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# Business performance of airports: Non-aviation revenues and their determinants

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A B S T R A C T

Management of non-core commercial activities has become a key issue amongst the leverages for improving modern airport industry. Today airports have increased dramatically their dependence on non-aeronautical revenues, which on average account for half of all revenues with this share being highly heterogeneous across regions and airports. Using a dataset of German airports, this paper discusses the improvement of commercial revenues by exploring its determinants. Previous contributions assessed the impact of a selected set of variables non-aviation revenues. Such approach was mainly the effect of multicollinearity, as the majority of relevant variables are strongly correlated to the size of the structures. We address this issue by using ridge regression and partial least squares. Results suggest the potential conflict of non-aviation revenues per passenger and per square meter with the need to expand the number of passengers.



## 1. Introduction

Changes in the modern air transport business have increasingly transformed the role of airports and their perception by travellers and consumers. The joint interaction of factors such as the expansion of low-cost carriers (LCC), raising competition between airlines, increasing ease in purchasing tickets, changes in travelling habits, privatization of infrastructure, have modified the business worldwide (Papatheodorou and Lei, 2006; Graham, 2009; Castillo-Manzano, 2010). As a consequence, the search for revenues maximisation has gradually shifted its main focus from traditional core aeronautical service to non-aviation or commercial sources (Edwards, 2005; Morrison, 2009). In fact, the strong interrelationships between tourism and shopping have convinced airport managers to expand their view of airports from serving the sole transportation of passengers to leisure attraction (Freathy & O'Connell, 1999; Geuens et al., 2004). Today airports provide a wide variety of entertaining services to travellers, besides having expanded traditional shopping-related ones.

Such revolution has been relatively recent. Indeed, airport managers have dealt with non-aviation activities as important assets for their decisions for six decades (Castillo-Manzano, 2010). However, only since 1980s airports began to transform from central or local government organizations to enterprises capable of generating substantial profits (Kim and Shin, 2001). Starting from about a decade later, non-aviation sources of revenues have considerably grown (Francis et al., 2004; Graham, 2009; Morrison, 2009; Fasone and Maggiore, 2012), to the point that such parallel business has become crucial for many airports, sometimes showing a more rapid rise than passengers traffic (Doganis, 2006; Brechin, 1999; Kim and Shin, 2001; Torres et al., 2005; Fasone and Scuderi, 2012). Such timing goes parallel with the evolution of tourism since the Eighties, from mass phenomenon to larger and highly segmented market (Aguilò Perez and Juaneda Sampol, 2000; Brida and Scuderi, 2013), whose growth and economic effect has put pressure to policymakers in building infrastructures such as roads, airports and harbours (Mak, 2004; Van Vijk and Persoon, 2006).

All this justifies the growing interest towards the assessment of the elements that likely influence commercial or non-aviation revenues (NAR), although the topic has still remained under investigated (Geuens et al., 2004; Castillo-Manzano, 2010). Consistently, different contributors have tried to explain the main factors influencing these important sources for profits. The topic is

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complex, inasmuch as various factors such as passengers characteristics, structure of airport, supply of retail shops and their positioning at the airport, contingent factors as flight delays may cause travellers to spend (Graham, 2008; Castillo-Manzano, 2010). Within the literature, only a limited number of works applied regression models in order to assess the determinants of spending. A subset of them used a demand-based approach and gathered data from direct interviews to passengers. Others adopted a supply-side perspective through airport-level information. Of course, both have provided useful though different indications to managers. The former approach has been usually limited to a single structure – with the exception of Castillo-Manzano (2010) – and it can potentially survey a considerable number of variables that provide highly detailed information on passengers. The latter exploits data from different structures and can be suitable to find significant regularities in the way structures are managed. The present contribution adopts the second approach. We try to learn lessons for management practice from data coming from a set of airports. In a sense, we follow Graham's (2009) and Papatheodorou and Lei's (2006) invitation to test new models for explaining the determinants of airport revenues. It is based on a longitudinal dataset of German airports. However, unlike similar previous studies we extend the set of control variables in order to test the simultaneous significance of different regressors and provide a more complete overview of the topic.

The peculiar empirical strategy we will adopt in what follows is addressed to handle an estimation issue that has heavily influenced the approach and related findings of previous contributors. The latter used to drop relevant variables in order to avoid collinearity, which would create instability in parameters estimation, when not making estimation itself far from being performed – see for instance Papatehdorou and Lei (2006) and Lei and Papatheodorou (2010). Actually, when dealing with airport-level data, size is one of the most crucial elements to account for (Papatheodorou and Lei, 2006) as it is highly correlated with many candidate explanatory variables of NAR. Just to cite some size-related aspects, larger airports have wider supply of retail shops, larger retail surface, higher number of shops, more passengers and more movements than smaller ones (Jarach, 2001; Geuens et al., 2004; Graham, 2009). The resulting high correlation, and the related selection of a limited number of explanatory variables, sometimes led to exclude relevant variables to policymakers. In statistical literature collinearity has been addressed by several regression techniques, under a literature that is still under development. In this paper we apply two classic regression techniques, namely ridge and partial least squares (PLSR) for the sake of accounting for the high correlation between covariates. We will initially provide a description of the state of the art of the literature on NAR and their determinants. We will then illustrate the models and their advantages. Discussion of results and their comparison with previous contributions will conclude the work.

## 2. Background

Successfully, airport managers and retailers have increasingly seen passenger's stay at the terminal as key element to develop their operational approach. This has been the consequence of many factors such as the evolution of the airport sector from public utility to commercialised and privatised industry (Kolk & Van Der Veen, 2002; Graham, 2009), the decrease in aviation revenues that followed the low-cost revolution and government regulations (Sull, 1999; Francis et al., 2004; Doganis, 2006; Pate and Beaumont, 2006; Wallace et al., 2006; Graham, 2008, 2013), the underuse of many airports and their need to pursue financial sustainability (Papatheodorou and Lei, 2006; Castillo-Manzano, 2010), the reliance of many airports on LCC, especially secondary and small ones (Vlaar et al., 2005; Dobruszkes, 2006; Hunter, 2006).

Today airports have increased dramatically their dependence on NAR, which on average account for half of all revenues (Graham, 2009) with this share being highly heterogeneous across regions and airports (Zhang and Zhang, 1997). After all, diversification of airport business through commercial activities has been proven to increase the efficiency of airports (Huang and Kuai, 2006a, 2006b; Tovar and Martín-Cejas, 2009; Brida et al., 2014). Consequently, the same design of terminals has been taking into account such novel needs (Edwards, 2005), with the check-in and departures areas being the most crucial elements (Bandeira and Correia, 2012). Retail plays the very major role, as it is the largest and most important commercial source (Graham, 2009). However, and unlike outer shops, airport managers' challenge is the achievement of a balance between commercial and aeronautical aspects, inasmuch as the retail function may interfere with the normal flows of passengers through the airports. In addition, other operational concerns regard the managing of revenues sources as single (total revenues) or dual (commercial and non aviation) financial entity (Graham, 2009). Related to the latter point, other decisive aspects are the choice between direct managing and concession agreements and their various forms, where the latter are prevailing in modern airports (Kim and Shin, 2001). Also from a theoretical point of view, the model where concessionaire subsidies aeronautical operations has been shown to increase social welfare (Zhang and Zhang, 1997).

