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Volodymyr Bilotkach, Joseph A. Clougherty, Juergen Mueller and Anming Zhang

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Volodymyr Bilotkach, University of Northumbria, Newcastle
Joseph A. Clougherty, University of Illinois, Urbana-Champaign and CEPR
Juergen Mueller, HWR-Berlin
Anming Zhang, University of British Columbia

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Centre for Economic Policy Research
77 Bastwick Street, London EC1V 3PZ, UK
Tel: (44 20) 7183 8801, Fax: (44 20) 7183 8820
Email: cepr@cepr.org, Website: www.cepr.org

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ABSTRACT

Regulation, Privatization, and Airport Charges: Panel Data Evidence from European Airports*

This paper examines the determinants of airport aeronautical charges by employing a unique panel dataset covering sixty-one European airports over an eighteen-year period. We are able to extend the literature on the role of airports as an essential element in transport infrastructure by offering the first analysis of the impact of different regulatory policies and privatization on airport charges in a panel data setting where fixed effects can be employed to mitigate endogeneity concerns. Our main empirical results indicate that aeronautical charges are lower at airports when single-till regulation is employed, when airports are privatized, and – tentatively – when *ex post* price regulation is applied. Furthermore, hub airports generally set higher aeronautical charges, and it appears that price-cap regulation and the presence of nearby airports do not affect aeronautical charges.

JEL Classification: L33, L93, R40 and R48
Keywords: airport charges, airports, hubs, privatization, regulation and single-till

Volodymyr Bilotkach
Northumbria University
City Campus East 1
Newcastle Upon Tyne
NE1 8ST

Email: volodymyr.bilotkach@northumbria.ac.uk

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Joseph A. Clougherty
University of Illinois, Urbana-Champaign
350 Wohlers Hall, 1206 S 6th St
Champaign , IL 61820
USA

Email: jaclough@illinois.edu

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Juergen Mueller
HWR Berlin
Badensche Straße 50-51
10825 Berlin
GERMANY

Anming Zhang
Sauder School of Business
University of British Columbia
2053 Main Mall
Vancouver BC V6T 1Z2
CANADA

Email: anming.zhang@sauder.ubc.ca

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1 Introduction

Airports have always been viewed as an essential element in transport infrastructure; yet since the mid-1980s, airports have been increasingly recognized as full-fledged business enterprises that provide a number of different services to airline industry customers (Doganis, 1992; Winston and de Rus, 2008; Starkie, 2008). Despite the increasing potential for airports to be innovative businesses that provide services beyond take-offs and landings (e.g., parking, concessions, retail and other related services), it must be recognized that airports generally exhibit many of the classic properties of local monopolies. The natural monopoly tendency implies that leaving these businesses unregulated might not be the best course of action from a social welfare perspective. Nevertheless, some countries – such as Australia and the UK – have allowed many airports to freely set charges in an unfettered manner; though, even in these instances, airport service pricing is subject to monitoring (an ex-post regulation) by industry regulators (Forsyth, 2008).

In light of the economic importance of the aviation industry and the relative maturity of research on the airline service industry (see Borenstein and Rose, forthcoming, for a recent review), the airport sector has recently experienced increased attention by scholars. For instance, Forsyth et al. (2004) provide a comprehensive overview of the history and practice of worldwide airport regulation. In addition to more traditional descriptive studies, we also see theoretical scholarship beginning to tackle some of the salient issues regarding airports. For example, Czerny (2006) and Yang and Zhang (2011) consider the optimal form of airport regulation, while Brueckner (2002) and Basso and Zhang (2008) explore the airport-airline relationship concerning aeronautical charges in the peak/off-peak context. The existing empirical literature on airports, however, consists mostly of benchmarking studies that examine the factors determining airport productivity (e.g., Oum et al., 2003; Oum and Yu, 2004; ATRS, 2008; Perelman and Serebrisky, 2010; Liebert and Niemeier, 2010).

