GDP per capita:

- A satisfactory value for the coefficient of determination ($R^2 > 0.90$) is deduced for the following geographical areas: North America ($R^2 = 0.93$), Europe and Central Asia ($R^2 = 0.96$), East Asia and the Pacific ($R^2 = 0.99$), Latin America and the Caribbean ($R^2 = 0.92$), all of which are commonly considered as mature air markets or air markets in growth.
- The coefficient of determination is less satisfactory for geographical areas which are considered as non mature air markets ($R^2 = 0.86$ for South Asia, $R^2 = 0.75$ for Sub-Saharan Africa, $R^2 = 0.75$ for Middle East and North Africa).
- At world level, the coefficient of determination attains a high and very satisfactory value of $R^2 = 0.96$.

## 3. A global correlation of air passenger transport activity with world GDP

Fig. 2 illustrates the results of our analysis concerning the correlation of the number of air trips per inhabitant with GDP per capita for the year 2013 for 53 countries in total, which represent 84.2% of world population, 89.5% of world GDP (in PPP) and 88.7% of total air trips at world level.

Fig. 3 illustrates the existence of a solid correlation between GDP per capita and the number of air trips per 1000 inhabitants for the areas under consideration and for the previous years 1980, 1990, 2000, 2010, 2010 and 2013. We can identify a strong correlation ($R^2 = 0.98$) between these two parameters and an asymptotic tendency towards a number of 3 air trips per inhabitant, as long as GDP per capita exceeds 60,000 US$. From Fig. 3, we can also calculate that 1% increase of per capita GDP causes a 1.47% increase of per capita air trips at worldwide level. Although this percentage does not represent income elasticity, it can be compared, as magnitude, to income elasticities reported in other studies. The literature review gives a wide range of income elasticities for air travel, generally in the range of +1.3 to +2.2, (Graham, 2000; Njegovan, 2006).

## 4. An estimation of air passenger transport activity in the world towards 2020 and 2030 – comparison with other studies

From Fig. 1 we can draw conclusions about the relationship between the number of air trips per 1000 inhabitants and GDP per capita and thus we can attempt to estimate air passenger transport activity, which however demands as a prerequisite an estimation for the evolution of population and GDP; this analysis is presented hereafter.

The formulas for the estimation of the future evolution of population were calibrated by the authors; they take into account medium fertility, and are based on the United Nations' published forecasts of population (United Nations, 2013). The formulas for the estimation of the evolution of GDP were calibrated by the authors, using the data published by the World Bank for the period 1980 to 2013. The selection of the appropriate formula was based both on the high values of the coefficient of determination and the functional form of the formula. Fig. 4 summarises the estimated annual change of GDP until 2030, while comparing with results of other studies.

North America:

Population $= -11{,}918.90\ \text{Year}^2 + 5.0999 \cdot 10^7\ \text{Year} - 5.4009 \cdot 10^{10}$, $R^2 = 1.00$.

GDP $= e^{0.0285\ \text{Year}} \cdot 2.5804 \cdot 10^{-12}$, $R^2 = 0.98$.

Europe & Central Asia:

Population $= -67{,}405.70\ \text{Year}^2 + 2.7370 \cdot 10^8\ \text{Year} - 2.7692 \cdot 10^{11}$, $R^2 = 0.99$.

GDP $= e^{0.0185\ \text{Year}} \cdot 0.00147$, $R^2 = 0.96$.

East Asia and Pacific:

Population $= -339{,}706\ \text{Year}^2 + 1.3841 \cdot 10^9\ \text{Year} - 1.4073 \cdot 10^{12}$, $R^2 = 1.00$.

GDP $= e^{0.0532\ \text{Year}} \cdot 8.2707 \cdot 10^{-34}$, $R^2 = 1.00$.

South Asia:

Population $= -185{,}769\ \text{Year}^2 + 7.7078 \cdot 10^8\ \text{Year} - 7.9706 \cdot 10^{11}$, $R^2 = 1.00$.

GDP $= 6.816 \cdot 10^9\ \text{Year}^2 - 2.702 \cdot 10^{13}\ \text{Year} + 2.678 \cdot 10^{16}$, $R^2 = 0.99$.

Latin America & Caribbean:

Population $= -59{,}034.10\ \text{Year}^2 + 2.4454 \cdot 10^8\ \text{Year} - 2.5242 \cdot 10^{11}$, $R^2 = 1.00$.

GDP $= e^{0.0275\ \text{Year}} \cdot 7.461 \cdot 10^{-12}$, $R^2 = 0.99$.

Middle East & North Africa:

Population $= -38{,}739.20\ \text{Year}^2 + 1.6343 \cdot 10^8\ \text{Year} - 1.7103 \cdot 10^{11}$, $R^2 = 1.00$.

GDP $= 3.221 \cdot 10^8\ \text{Year}^2 - 9.459 \cdot 10^{11}\ \text{Year} + 6.168 \cdot 10^{14}$, $R^2 = 1.00$.

Sub-Saharan Africa:

Population $= 226{,}469\ \text{Year}^2 - 8.8811 \cdot 10^8\ \text{Year} - 8.7096 \cdot 10^{11}$, $R^2 = 1.00$.

GDP $= 2.628 \cdot 10^9\ \text{Year}^2 - 1.044 \cdot 10^{13}\ \text{Year} + 1.036 \cdot 10^{16}$, $R^2 = 0.99$.

With the help of the previous formulas, our estimation for the population at world level for 2030 is 8.39 billion inhabitants, which is almost equal to the findings of Van der Mensbrugghe et al. (2011), who estimated for the year 2030 8.4 billion inhabitants around the world.

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