### 2.1. Motivation to shopping at airport

Airport is the first and last point of tourists' contact in their destination, where managers are required to fulfil travellers' expectations of minimizing the travel time and enjoying shopping and leisure at the commercial area (Martin-Cejas, 2006). The increasing success of profit maximizing strategies based on NAR can be attributed to the idea that shopping is the oldest and most important aspects of tourism, with the belief in the "urge to shop" being a motivator to travel (Geuens et al., 2004). The waiting time at the commercial area has to be managed in such a way that shopping can be part of the experience especially of holiday or leisure travellers (Castillo-Manzano, 2010) who spend relatively long time of waiting at the airport (Vester, 1996; Geuens et al., 2004). This has generated the supply of a wide variety of goods and services that serve the twofold function of maximising sales and entertaining the traveller through the improvement of her satisfaction while waiting for the flight (French, 1994; Kim and Shin, 2001; Kasarda, 2009). To common retail shops as duty-frees, food and beverage services, passenger and leisure facilities, some airports have added structures as golf facilities, karaoke, swimming pool and bathing room (Kim and Shin, 2001; Geuens et al., 2004). This way, the passenger has become a shared customer of both airlines and airports with complex commercial relationship with each other (Gillen and Lall, 2004; Castillo-Manzano, 2010).

Consumers perceive airports as special environments (Geuens et al., 2004) where their engagement in commercial activities is influenced by various shopping motivations, mainly related to the use of their dwell time to reduce anxiety and boredom (Li and Chen, 2013). In addition to the traditional needs for shopping, the specific infrastructure and atmosphere can incite travellers to consume. Geuens et al. (2004) come to these conclusions from direct surveys to travellers where they found that functional, social and experiential motivations are added with the travel-related ones of escaping out of the routine. This testifies the active role of the terminal policymakers in stimulating expenditure of passengers through the design of an appropriate environment and marketing strategies. This is also the conclusion of Li and Chen (2013) who stress that price and quality affect the purchases of luxuries and travel products, whereas environment, communication motivation, culture and atmosphere are drivers for dining and leisure activities. Their suggestion about the need to create a comfortable atmosphere is highlighted also by the positive effect of impulse purchase and time pressure – see also Bowes (2002) and Kim and Kim (2008). However, Graham (2009) argues that some passengers can be less familiar to the airport environment and thus be more stressed to shop in there. Still in Graham (2009), significant obstacles to the increase of such revenue sources are the different motivation for shopping compared to outside the airport, the higher percentage of purchases on impulse, the higher fluctuations in demand because of security scares issues, as well as the growing traffic congestion at many airports.

Other contributors tested individual motivations to consumption from passenger-level data, most of which have been surveyed at a single airport. Torres et al. (2005) point out the higher consumption levels of leisure travellers than business ones, as well as the absence of relationship between waiting time and consumption level. Huang and Kuai (2006a, 2006b) reported the significance of the age effect of purchasers, and psychographic factors such as impulse purchase, awareness of brands and prices and lower risk perception. Castillo-Manzano's (2010) study on a large sample of seven Spanish airports finds positive effects of waiting time prior to embarking – unlike Torres et al. (2005), – leisure travellers, foreign passengers, presence of children in the travel party who increase the occasions to consume but not levels. In addition, among other things he stresses that LCC passengers have the same likelihood of purchasing than the ones of traditional carriers, though they seem to purchase less.

### 2.2. Studies using airport-level data

Table 1 reviews the main studies on NAR determinants that used regression models from firm-level data. One of the earliest contributions is by Papatheodorou and Lei (2006) on a longitudinal sample of UK airports. They tested the influence of the number of passengers of LCC, charter, and full-service operators on total NAR, using a panel data approach and running separate regressions on overall sample, large and small airports. They found a highly significant role for the number of LCC passengers in all samples, and non-significance of charter and full-service passengers for large airports. The same authors tested another model in Lei and Papatheodorou (2010), by adding one more year to their previous dataset and including further variables. Regression on the total amount of real revenues found again a positive impact of the number of passengers for every kind of carrier, though LCCs' is smaller, importance of being located in London area, negative effect of duty-free abolition (Freathy & O'Connel, 2000). Another study by Appold and Kasarda (2006) made use of a higher and different number of regressors on a sample of 75 US airports. Their findings about several retail categories of total revenues suggest that the number of departing passengers had large impact. Other significant impact came from dwell time, long flight distance, surface of retail activities. They also tested different categories of per passenger revenues as dependent variable. Also in this case results reported the significant role of retail space and travel distance, whereas passenger traffic had a negative effect because of the influence of passengers' congestion on sales.

The work of Fuerst et al. (2011) used a sample of European airports from a self-constructed dataset. Different model specifications are used for each dependent variable. From 2SLS regression, likely determinants positively influencing NAR are the ratio of commercial to total revenues as proxy of the larger number of retail facilities at large airport, and GDP per capita in the airport country. They also found the same negative overcrowding effect of passenger traffic as in Appold and Kasarda (2006). Testing other regressors on the same dependent variable through OLS model, they found that the same dependent variable is significantly and positively influenced by the proportion of domestic travellers and the volume of traffic movements. Another test via OLS estimates concerned revenue per square meter, where the share of domestic passengers and the volume of traffic movements had positive impact, whereas increasing business travellers and space for retail reduced the impact.

## 3. Dataset and method

The empirical study of the determinants of NAR from firm-level data through regression models presents some critical aspects. Two of them are data availability and model specification. This second aspect will be discussed in Section 3.2.

For what concerns the data, in general no commonly recognized definition of non-aviation activities exists (Zenglein and Müller, 2007; Fuerst et al., 2011). Such definition may vary even from airport to airport of the same country (Graham, 2009). Also, data availability is often limited and not all aviation authorities provide official data on all relevant indicators.

We consider a longitudinal sample of international German airports over 2009–2012. To the best of our knowledge, no previous studies tested the determinants of non-aviation revenues in German structures through regression models. The reason for the use of repeated measurement over time is obviously related to the possibility of searching for robust findings. In addition, the restriction to international airports allows to test for the composition of passengers according to their destination, as also previous contributors did. The overall set of German airports is made of 39 units, out of which 21 are international. Due to data availability the final sample size reduced to 15 (Frankfurt, Munich, Berlin, Düsseldorf, Hamburg, Stuttgart, Köln/Bonn, Hannover, Nürnberg, Leipzig/Halle, Dortmund, Dresden, Karlsruhe, Münster/Osnabrück, Hahn). They represent about 96% of total passengers, 99% of cargo and 94% of flight movements. Overall, the test we propose is based on 60 observations – 15 units, 4 years.

No unified data source exists for the sake of supporting our analysis. Indeed, this was a commonly recognised problem by past contributors. Annual reports and financial statements of the airports were the main data sources. Integration with what reported on websites and brochures was needed in order to gather more complete information on non-aviation activities. Airports were also contacted directly via telephone to obtain data on retail surface. Data on traffic and passengers composition were taken from the yearly traffic reports of the German Airports Association website. German Centre of Aerospace annual low-cost monitor (DLR, 2014) was considered to get unified data for low-cost flights.

### 3.1. Variables and research hypothesis

In this study we perform two separate groups of tests on two dependent variables. The first one is NAR per passenger, a measure of airport performance (Graham, 2009; Appold and Kasarda, 2006). An alternative index as the share of revenue from commercial sources can give a broad indication of the importance of such non-core activities, but it is often misleading as performance measure since it is depends on the nature and level of all revenues at an airport (Graham, 2009). NAR per square meter is the second dependent variable. According to Fuerst et al. (2011), unlike indicators related to passengers' volumes as total NAR, it has the advantage to account for the supply of retail space, which is under the direct control of airport managers.