While the benchmarking studies have begun to converge on the factors which enhance airport productivity and efficiency, empirical literature concerning the essential topic of what drives airport pricing is surprisingly scarce. We could only identify two empirical studies (van Dender, 2007; Bel and Fageda, 2010) focusing on the determinants of airport pricing. Such a relative scarcity of literature on airport pricing is all the more surprising when one recalls that pricing was the focus of the early empirical work on the airline industry (e.g., Keeler, 1978; Borenstein, 1989; Werden et al., 1991; Brueckner et al., 1992; Kim and Singal, 1993). This lack of empirical work on the drivers of aeronautical charges might be a function of the still prevalent view that airports are infrastructure objects rather than full-fledged businesses. Yet, providing substantive evidence on the impact of regulation and privatization policies on airport pricing is of particular interest to policymakers since many airport authorities in the cross-national environment have recently been experimenting with different regulatory regimes and privatized operations.

Accordingly, our aim here is to use empirical evidence to study the impact of different forms of regulation and privatization – as well as other factors – on the aeronautical charges manifesting at different airports. We employ a unique panel dataset covering sixty-one European airports: data that were collected within the framework of the German Airport Efficiency Project (GAP Project).[1] The data from this project were compiled in order to allow the creation of a panel dataset with operating information on these sixty-one airports over a span of eighteen years (1990 to 2007). The panel nature of the data is one feature that distinguishes this study from that of Bel and Fageda (2010) – who use a cross-section of one-hundred large European airports. While van Dender's (2007) US-based study actually involves a cross-section of US airports spanning the 1998-2002 period, he is not able to fully employ panel-data econometric techniques (i.e., fixed effects) due to non-variation in some key variables. Furthermore, van Dender's study could not shed light on some of the issues we can examine since US airports strictly operate as public enterprises that in turn charge simple cost-based aeronautical fees. Accordingly, the European environment – the focus of this study – is the optimal context in which to study the impact of privatization and regulation on airport charges, as this is the environment where substantial variation in airport policies exists. Furthermore, the panel nature of the data allows us to fully exploit within-airport variation in the key variable constructs, and thereby mitigate some of the endogeneity issues involved with the questions we address. Our study is then complementary to the existing studies of Van

[1] See www.gap-projekt.de for additional information.

Dender (1997) and Bel and Fageda (2010) on aeronautical charges, though the dataset, variable constructs and econometric methods employed are somewhat different to those previous efforts.

Our empirical findings indicate the following. First, the onset of single-till regulation generates – in line with expectations – lower aeronautical charges. Second, airport privatization leads to lower aeronautical charges on average. Third, airports experiencing ex-post regulation (i.e., monitoring and the threat of re-regulation) tend to have lower aeronautical charges; though, this result is based on a small number of airports experiencing a shift away from ex-post regulation. Fourth, hub airports have higher aeronautical charges, thus suggesting that hubbing involves increased demand for airport services which naturally leads to higher prices. Fifth, the introduction of price-cap regulation and the presence of nearby airports does not appear to significantly affect aeronautical charges.

The rest of the paper is organized as follows. Section 2 considers airport regulation and privatization developments in the European context. Section 3 describes the data. Section 4 outlines the hypotheses and the methodology employed in the empirical analysis. Section 5 presents and discusses the panel-data empirical results. Section 6 concludes.

2 Airport Regulation and Privatization in Europe

Airports have traditionally been owned and managed as government entities. Yet, starting with the privatization of some UK airports in 1987, many airports have been fully or partially privatized throughout the world—in particular, a number of airports in Europe, Australia, and New Zealand have been privatized.[2] While there are gains to privatizing airports for local municipalities (removal of a fiscal burden and one-time government revenue boost via the purchase price for the assets), the concern has been that privatized airports will more fully utilize their market power and increase aeronautical charges. In fact, Bel and Fageda (2010) found higher aeronautical charges at private unregulated airports in their cross-sectional study. Accordingly, as the ownership of airports changes

[2] Furthermore, US authorities are contemplating the privatization of some airports. Additionally, a number of developing countries in Asia, South America and Africa are also in the process of privatizing their airports (Oum et al., 2004; Winston and de Rus, 2008).

from public to private hands, economic regulation may become increasingly necessary due to the local monopoly nature of airports.

Two principal types of economic regulation have generally been practiced with respect to airport pricing: the traditional cost-based (i.e., rate of return) regulation and the more incentive-minded price-cap regulation. Under rate of return (ROR) regulation, the airport is allowed to charge a price that would prevail in a competitive market; i.e., the price equal to efficient costs of production plus a market-determined rate of return on capital investment.[3] Price-cap regulation – first introduced in the mid-1980s – instead adjusts an airport's charges according to the price-cap index that reflects the overall rate of inflation in the economy and the ability of the airport to gain efficiencies relative to the average firm in the economy.