**Table 1**
Studies analysing airport-level data trough econometric models. Signs are reported only for significant variables.

| Paper | Sample | Dependent variable | Sample and Model | Regressors |
|---|---|---|---|---|
| Papatheodorou and Lei (2006) | 21 UK airports, 8 years | Total NAR (log) | All airports, FE | No. passengers: LCC (+), Charter (+), Full-service |
| | | | Large airports, FE | No. passengers: LCC (+), Charter, Full-service |
| | | | Small airports, RE | No. passengers: LCC (+), Charter (+), Full-service (+) |
| Appold and Kasarda (2006) | 75 US airports, 1 year | F&B sales (log) | All airports, OLS | Departing passengers (log) (+), Airport dwell time, Proportion of non-transfers, International gateway, Major tourist destination, Mean logged flight distance (+), Food and beverage retail space (log) (+) |
| | | F&B sales pax (log) | | Departing passengers (log) (−), Airport dwell time, Proportion of non-transfers, International gateway, Major tourist destination, Mean logged flight distance (+), Food and beverage retail space (log) (+) |
| | | Non-food sales (log) | | Departing passengers (log) (+), Airport dwell time, Proportion of non-transfers, International gateway, Major tourist destination, Mean logged flight distance (+), Total domestic non-food retail space (log) (+) |
| | | Non-food sales pax (log) | | Departing passengers (log) (−), Airport dwell time, Proportion of non-transfers, International gateway, Major tourist destination, Mean logged flight distance (+), Total domestic non-food retail space (log) (+) |
| | | Domestic sales (log) | | Departing passengers (log) (+), Airport dwell time, Proportion of non-transfers, International gateway, Major tourist destination, Mean logged flight distance (+), Total domestic retail space (log) (+) |
| | | Domestic sales pax (log) | | Departing passengers (log) (−), Airport dwell time, Proportion of non-transfers, International gateway, Major tourist destination, Mean logged flight distance (+), Total domestic retail space (log) (+) |
| | | Total sales (incl. duty-free, log) | | Departing passengers (log) (+), Airport dwell time, Proportion of non-transfers, International gateway, Major tourist destination, Mean logged flight distance (+), Total retail space (log) (+) |
| | | Total sales, pax (incl. duty-free, log) | | Departing passengers (log) (−), Airport dwell time, Proportion of non-transfers, International gateway, Major tourist destination, Mean logged flight distance (+), Total retail space (log) (+) |
| Lei and Papatheodorou (2010) | 21 UK airports, 9 years | Real commercial revenue | All airports, POLS | No. LCC passengers (+), No. charter and full-service passengers (+), Location in the Greater London area (+), Time dummy for the abolition of duty-frees (−) |
| | | | All airports, FE | No. LCC passengers (+), No. charter and full-service passengers (+), Time dummy for the abolition of duty-frees (−) |
| | | | All airports, RE | No. LCC passengers (+), No. charter and full-service passengers (+), Location in the Greater London area (+), Time dummy for the abolition of duty-frees (−) |
| Fuerst et al. (2011) | 41 European airports | NAR pax (log) | Selection upon data availability, 2SLS (log−log) | No. passengers (−), Ratio of commercial to total revenue (+), GDP per capita (+) |
| | 29 European airports | NAR pax (log) | Selection upon data availability, OLS (log−log) | % Domestic passengers (+), % Business travelers, Traffic movements (+) |
| | 26 European airports | NAR/sq. meter (log) | Selection upon data availability, OLS (log−log) | No. domestic passengers (+), % Business travelers (−), No. traffic movements (+), Retail space per PAX (−) |

Models acronyms are as follows. OLS: Ordinary Least Squares; FE: Fixed Effect; RE: Random Effect; 2SLS: two-stage least squares; POLS: Pooled OLS.

Table 2 lists the independent variables. As already mentioned in the introductory section, we will test a much higher number of regressors than in previous studies. This has the advantage of conditioning for several aspects related to managing of airports. However, as it will be discussed in the next session, the high correlation between some indicators is a major shortcoming that needs to be addressed properly.

From the literature review we can observe that the ways past contributors measured passengers-related regressors are basically two, i.e. levels and shares/percentages. This occurs for incidence of LCC and type of route (i.e., domestic or not). For this reason we will adopt separate model specifications also for these two kinds of measures. The main obvious meaning of this difference is that, unlike levels, percentage constraints the total number of passengers for a given categorised item to be equal to the same amount for each airport. Thus, the number of passengers allows the testing for the marginal contribution of flyers, whereas increase in a share is helpful to detect what are the effects of the variation in the relative composition of flyers.

As to independent variables, we formulate the following hypotheses.

H1 *Higher number of passengers negatively affects NAR*. This hypothesis is taken from the findings of both the two studies that inserted the total number of passengers as regressor of NAR per passenger (Appold and Kasarda, 2006; Fuerst et al., 2011), in the same way as we do in what follows. As Appold and Kasarda (2006) comment, such finding may be attributed to the congestion discouraging sales as passenger traffic increases, given available space at the terminal. Additionally, we test it as explanatory of NAR per square meter. Also for this second dependent variable we expect that a higher

**Table 2**
Variables description. Items regarding the number of passengers consider boarding, alighting and transfers.

| Variable | Label |
|---|---|
| Logged non-aviation revenues per passenger, Euro | (dependent variable) |
| Logged non-aviation revenues per square meter, Euro | (dependent variable) |
| Number of total passengers, million | ptot |
| % passengers of domestic routes | pdom.p |
| % passengers of European routes | peur.p |
| % passengers of other international routes | pint.p |
| % LCC passengers | plcc.p |
| % passengers other than LCC | pnolcc.p |
| Number of passengers of domestic routes, million | pdom |
| Number of passengers to European routes, million | peur |
| Number of passengers to other international routes, million | pint |
| Number of low-cost carriers passengers, million | plcc |
| Number of passengers other than LCC, million | pnolcc |
| Number of movements (departing and landing) | movem |
| Number of airlines operating in the airport | noairlines |
| Overall surface of commercial activities, square meters | navsur |
| Surface of non-aviation activities, hundred of square meters | navsurpas |
| Number of retail shops, excluding food and beverage | ret.shop |
| Number of restaurants and food and beverage shops | ret.fb |
| Yearly time dummies | d09, d10, d11, d12 |

number of passengers impacts negatively on earnings per surface unit, for the same congestion reasons as the ones we just reported. Another reason in support for the use of this regressor is that it measures airport size, which is a crucial element to account for while studying NAR (Papatheodorou and Lei, 2006). It may be thought as a biased measure of the actual basin of potential purchasers at airports as it excludes those who accompany or meet passengers as well as airport personnel. However the role of the latter categories is marginal (Papatheodorou and Lei, 2006; Gillen and Hinsch, 2001).

H2 *Categories of passengers by type of route (domestic, European, other international) are not main drivers.* According to Appold and Kasarda (2006), the mix of passengers and type of trips may influence the amount of purchasing in the time block of the waiting. The same authors find positive correlation between flight distance and per passenger NAR, whereas Fuerst et al. (2011) report positive influence of domestic passengers on NAR per passenger. Also, Graham (2009) argues that international passengers are higher spenders than others. However, if on one side it can be plausible that this might happen while analysing individual consumption, on the other side when dealing with aggregated firm-level data it is not clear whether and how passengers destination can averagely influence NAR. Despite previous empirical evidence of the above mentioned studies seems to confirm such feature, we will test if this occurs in a model with a larger number of conditioning variables, and for this reason less restrictive, than the ones proposed by other contributors.

H3 *LCC passengers have lower impact on revenues than other passengers.* Evidence about the incidence of this kind of passengers on NAR is not clear in the literature. Castillo-Manzano's (2010) analysis from traveller-level data reports that they has positive attitude towards spending, although lower than customers of full-service carriers. On the other side, firm-level findings of Papatheodorou and Lei (2006) and Lei and Papatheodorou (2010) report the opposite evidence of a positive impact of the number of passengers, but this is found on total NAR instead of the average levels we consider in this paper.

H4 *Movements have positive impact on revenues as they bring customers to the airport.* The number of air transport movements is a measure of the “chances” for an airport to bring candidate shoppers in. Therefore it is reasonable to expect that they impact positively on revenues.

H5 *The number of operating airlines is positively related with spending.* The number of airlines is meant to proxy further aspects of the demand. Today small airports often rely on a relatively limited number of carriers, of which most (if not all) of them are low-cost ones. As the number of airlines increases, we expect the share of full-service carriers to raise. This emerges also from the significant correlation between *noairlines* and *plccno* in Table 3. Consequently, the demand is likely to be more heterogeneous and composed by customers with higher willingness to pay for the air ticket and presumably even for additional services of traditional carriers. Such higher propensity can be supposed to be related to a higher propensity to shop, as also Castillo-Manzano (2010) suggests. Further support to this view seems to emerge from the positive relationship between the increasing number of airlines and the number of retail shops (Table 3).

H6 *Higher total surface for commercial activities impacts positively on NAR.* This recalls Appold and Kasarda (2006) findings, and it is due to the increase of the available spaces and the related reduction of overcrowding, as well as a more heterogeneous supply that could meet the tastes of consumers. The amount of space is also, in part, an indirect measure of anticipated demand (Appold and Kasarda, 2006).

H7 *Higher per passenger surface for commercial activities positively influences NAR per passenger, whereas it negatively impacts on NAR per square meter.* The former is due to the increase in the service level perceived by the customer (Kim and Shin, 2001) that is generated by positive externalities with the existing space. The latter is suggested by Fuerst et al. (2011) and deals with decreasing marginal revenues as it would be expected in a monopolistic structure.

H8 *The number of retail shops influences NAR positively.* Higher number of retail shops increases heterogeneity in supply, and thus it can impact positively on revenues. These numbers exclude restaurants and food and beverage shops, travel agencies, car rentals.

H9 *The number of restaurants and food and beverage shops do not have a noticeable positive impact on NAR.* Heterogeneous behaviour of travellers in buying food and beverage at airports, as well as the smaller amount of money than can be invested compared to other retail items, can have a non-

**Table 3**
Correlation matrix. P-values in italics.

| | pdom.p | peur.p | pint.p | plcc.p | plccno.p | pdom | Peur | Pint | plcc | Plccno | Movem | Noairlines | Navsur | Navsurpas | ret.shop | ret.fb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ptot | −0.265 | −0.273 | 0.881 | −0.641 | 0.641 | 0.826 | 0.977 | 0.891 | 0.363 | 0.975 | 0.988 | 0.911 | 0.955 | −0.319 | 0.944 | 0.989 |
| | *0.041* | *0.035* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *0.013* | *<0.01* | *<0.01* |
| pdom.p | | −0.814 | −0.256 | −0.252 | 0.252 | | | | | | −0.229 | −0.160 | −0.258 | 0.126 | −0.245 | −0.255 |
| | | *<0.01* | *0.049* | *0.053* | *0.053* | | | | | | *0.078* | *0.221* | *0.047* | *0.336* | *0.059* | *0.049* |
| peur.p | | | −0.353 | 0.654 | −0.654 | | | | | | −0.289 | −0.325 | −0.274 | −0.054 | −0.278 | −0.285 |
| | | | *<0.01* | *<0.01* | *<0.01* | | | | | | *0.025* | *0.011* | *0.034* | *0.682* | *0.031* | *0.027* |
| pint.p | | | | −0.683 | 0.683 | | | | | | 0.849 | 0.798 | 0.872 | −0.114 | 0.858 | 0.887 |
| | | | | *<0.01* | *<0.01* | | | | | | *<0.01* | *<0.01* | *<0.01* | *0.387* | *<0.01* | *<0.01* |
| plcc.p | | | | | −1.000 | | | | | | −0.674 | −0.721 | −0.651 | 0.127 | −0.674 | −0.663 |
| | | | | | *<0.01* | | | | | | *<0.01* | *<0.01* | *<0.01* | *0.334* | *<0.01* | *<0.01* |
| plccno.p | | | | | | | | | | | 0.674 | 0.721 | 0.651 | −0.127 | 0.674 | 0.663 |
| | | | | | | | | | | | *<0.01* | *<0.01* | *<0.01* | *0.334* | *<0.01* | *<0.01* |
| pdom | | | | | | | 0.869 | 0.497 | 0.698 | 0.710 | 0.872 | 0.807 | 0.780 | −0.393 | 0.779 | 0.813 |
| | | | | | | | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* |
| peur | | | | | | | | 0.806 | 0.466 | 0.926 | 0.981 | 0.901 | 0.937 | −0.349 | 0.920 | 0.962 |
| | | | | | | | | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *<0.01* |
| pint | | | | | | | | | −0.033 | 0.954 | 0.837 | 0.769 | 0.855 | −0.165 | 0.855 | 0.890 |
| | | | | | | | | | *0.799* | *<0.01* | *<0.01* | *<0.01* | *<0.01* | *0.208* | *<0.01* | *<0.01* |
| plcc | | | | | | | | | | 0.147 | 0.400 | 0.408 | 0.241 | −0.422 | 0.177 | 0.329 |
| | | | | | | | | | | *0.264* | *<0.01* | *<0.01* | *0.063* | *0.001* | *0.175* | *0.010* |
| plccno | | | | | | | | | | | 0.954 | 0.870 | 0.956 | −0.238 | 0.960 | 0.971 |
| | | | | | | | | | | | *<0.01* | *<0.01* | *<0.01* | *0.067* | *<0.01* | *<0.01* |
| movem | | | | | | | | | | | | 0.918 | 0.971 | −0.301 | 0.957 | 0.984 |
| | | | | | | | | | | | | *<0.01* | *<0.01* | *0.020* | *<0.01* | *<0.01* |
| noairlines | | | | | | | | | | | | | 0.848 | −0.288 | 0.840 | 0.938 |
| | | | | | | | | | | | | | *<0.01* | *0.026* | *<0.01* | *<0.01* |
| navsur | | | | | | | | | | | | | | −0.174 | 0.982 | 0.959 |
| | | | | | | | | | | | | | | *0.183* | *<0.01* | *<0.01* |
| navsurpas | | | | | | | | | | | | | | | −0.238 | −0.309 |
| | | | | | | | | | | | | | | | *0.067* | *0.016* |
| ret.shop | | | | | | | | | | | | | | | | 0.953 |
| | | | | | | | | | | | | | | | | *<0.01* |

significant impact in increasing average levels per traveller. In addition, unlike other retail shops that can sell goods of different kinds, and for which customers can decide to purchase items from each of them, food and beverage ones satisfy contingent needs such as hunger and thirst, which can be seen as a relatively fixed demand. Therefore we expect that, if we account somehow for such steady demand, as by fixing the amount of passengers composition for every airports as done with percentages, increasing the number of these shops just produces the effect of increasing the competition, with the effect of reducing spending per passenger. Specular considerations should be done for NAR per square meter, where we expect that, if we condition for the actual numbers of passengers composition (i.e., levels), that is if we don't predetermine their number to sum up to a certain amount as for percentages, raising the number of food shops should stimulate revenues because of variety effects.

Data availability for the number of airlines and shops, as well as for the surface of commercial activities, was limited to 2014. We extended these numbers also to each of the past years, under the hypothesis that they are good proxies of the actual numbers.

### 3.2. Ridge and partial least squares regression

Model specification is the second methodological aspect to be considered. The major problem with the selected variables is the high correlation between regressors, which limits the possibility to use classic regression models. As already mentioned, often correlation between candidate explanatory variables led scholars to drop variables from the analysis (Papatheodorou and Lei, 2006; Lei and Papatheodorou, 2010). Table 3 reports the correlation matrix between selected indicators, where only relevant values for model estimations are reported – specifically we omitted the correlation between regressors not included in the same model. It can be easily seen that high correlation arises. As said in the Introduction, indeed airport size is a major aspect. Larger airports with a higher number of passengers are those with a higher share of international passengers, lower number of LCC, higher number of airlines and movements, and with better-developed non-aviation activities. Size may explain also the correlation within the set of indicators expressed in terms of number of passengers. Less important effects arise for values expressed in shares, as well as for the surface per passenger. Multicollinearity leads to parameter instability, in the sense that one of the correlated variables can exhibit a higher coefficient than the one having a similar effect on the dependent variable (see Breiman, 1996).