The exact form of price regulation appears to vary both across countries and over time. For example, a number of countries – including Germany and Canada – have adopted cost-based regulation, while price-cap regulation has been popular in countries such as the UK, Denmark, Ireland and Australia. A major limitation of the cost-based approach is the well-known Averch-Johnson effect: i.e., if the allowable ROR is set too high, the regulated firm can increase its profit by enhancing capital assets, thus firms have a consequent tendency to over-invest (Averch and Johnson, 1962). In addition to the Averch-Johnson distortion, concerns also exist regarding productive inefficiency. In particular, the cost-based nature of ROR regulation suggests that airports would not benefit from cost reduction. Price-cap regulation has become popular because it is generally believed that this approach gives firms incentives to be cost efficient, thus price-cap regulation is often referred to as 'incentive regulation'. For example, while German airports have traditionally been regulated by cost-based regulation, price-cap regulation has been in place since 2000 for Hamburg and a few other airports (Mueller et al., 2010). Niemeier (2002) argues that such a change improves the economic efficiency of airports.

[3] The traditional cost-based approach resembles the airport-charge policy from the International Civil Aviation Organization (ICAO): an inter-governmental agency that deals with cross-national aviation issues. As noted in Odoni (2009), the ICAO Council has stated that airport operators may recover the full cost, "but no more", of aeronautical facilities and services (ICAO, 1992). The full cost includes the cost of operations, maintenance, management and administration, as well as interest on capital investment, depreciation of assets, and – when conditions permit – a fair return on investment.

An airport derives revenue from two facets of its business: the traditional aeronautical operation, and the commercial (concession) operation. The former refers to the aviation activities associated with runways, aircraft parking and terminals, whereas the latter refers to the non-aeronautical activities within terminals and on airport land, including terminal concessions (duty-free shops, restaurants, etc.), car rental, automobile parking, and other activities. Over the last twenty-five years, commercial revenues have grown faster than aeronautical revenues and, as a result, have become the main source of income for many airports. For instance, van Dender's (2007) investigation of fifty-five large US airports found that concession revenue represents more than half of the total airport revenue during the 1998-2002 period (see Doganis, 1992, for figures on earlier years in the US). Note also that the commercial operations of European airports tend to be more profitable than aeronautical operations (see Jones et al., 1993; Starkie, 2001; and Francis et al., 2004) owing in part to the prevailing regulations and charging mechanisms (e.g., Starkie, 2001).

In light of there being two main sources of airport revenue (aeronautical and non-aeronautical), airport regulation in the European context has varied in another dimension: whether airport charges are based on both aeronautical and non-aeronautical operations, or based strictly on aeronautical operations. More specifically, under the single-till approach, operating profits from both the aeronautical and non-aeronautical (concession) operations are considered in the determination of regulated aeronautical charges. Under the dual-till approach, the aeronautical charges are determined solely on the basis of aeronautical activities.[4] Single-till regulation represents the more traditional approach here, while dual-till represents a relatively recent regulatory innovation.[5] Note that

[4] Note that US airports are under either the 'residual cost' or 'compensatory' systems. Under the former, the airport charges airlines the airport's total (net) revenue minus all (net) revenues collected from non-aeronautical services such that the airport breaks even. As such, this pricing scheme may be considered a single-till regulation. In comparison, an airport under the compensatory system charges airlines and other aviation users only for the facilities and services they actually use (i.e., aeronautical services) such that the airport breaks even. The compensatory pricing may consequently be considered dual-till regulation (see, e.g., Graham, 2002; Oum et al., 2004).