In order to test the model without dropping any variable of potential interest for the sake of satisfying uncorrelation preconditions, we use ridge regression (RR henceforth – Hoerl and Kennard, 1970) and PLSR (Wold et al., 1987; Tenenhaus, 1998). One of their main advantages is the prevention of parameter instability caused by autocorrelation. They are also useful in all those contexts where high dimensionality issues arise, i.e. when the number of variables is equal to or exceeds the number of observations. Despite the latter does not concern the current study, more in general relevant determinants of NAR are potentially as numerous as the airports for which information is available, if not higher (Fuerst et al., 2011). Indeed, both correlation and limited sample size are of actual importance inasmuch as they caused scholars to adopt particularly parsimonious models in past studies on NAR.

RR has been widely applied in genetics and specifically in genome-wide association studies. Typically, a large number of genetic variants are tested as explanatory of phenotypes, the latter expressing the presence of a specific disease or physical feature of an individual. If on one side the phenotypes (dependent variables) emerge during lifetime, genes are fixed at birth. Genotypes are in a very large numbers – from thousands to millions – and are highly correlated with each other. Also, the availability of a sufficient population size to be greater than the number of genotypes cannot be reachable. Under these conditions, RR can perform parameter estimates in order to account for both multicollinearity and high dimensionality. Results are such that perfectly and directly correlated predictors have the same coefficient, whereas sets of highly correlated predictors have similar values. The method can be suitable also to overcome the selection problem that occurs with dummy variables when one drops a reference category, inasmuch as all dummies can be included.

Let $n$, $p$ and $t$ be respectively the number of individuals, predictors and times at which observations are recorded. Consider the following regression model:

$$y = X\beta + \varepsilon \tag{1}$$

where $X_{(nt)\times p} = [\mathbf{x}_1, \ldots, \mathbf{x}_j, \ldots, \mathbf{x}_p]$, $\mathbf{x}_j$ is the generic predictor reporting pooled time observations, $\beta=[\beta_1,\ldots,\beta_j,\ldots,\beta_p]'$ is the vector of unknown parameters and $\varepsilon_{(nt)\times 1}$ is the additive noise. Classic OLS finds parameter estimates from minimizing the squared sum of the residuals. This can be expressed by the optimization problem $\widehat{\beta}^{OLS} = \text{argmin}_{\beta}\|y - X\beta\|^2$, whose well-known solution is $\widehat{\beta}^{OLS} = (X'X)^{-1}X'y$. To overcome multicollinearity and high dimensionality, estimate of $\widehat{\beta}^{RR}$ adds the so-called "penalty" to the OLS optimization problem, which is equal to the sum of squared regression parameters ($l_2$ norm, equal to $\|\beta\|^2$) weighted by another parameter $\lambda$. The RR optimization problem then is:

$$\widehat{\beta}^{RR} = \text{argmin}_{\beta}\|y - X\beta\|^2 + \lambda\|\beta\|^2 \tag{2}$$

with the solution $\widehat{\beta}^{RR} = (X'X + \lambda I)^{-1}X'y$, where $I$ is the identity matrix. Compared to $\widehat{\beta}^{OLS}$, $\widehat{\beta}^{RR}$ is biased, or "shriked", towards zero. However such bias comes with a lower variance of the estimator, with the overall result that the mean square error (MSE) of RR (variance of the estimator plus squared bias) is lower than the one of OLS. From Equation (2), it turns out how crucial the estimation of $\lambda$ is: as $\lambda$ increases $\widehat{\beta}^{RR}$ tends to 0, whereas as $\lambda$ tends to 0 $\widehat{\beta}^{RR}$ tends to $\widehat{\beta}^{OLS}$.

Among the number of methods to estimate $\lambda$ we apply the one of Cule and De Iorio (2013), where the interested reader can find details on the estimation procedure. The algorithm is also implemented in the package *ridge* of the software *R* (Cule, 2014).

Despite ridge regression provides lower MSE than OLS, bias still remains an issue of nontrivial importance. In some cases, it can even alter the sign of regressors to the point that they can provide misleading policy implications. In order to provide additional indications to our analysis concerning the magnitude and sign of coefficients while still controlling for collinearity, we will perform a supplementary analysis via PLSR. The idea of the technique is simple. Consider the model of Equation (1). The approach extracts the matrix of the first $a$ principal components $Z$ from the singular matrix of regressors $X$, and then it uses $Z$ as regressor matrix on $y$. The main shortcoming of this technique is that the distributional properties of the estimates are not known. The selection of the number $a$ of components to consider is done via LOO cross-validation. Estimations for PLSR are performed through the *R* package *plsdepot* (Sanchez, 2012).

## 4. Results

Table 4 displays results of RR on pooled data. For other coefficients than the intercept we report their scaled version to correlation form, obtained by converting the correlation matrix to have unit diagonal, as well as tests on such scaled coefficients (Cule, 2014). As premised above, the four models differ in terms of dependent variable (NAR per passenger in Models 1 and 2, and NAR per square meter in Models 3 and 4) and regressors' measurement for LCC passengers and flight destination (percentages in Models 1 and 3, levels in Models 2 and 4). The same models under PLSR are presented in Table 5.

### 4.1. NAR per passenger

Models 1 and 2 report the expected negative sign for airport size (*ptot*). The two groups of variables measuring the passengers' routes as shares (*pdom.p, peur.p, pint.p*) and levels (*pdom, peur, pint*) are not significantly related to NAR, thus contrasting with Fuerst et al. (2011) who find significant positive impact of domestic spenders. The only significant variable is the number of passenger of international routes (*pint*) in Model 2, which shows negative sign. The latter can be attributed to the already mentioned overcrowding effect to individual spending that characterizes bigger sized airport.

For what concerns LCC, both share (*plcc.p*) and number (*plcc*) of passengers impact negatively on per passenger spending. This is somehow in line with the evidence from microdata of Castillo-Manzano (2010). Overall, this is an interesting indication of how negative the impact of LCC can be on spending also at aggregate level. Consistently, same magnitude but different positive sign of the coefficient comes from the share of other carriers (*plccno.p*), which is obviously related to their perfect and inverse correlation. Instead, the number of passengers taking other traditional carriers is not likely to impact on per passenger spending (*plccno*). The latter is perhaps due to the inclusion of both charter and full-service carriers in the number of no-LCC passengers (Table 3).

In line with research hypothesis H4, the sign of *movem* is opposite between Model 1 (negative) and 2 (positive), although significant for both. This is not surprising if we consider that the two models differ by the inclusion of, respectively, percentages and levels of LCC passengers and type of route. Percentages are constraints of the overall number of customers to the same amount, whereas the level is not. More explicitly, if the number of movements increases whereas the one related to passengers composition is the same for each airport – as it happens with percentages – there will be negative impact of movements to average purchases per passenger. Such interpretation is confirmed when comparing the signs of *movem* throughout the four models. The same phenomenon can explain what we find for *noairlines*. The latter explains NAR per passenger significantly in Model 1 though with negative sign, whereas in Model 2 it is not significant. However, looking at their significance in Ridge, as well as their sign compared to PLSR, their role in explaining NAR per passenger can be seriously questioned and not to be taken as a robust indication.

As expected, greater availability of total surface (*navsur*) for commercial activities seems to impact positively on average spending per passenger. Instead, looking at both Ridge and PLSR, coefficients evidence about per passenger surface (*navsurpas*) seems to be partially contrasting with what expected. In fact in Model 1 signs are opposite between the two models, perhaps due to the already mentioned effect of considering regressors reporting percentages. Instead results of Model 2 are in line with previous hypothesis. Positive effect comes from the increase in the number of retail shops different than restaurants and food and beverage (*ret.shop*). Weaker evidence concerns *ret.fb*, which are significant only in Model 1 with a negative sign, as said in H9, which however does not find support in PLSR. Finally, no significant year effect is recorded, as overall expressed by the dummy variables *d09*, *d10*, *d11* and *d12*.