[5] As noted by an anonymous referee, single-till regulation could also be the result of international regulatory constraints. Unlike many other industries, air transportation is regulated internationally: ever since the Chicago Convention was negotiated in 1944, virtually all commercial aspects of international air transportation have been governed by bilateral air services agreements (ASAs) which are negotiated by the relevant national governments. ASAs generally specify services (passenger, cargo) and routes to be operated between the two countries, and stipulate fare-setting mechanisms. They usually specify the

aeronautical charges are likely set lower under single-till price-cap regulation than under dual-till price-cap regulation, due to the cross-subsidy from the usually (largely unregulated) profitable commercial operation. Zhang and Zhang (1997) and Czerny (2006) point out that such cross-subsidization can be welfare enhancing at a non-congested airport. At a congested airport, however, dual-till price-cap regulation can be more desirable than single-till price-cap regulation, since economic efficiency of constrained airport capacity requires higher aeronautical charges (Yang and Zhang, 2011).[6] The single-till and dual-till distinction can also carry over to cost-based regulation where the ROR can be set on the capital investment for both the aeronautical and non-aeronautical operations (single-till), or strictly on the aeronautical operations (dual-till).

Another more-recent regulatory mechanism that has been employed on the airport sector is ex-post regulation: which essentially involves price monitoring and the threat of re-regulation by authorities. More specifically, no regulation is applied to the airport unless the 'regulated' airport sets prices, earns profits, or reduces service quality beyond certain critical levels. If the thresholds are violated, then a long-term commitment to re-regulation is imposed; as such, this mechanism is sometimes referred to as conduct regulation, or 'light handed' price regulation (Forsyth, 2008). In short, this category includes all the airports that are not subject to prices being explicitly set by the regulator; instead, the charges proposed by these ex-post airports are subject to approval and/or monitoring by the regulator.

The ex-post approach is currently implemented in Australia, New Zealand and Switzerland, as well as some airports in the UK and Eastern Europe. For example, ex-

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airlines with the right to fly on each route and determine the capacity that can be provided by each designated airline, but occasionally might also impose certain constraints on the charging mechanism of airport services. For example, the single-till mechanism was required for UK airports under ASAs into the 1990s. However, more recent renegotiations of ASAs – beginning with the US-Netherlands agreement of 1992 – have moved in the direction of greater liberalization. In particular, the implementation of the third package of the EU's single air transport market—started in 1993 and concluded in April 1997—permitted the airlines of each country full cabotage rights in the other countries as well as freeing up airport charging mechanisms (subject, of course, to EU-wide Competition Law). The impact of ASAs on airport charges is thus of less importance for the majority of our sampled observations—which are post-1997. See Zhang, et al. (2011) for further discussion on the international aviation regulatory framework.

[6] For this reason, Beesley (1999) argues that the single-till price-cap is inappropriate in the case of Heathrow—a heavily congested gateway airport. Beesley also notes that it might be difficult to isolate aeronautical activities from concession activities, thus making it difficult to implement dual-till regulation in practice.

post regulation has been applied to many small/medium-sized airports throughout the UK (excluding, of course, those airports designated for price-cap regulation: Manchester airport and those in London).[7] The rationales for ex-post regulation include: (i) airports have incentives to lower aeronautical charges in order to attract more traffic and increase their concession revenues (Starkie, 2001); and (ii) the threat of re-regulation can help mitigate the potential exploitation of market power by privatized airports (Forsyth, 2008). The obvious danger is that the deterrence effect of re-regulation is insufficient to prevent airports from taking full advantage of their market power by setting relatively high aeronautical charges. Thus, it remains an empirical question as to whether ex-post regulation substantially affects airport pricing.

3 Data

In our analysis, we use the data collected and compiled by the German Airport Efficiency Project (GAP Project)—a partnership of three German Universities (FHV Berlin, Hochschule Bremen, and Internationale Fachhochschule Bad Honnef) supported by the Federal Ministry of Research and Technology. The project involved the collection of data on a number of airports across Europe.[8] The data obtained included information on airports' annual basic operating results, such as total aeronautical revenue and non-aeronautical revenue, aircraft movements, number of passengers served, cargo transported, etc. Information on the institutional environment in which airports operate is also available—this includes the share of private ownership, as well as classification of airports by the type of regulation employed.[9] The original dataset classifies airports as subject to cost-based regulation, price-cap regulation, and ex-post regulation. Further, we are able to observe whether airports are subject to single-till or dual-till regulation. Table

[7] The UK did not allow the 'designated airports' (Heathrow, Gatwick, Stansted and Manchester) to freely set charges, thus for our sampled period these airports were price capped. Furthermore, no Scottish airports were subject to price cap regulation. Price caps were once proposed for Aberdeen Airport, but the proposal was dropped (see: http://www.airportwatch.org.uk/scotland/index.php/archives/129).

[8] See the Appendix for the list of airports in our sample. Within the GAP project, researchers assembled publicly available data on European airports and used industry contacts to obtain additional information which was not immediately accessible via public sources. Most importantly, it should be stressed that in terms of selection effects, no European airports – for which data was available – have been excluded from the study.

[9] Unfortunately, we cannot breakdown privatization beyond the share of private ownership into the different types of privatization: e.g., sell-offs, concession agreements, etc.

1 illustrates the pertinent descriptive statistics for the variables employed in our estimations.

In addition to the above-mentioned airport characteristics, some additional features of the dataset are worth mentioning. The dataset classifies airports as either hubs or non-hubs (only about ten percent of our observations represent hub airports—the hub definition is given below).[10] We also have information on the number of airports located within the airport's catchment area[11] that serve over one-hundred thousand passengers; thus, we can test for potential airport competition effects. Furthermore, we adjusted aeronautical and non-aeronautical revenues for inflation – expressing them in year 2000 prices – before conducting the empirical analysis. Some demographics (population and per capita income) for the surrounding area of the airport were also included in the GAP data. We have supplemented this data by locating additional information, and/or by interpolating the numbers for a few missing years.[12] In total, our unbalanced panel dataset contains information on sixty-one airports from seventeen countries, and spans the time period from 1990 to 2007.[13]

A merit of our sample is that we have a number of different airport types in our data: small airports, airports primarily used by low-cost carriers, airports specializing in cargo transportation, as well as large European hubs. This heterogeneity differs somewhat with Bel and Fageda's (2010) focus on the one-hundred largest European airports and with van Dender's (2007) focuses on US airports specializing in commercial passenger operations. A quick glance at the descriptive statistics in Table 1 confirms that we are dealing with a diverse set of airports over many dimensions; thus, our sample involves the necessary amount of variation in order to employ panel-data econometric

[10] Over the time period covered by our sample, two airports – Brussels and Copenhagen – have been declassified as hubs. This variation allows us to estimate the impact of hub status in fixed effects econometric specifications; though, interpretations of the coefficient estimate must be understood with this small set of actual hub changes in mind.

[11] Catchment area has been defined by GAP Project to encompass a 90-kilometer radius around the airport.

[12] Sources of information on these variables primarily involve Eurostat and IMF. Note that in some cases (especially for smaller countries) per capita income and population data were only available at the country level. Accordingly, we might expect some measurement error in these variables.

[13] The original dataset includes information on over 70 airports; however, data on operating outcomes and/or the institutional environment were not available for some of these airports which led to the current sample size of 61 airports. For these 61 airports we have a total of 748 observations, yet only 672 observations are actually employed in the less exacting regression specification due to our lagging of right-hand-side variables.

techniques. In particular, we will control for airport specific fixed effects and rely then on within-airport variation in making causal inferences. To add more specificity here, we observe regulation regimes changing in nine airports, till types changing in fourteen airports, and private ownership shares changing in nineteen airports. In short, our main explanatory constructs indicate a decent degree of within-airport variation.

In order to construct a measure of aeronautical charges – our dependent variable – we take the simple ratio of real aeronautical revenue over the number of aircraft movements: where either a landing or a take-off represents one movement. This is a rough proxy for average price since aeronautical charges consist of both weight-based take-off and landing fees (with the weight-charge relationship not always being linear), and per passenger charges.[14] Note also that some airports set different charges for origin-and-destination passengers as compared to transfer passengers; set higher take-off and landing charges for noisier aircraft; and impose higher nighttime charges. At the same time, average revenue per aircraft is a good overall measure of the level of aeronautical charges, has been previously employed in the literature (van Dender, 2007), and the panel nature of our data allows controlling for airport-specific differences. Furthermore, our approach to constructing a measure of aeronautical charges is fundamentally different to that of Bel and Fageda (2010) who focus on the total airport charges for a particular type of aircraft (a narrow-bodied Airbus) assuming a certain load factor. While this approach is meticulous and appropriate for a cross-section of passenger-oriented airports, the use of our proxy enables taking full advantage of the data's panel nature.