### 4.2. NAR per square meter

Results about NAR per surface unit are to be interpreted from the point of view of the chances for the management to govern at least one aspect of the dependent variable as the surface of commercial activities. Overall, almost all coefficients signs are consistent between Ridge and PLSR. We find that the overcrowding effect of *ptot* turns out to be significant only in Model 3. As also seen in the first two models, passengers' classification by the type of route does not explain expenditure significantly. Also for this variable, both share and level of low-cost passenger have the same effect as for *NAR* per *passenger*.

Movements have the same sign as for NAR per passengers, and similar reasons as above can be applied to explain this. The variable *noairlines* is found to be positively and significantly related to NAR only in the regression that accounts for levels, and also for this case we find it plausible to refer to the above explanation of a higher impact of movements if paired with a varying and proportionally higher number of passengers. As stated in the research hypothesis, the major justification for it can be the higher propensity level to consume exhibited by those passengers that are carried by full-service airlines.

Total surface of commercial activities (*navsur*) is not significant to explain the levels of NAR per square meter. This indicates the absence of significant marginal increase in the average level of revenue per surface unit due to the mere increase of total surface. Also, as expected we find that both the surface per passenger (*navsurpas*) and number of retail shop (*ret.shop*) report negative sign. For what concerns food and beverage, expectedly it reports significant and positive sign. Finally, we notice that in Model 3 there is a weak year-effect, for which in 2009 there have been significantly lower NARs per square meter.

## 5. Discussion

Is this the story of a conflict? Apparently yes. From managerial practice, we know that the raise of the performance of the core/aviation activity is one of the main obsessions of airport policy-makers (Doganis, 2006), which means working to increase of the number of passengers year after year. Controlling for other factors, the story told by our data seems to question the mere existence of the non-aviation side as mean to improve profits through revenue increasing. In fact the raise in the number of passengers would cause decrease in NAR, both per passenger and partly per square meter. If on one side this can be somewhat compensated by aviation fees from airline, on the other side this becomes a matter of survival for instance for smaller airports in terms of traffic flows, which should try to compensate the lesser, even negative in some cases, revenue from aviation with the one from commercial sources. However, despite such conflict exists, its consequences are less heavy. After all, if these were major shortcomings, such a big success of NAR in modern airports would not be explained.

Looking at our empirical evidence, the story can be interpreted also in a different way. As also written above, data lead us to agree with the idea of aviation and non-aviation as two conflicting sides of the same business. Undoubtedly, passengers queuing for the flight, as well as a high concentration of people in the airports corridors, can discourage shopping. However, the empirical evidence of a negative correlation of NAR with size can have a second

**Table 4**
Ridge regression, results. Standard errors in italics.

| | NAR per passenger | | | | NAR per square meter | | | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
| | Estimate | Scaled est. | Estimate | Scaled est. | Estimate | Scaled est. | Estimate | Scaled est. |
| ptot | −0.0052 | −0.5940*** | −0.0025 | −0.2900*** | −0.0080 | −0.9196*** | −0.0002 | −0.0206 |
| | | *0.1132* | | *0.0872* | | *0.2194* | | *0.0690* |
| pdom.p | 0.0001 | 0.0183 | | | −0.0011 | −0.1384 | | |
| | | *0.1835* | | | | *0.2245* | | |
| peur.p | −0.0010 | −0.1314 | | | 0.0023 | 0.2966 | | |
| | | *0.1747* | | | | *0.2269* | | |
| pint.p | 0.0025 | 0.1893 | | | −0.0035 | −0.2708 | | |
| | | *0.2077* | | | | *0.3531* | | |
| plcc.p | −0.0047 | −0.9975*** | | | −0.0076 | −1.6197*** | | |
| | | *0.1700* | | | | *0.2364* | | |
| pnolcc.p | 0.0047 | 0.9975*** | | | 0.0076 | 1.6197*** | | |
| | | *0.1700* | | | | *0.2364* | | |
| pdom | | | −0.0003 | −0.0060 | | | 0.0081 | 0.1856 |
| | | | | *0.2207* | | | | *0.1624* |
| peur | | | −0.0038 | −0.2174 | | | 0.0005 | 0.0262 |
| | | | | *0.1510* | | | | *0.1012* |
| pint | | | −0.0114 | −0.4809** | | | −0.0044 | −0.1849 |
| | | | | *0.2121* | | | | *0.1585* |
| plcc | | | −0.0459 | −1.1833*** | | | −0.0168 | −0.4329** |
| | | | | *0.2669* | | | | *0.2208* |
| pnolcc | | | −0.0002 | −0.0254 | | | 0.0008 | 0.0815 |
| | | | | *0.0993* | | | | *0.0836* |
| movem | −0.2871 | −0.2954*** | 0.1866 | 0.1919** | −0.5476 | −0.5633*** | 0.1283 | 0.1319** |
| | | *0.1118* | | *0.0786* | | *0.2054* | | *0.0645* |
| noairlines | −0.0016 | −0.3942* | 0.0014 | 0.3460 | −0.0012 | −0.2943 | 0.0014 | 0.3661** |
| | | *0.2027* | | *0.2617* | | *0.3616* | | *0.1765* |
| navsur | 0.0005 | 0.4607*** | 0.0008 | 0.7790*** | 0.0004 | 0.3314 | 0.0002 | 0.1814 |
| | | *0.1363* | | *0.1623* | | *0.2424* | | *0.1143* |
| navsurpas | 142.8216 | 0.8062*** | 121.1522 | 0.6839** | −399.0467 | −2.2526*** | −230.0373 | −1.2986*** |
| | | *0.2648* | | *0.3148* | | *0.3206* | | *0.2601* |
| ret.shop | 0.0012 | 0.4471*** | 0.0018 | 0.7125*** | 0.0018 | 0.7007** | 0.0010 | 0.3968*** |
| | | *0.1566* | | *0.1677* | | *0.2965* | | *0.1204* |
| ret.fb | −0.0014 | −0.2082** | 0.0008 | 0.1187 | −0.0007 | −0.0969 | 0.0012 | 0.1679** |
| | | *0.0929* | | *0.0948* | | *0.1574* | | *0.0721* |
| d09 | −0.0911 | −0.3056 | −0.0622 | −0.2087 | −0.1770 | −0.5937** | −0.0528 | −0.1770 |
| | | *0.2203* | | *0.2567* | | *0.2485* | | *0.2282* |
| d10 | 0.0251 | 0.0843 | 0.0151 | 0.0505 | 0.0357 | 0.1196 | 0.0073 | 0.0245 |
| | | *0.2211* | | *0.2569* | | *0.2457* | | *0.2285* |
| d11 | 0.0347 | 0.1164 | 0.0212 | 0.0712 | 0.0567 | 0.1903 | 0.0180 | 0.0604 |
| | | *0.2211* | | *0.2569* | | *0.2460* | | *0.2285* |
| d12 | 0.0313 | 0.1050 | 0.0259 | 0.0870 | 0.0846 | 0.2839 | 0.0275 | 0.0921 |
| | | *0.2207* | | *0.2568* | | *0.2464* | | *0.2284* |
| (intercept) | −4.9869 | | −5.1011 | | 2.5065 | | 2.1377 | |
| Ridge parameter | 0.5883 | | 0.5017 | | 0.1964 | | 0.9653 | |
| Degrees of freedom | | | | | | | | |
| model | 5.4040 | | 5.1340 | | 7.2240 | | 4.0720 | |
| variance | 3.6180 | | 3.5400 | | 5.7230 | | 2.4410 | |
| residual | 7.1900 | | 6.7280 | | 8.7240 | | 5.7040 | |

Significance of estimates: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

interpretation, and specifically in the sense that bigger airports rely less on NAR and more on aviation activities than smaller ones. The already mentioned incidence of low-cost carriers is a major reason for that. Another reflection means to expand the intuition of Fuerst et al. (2011). The decreasing revenues per unit, as well as all the symptoms that indicate a sort of decay in the commercial structure as the number of passengers increases, may be just indicative of airports as monopolies for what concerns non-aviation sources.

All this suggests that the challenges of the modern airport manager are indeed complex. Traditional sources of revenues need to be properly mixed with the new opportunities of obtaining revenues from passengers, being careful in not to create diseconomies that might decrease the satisfaction of consumers and discourage their shopping. As to the number of passengers, if on one side it is true that policymakers can handle them only partially, on the other side from this paper interesting indications emerge. One aspect concerns the managing of air transport movements, seen as opportunities to bring customers in. They are likely to be effective channels for the improvement of non-core activities if opportunely combined with the already mentioned needs of avoiding confusion and overcrowding at terminals. But also, the mix of full-service and LCC can be crucial. In this sense, it seems that the positive effect of customers of traditional airlines may occur if they increase proportionally to LCC. This recalls the twofold need of compensating the lower attitude of LCC passengers to spend, and the one of avoiding overcrowding. But again, such passengers' mix for enhancing the effect of non-aviation activities might have secondary actual importance with respect to the need of increasing the total number of passengers. In fact, if on one side this leads the marginal NAR to decrease, on the other side total revenues increase. Therefore managers might be tempted to bring more and more travellers in with an improved supply of flights, rather than thinking in terms of optimal size for managing both aviation and non-aviation.

**Table 5**
PLSR coefficients.

| | NAR per passenger | | | | NAR per square meter | | | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
| | Regular | Standardised | Regular | Standardised | Regular | Standardised | Regular | Standardised |
| ptot | −0.0850 | −2.2847 | −0.0145 | −0.3903 | −0.0111 | −0.2653 | −0.0114 | −0.2724 |
| pdom.p | −0.0037 | −0.1085 | | | −0.0047 | −0.1198 | | |
| peur.p | −0.0003 | −0.0101 | | | 0.0059 | 0.1578 | | |
| pint.p | 0.0106 | 0.1915 | | | −0.0044 | −0.0696 | | |
| plcc.p | −0.0078 | −0.3914 | | | −0.0117 | −0.5186 | | |
| pnolcc.p | 0.0078 | 0.3914 | | | 0.0117 | 0.5186 | | |
| pdom | | | 0.0211 | 0.1133 | | | 0.0493 | 0.2351 |
| peur | | | −0.0179 | −0.2391 | | | −0.0126 | −0.1493 |
| pint | | | −0.0795 | −0.7869 | | | −0.0705 | −0.6178 |
| plcc | | | −0.1263 | −0.7640 | | | −0.1209 | −0.6473 |
| pnolcc | | | −0.0092 | −0.2319 | | | −0.0060 | −0.1346 |
| movem | −4.7579 | −1.1473 | 0.6701 | 0.1616 | −0.8034 | −0.1715 | 0.3275 | 0.0699 |
| noairlines | 0.0021 | 0.1227 | 0.0072 | 0.4301 | −0.0025 | −0.1304 | 0.0096 | 0.5039 |
| navsur | 0.0086 | 1.8866 | 0.0032 | 0.6885 | 0.0002 | 0.0382 | 0.0013 | 0.2546 |
| navsurpas | −25.2013 | −0.0333 | 37.3705 | 0.0494 | −490.4897 | −0.5746 | −594.1551 | −0.6960 |
| ret.shop | 0.0037 | 0.3389 | 0.0062 | 0.5659 | 0.0021 | 0.1655 | 0.0053 | 0.4309 |
| ret.fb | 0.0157 | 0.5356 | 0.0023 | 0.0770 | −0.0031 | −0.0932 | 0.0016 | 0.0491 |
| d09 | −0.2400 | −0.1887 | −0.1659 | −0.1304 | −0.2389 | −0.1663 | −0.1673 | −0.1165 |
| d10 | 0.0290 | 0.0228 | 0.0295 | 0.0232 | 0.0461 | 0.0321 | 0.0299 | 0.0208 |
| d11 | 0.1121 | 0.0882 | 0.0584 | 0.0459 | 0.0525 | 0.0366 | 0.0583 | 0.0406 |
| d12 | 0.0989 | 0.0777 | 0.0781 | 0.0614 | 0.1403 | 0.0977 | 0.0791 | 0.0551 |
| (intercept) | −4.6016 | | −5.0187 | | 2.6917 | | 2.6110 | |

Managing the supply side rather than trying to constraint passengers is indeed the most immediate way to impact on commercial activities. Improving retail space and increasing the variety of shops can improve the impact of passengers' stay at terminals. Indeed, new forms of cooperation with airlines also on the non-aviation side can be a way to erode part of the consumer surplus. Of course this can concern bigger airports much more that smaller ones, where the share of full-service carriers is greater. The interaction with airlines, and the proper supply of dedicated services can be a way to gradually transform the waiting area from a terminal where the mass traveller waits for the flight to a place where the last needs before departure can be satisfied.

Airline network configuration is a key issue that has been not addressed directly by this paper, mainly because of data availability. As seen in the literature review, transit passengers exhibit peculiar purchasing attitude during their waiting time, and this varies from airport to airport. This combines with the new trend for airports to dedicate different terminals to different types of operations – i.e., separate hub-and-spoke operations from point-to-point traffic. Such aspect can be only very partly embodied by the airport size – the bigger the airport, the higher the size of hub-and-spoke traffic. Indeed, it is a complex issue that goes beyond the scopes of this paper and involves aspects related to both time (i.e., waiting and connection scheduling) and space (i.e., location of retail and departure spaces).

## 6. Conclusion and future research directions

This paper was an attempt to propose a broader empirical model than the ones of previous contributors, in order to explain the determinants of non-aviation revenues at firm level with a higher number of regressors. In fact, the use of ridge regression and PLRS made it possible to use simultaneously variables that were dropped by past contributors because of collinearity. Indeed, results are encouraging for future use of these techniques in the field.

Different indications came from empirical findings. The main one indeed concerns the potential conflict between the need to increase the number of passengers, and the obstacles of consumers to find adequate and comfortable places to shop. Finding a break-even point, if it exists, is not easy. Its utility can even be questioned, because airport managers tend to develop the aviation side of the business, which provides sure gains compared to the risk of providing commercial activities to passengers. However, there are ample aspects that managers can act on in order to improve profits through non-core activities, as this paper tried to highlight. Future research directions can concern the exploration of the limits of these two concurrent aspects of the airport business, in order to find appropriate equilibriums for their managing. As to adopted techniques, their enhancement through approaches that explore the presence of fixed or random effects, as well as the extension of the dataset, can provide further robust results.

## References


Aguilò Perez, E., Juaneda Sampol, C., 2000. Tourist expenditure for mass tourism markets. Ann. Tour. Res. 27, 624–637.
Appold, S.J., Kasarda, J.D., 2006. The appropriate scale of US airport retail activities. J. Air Transp. Manag. 12, 277–287.
Bandeira, M., Correia, A., 2012. Qualitative analysis of the relationship between the profile of departing passengers and their perception of the airport Terminal. J. Air Transp. Stud. 3, 78–102.
Bowes, B., 2002. The effects of emotion and time to shop on shopping behaviour in an international airport terminal. In: Paper Presented at the Association of Consumer Research Conference, Columbus, Ohio.
Brechin, M., 1999. Airport catering. Travel & Tour. Anal. 14, 87–104.
Breiman, L., 1996. Heuristics of instability and stabilization in model selection. Ann. Stat. 24, 2350–2383.
Brida, J.,G., Fasone, V., Monterrubianesi, P., Zapata-Aguirre, S., 2014. Air transport performance. Current evidences about the efficiency of Italian airports. Int. J. Bus. Perform. Manag. 15, 351–371.
Brida, J.G., Scuderi, R., 2013. Determinants of tourist expenditure: a review of microeconometric models. Tour. Manag. Perspect. 6, 28–40.
Castillo-Manzano, J.I., 2010. Determinants of commercial revenues at airports: lessons learned from Spanish regional airports. Tour. Manag. 31, 788–796.
Cule, E., 2014. Ridge: Ridge Regression with Automatic Selection of the Penalty Parameter. R Package Version 2.1-3. http://CRAN.R-project.org/package=ridge.
Cule, E., De Iorio, M., 2013. Ridge regression in prediction problems: automatic choice of the ridge parameter. Genet. Epidemiol. 37, 704–714.
DLR, 2014. Low-cost Monitor. http://ww.dlr.de. Retrieved on May 21, 2014.
Dobruszkes, F., 2006. An analysis of European low-cost airlines and their networks. J. Transp. Geogr. 14, 249–264.
Doganis, R., 2006. The Airline Business, second ed. Routledge, Oxon.
Edwards, B., 2005. The Modern Airport Terminal: New Approaches to Airport

Architecture, second ed. Spon Press, New York.
Fasone, V., Maggiore, P., 2012. Non-Aviation activities and the introduction of new thinking and ideas in the airport business: empirical evidence from an Italian case study. J. Airl. Airpt. Manag. 2, 34–50.
Fasone, V., Scuderi, R., 2012. Non-aviation revenues and growth in passengers' traffic: clustering Italian airports. Int. J. Aviat. Manag. 1, 304–317.
Francis, G., Humphreys, I., Ison, S., 2004. Airports' perspectives on the growth of low-cost airlines and the remodeling of the airport–airline relationship. Tour. Manag. 25, 507–514.
Freathy, P., O'Connell, F., 1999. Plannig for profit: commercialization of European airports. Long. Range Plan. 32, 587–597.
Freathy, P., O'Connell, F., 2000. Strategic reactions to the abolition of duty free: Examples from the European airport sector. Eur. Manag. J. 18, 638–645.
French, T., 1994. European airport capacities and airport congestion. Travel & Tour. Anal. 9, 4–19.
Fuerst, F., Gross, S., Klose, U., 2011. The sky is the limit? the determinants and constraints of European airports commercial revenues. J. Air Transp. Manag. 17, 278–283.
Geuens, M., Vantomme, D., Brengman, M., 2004. Developing a typology of airport shoppers. Tour. Manag. 25, 615–622.
Gillen, D., Lall, A., 2004. Competitive advantage of low-cost carriers: some implications for airports. J. Air Transp. Manag. 10, 41–50.
Gillen, D., Hinsch, H., 2001. Measuring the economic impact of liberalization of international aviation on Hamburg airport. J. Air Transp. Manag. 7, 25–34.
Graham, A., 2008. Managing Airports: an International Perspective, third ed. Butterworth Heinemann-Elsevier, Oxford.
Graham, A., 2009. How important are commercial revenues to today's airports? J. Air Transp. Manag. 15, 106–111.
Graham, A., 2013. Understanding the low cost carrier and airport relationship: a critical analysis of the salient issues. Tour. Manag. 36, 66–76.
Hoerl, A.E., Kennard, R., 1970. Ridge regression: biased estimation for non-orthogonal problems. Technometrics 12, 55–67.
Huang, W.H., Kuai, L., 2006a. The in-flight shopper. J. Air Transp. Manag. 12, 207–211.
Hunter, L., 2006. Low cost airlines: business model and employment relations. Eur. Manag. J. 24, 315–321.
Huang, W.H., Kuai, L., 2006b. The in-flight shopper. J. Air Transp. Manag. 12, 207–211.
Jarach, D., 2001. The evolution of airport management practices: towards a multi-point, multi-service, marketing-driven firm. J. Air Transp. Manag. 7, 119–125.
Kasarda, J.D., 2009. Airport Cities. Urban Land, pp. 56–60. April.
Kim, H.Y., Kim, Y.K., 2008. Shopping enjoyment and store shopping modes: the moderating influence of chronic time pressure. J. Retail. Consumer Serv. 15, 410–419.
Kim, H., Shin, J., 2001. A contextual investigation of the operation and management of airport concessions. Tour. Manag. 23, 149–155.
Kolk, H., Van Der Veen, M., 2002. Dilemmas of balancing organizational and public Interests:
How environment affects strategy in Dutch main ports. Eur. Manag. J. 20, 45–54.
Lei, Z., Papatheodorou, A., 2010. Measuring the effect of low-cost carriers on regional airports' commercial revenue. Res. Transp. Econ. 26, 37–43.
Li, Y.H., Chen, C.F., 2013. Passengers' shopping motivations and commercial activities at airports - the moderating effects of time pressure and impulse buying tendency. Tour. Manag. 36, 426–434.
Mak, J., 2004. Tourism and the Economy: Understanding the Economics of Tourism. University of Hawaii Press, Honolulu.
Martin-Cejas, R.R., 2006. Tourism service quality begins at the airport. Tour. Manag. 27, 874–877.
Morrison, W.G., 2009. Real estate, factory outlets and bricks: a note on non-aeronautical activities at commercial airports. J. Air Transp. Manag. 15, 112–115.
Papatheodorou, A., Lei, Z., 2006. Leisure travel in Europe and airline business models: a study of regional airports in great Britain. J. Air Transp. Manag. 12, 47–52.
Pate, J.M., Beaumont, P.B., 2006. The european low cost airline Industry:
The interplay of business strategy and human resources. Eur. Manag. J. 24, 322–329.
Sanchez, G., 2012. Plsdepot: Partial Least Squares (PLS) Data Analysis Methods. R Package Version 0.1.17. http://CRAN.R-project.org/package=plsdepot.
Sull, D., 1999. EasyJet's $500 million gamble. Eur. Manag. J. 17, 20–38.
Tenenhaus, M., 1998. La Regression PLS. Theorie et Pratique. Editions TECHNIP, Paris.
Torres, E., Domìnguez, J.S., Vladés, L., Aza, R., 2005. Passenger waiting time in an airport and expenditure carried out in the commercial area. J. Air Transp. Manag. 11, 363–367.
Tovar, B., Martin-Cejas, R., 2009. Are outsourcing and non-aeronautical revenues important drivers in the efficiency of Spanish airports? J. Air Transp. Manage. 15, 217–220.
Van Wijk, J., Persoon, W., 2006. A long-haul destination: sustainability reporting among tour operators. Eur. Manag. J. 24, 381–395.
Vester, H., 1996. Die shopping mall: eine touristische destination der postmoderne. Gruppendynamik 27, 57–62.
Vlaar, P., De Vries, P., Willenborg, M., 2005. Why incumbents struggle to extract value from new strategic options: case of the european airline Industry. Eur. Manag. J. 23, 154–169.
Wallace, J., Tiernan, S., White, L., 2006. Industrial relations conflict and Collaboration:
Adapting to a low fares business model in aer Lingus. Eur. Manag. J. 24, 338–347.
Wold, S., Geladi, P., Esbensen, K., Öhman, J., 1987. Multi-way principal components-and PLS-analysis. J. Chemom. 1, 41–56.
Zenglein, M.J., Müller, J., 2007. Non-Aviation Revenue in the Airport Business e Evaluating Performance Measurement for a Changing Value Proposition. GAP Project Working Paper, Berlin.
Zhang, A., Zhang, Y., 1997. Concession revenue and optimal airport pricing. Transp. Res. Part E Logist. Transp. Rev. 33, 287–296.