4 Empirical Analysis

4.1 Methodology

In order to properly employ our panel data covering European airports over the 1990-2007 period, it behooves us to consider a few econometric issues. As already noted, the data's panel structure enables airport fixed-effects estimations that yield coefficient estimates based on within panel variation. Yet in the course of empirical analysis, we need to tackle some additional econometric issues.

[14] Airport charges often consist of two components: charges for aircraft take-off/landing (as well as aircraft parking—which is quite small as compared to landing fee), and passenger-related charges such as terminal building services.

First, our dependent variable – aeronautical charge per aircraft movement – may be simultaneously determined with a few of our independent variables. In particular, average aircraft size (defined as the ratio of the number of passengers to the number of aircraft movements) and cargo volume can be considered measures of airport output; thus, we will effectively have two output measures on the right-hand side of our regression equation and price on the left-hand side. Technically, this means that the error terms in our regression equations may be correlated with these independent variables. The classical approach to addressing this problem is to find variables correlated with the regressors but not with the error term, and then employ instrumental variable (IV) techniques. One could also use the panel properties of the data and assume that past values of the explanatory variables might be uncorrelated with current shocks.[15] In our empirical estimations, we will combine these approaches by first lagging all of the independent variables in all of the regression specifications that we estimate in order to begin to mediate the endogeneity issue; and then by using twice lagged measures of an airport's output (average aircraft size and cargo) in order to instrument for the once-lagged explanatory constructs.

Second, the issue of autocorrelation needs to be addressed, as it can manifest due to the cyclical nature of the airline business. Autocorrelation may also manifest because airports are not able to immediately respond to a changing business environment (due to the regulated environment in which they operate) by adjusting prices for their services. We can address this issue by estimating a dynamic panel data model where the lagged dependent variable is introduced as a right-hand side regressor. Yet, dynamic panel data models can result in biased coefficient estimates due to the obvious endogeneity in the lagged dependent variable. In order to address this endogeneity threat, we will employ the Generalized Method of Moments (GMM) estimator for dynamic panel data. Specifically, we will use the system estimator proposed by Arellano and Bover (1995) which built and improved upon the Arellano and Bond (1991) GMM estimator. System GMM analysis is specifically designed to address endogeneity issues with dynamic panel data models (i.e., biases in the coefficient estimate for the lagged dependent variable).

[15] This is not necessarily a safe assumption in the regulated environment, where prices may be slow to respond to changes in demand; therefore, a current year's change in aeronautical charges could still be related to last year's abnormally high/low demand for the airport's services.

Moreover, GMM can also be used to address endogeneity in any additional explanatory variables; namely, the above mentioned measures of average aircraft size and cargo. Accordingly, we will use the System GMM procedure to estimate dynamic panel data models where we instrument for both the lagged dependent variable and the potentially endogenous explanatory variables.

Third, a few miscellaneous econometric issues also need to be addressed. As already noted, all the independent variables are lagged in all of the reported regression specifications in order to initially respond to the endogeneity issue. Furthermore, the IV regressions use twice lagged measures of airport output (average aircraft size and cargo) to respectively instrument for the once lagged measures of airport output that fall on the right-hand side of the regression specification. For the System GMM procedure, all available lags for aeronautical charges are employed as instruments for the lagged dependent variable, and twice lagged measures are employed as instruments for the once lagged output measures—akin to the IV estimations. This combination ensures no correlation between the instrumental variables and the error terms—a necessary condition for the GMM estimator to be valid. In addition, the reported standard errors also account for heteroscedasticity both between and within cross sections (i.e., we allow for the error variance to differ not only across the airports, but also across time). Lastly, we employ fixed period specific effects (i.e., year dummies) in all of the reported regression specifications in order to control for any common time trends across our sampled airports.

With the above econometric issues in mind, we estimate the following regression specifications. Specification 1 is a simple fixed effects estimation that does not employ a dynamic panel data model (i.e., no lagged dependent variable). Specification 2 is a similar fixed effects specification that introduces instrumental variable (IV) procedures for the two explanatory variables with potential endogeneity: average aircraft size and cargo volume. Specification 3 introduces the lagged dependent variable into a simple fixed effects specification where no instrumentation takes place. Specification 4 does the same as specification 3, except it instruments – via the IV procedure – for the two explanatory variables (average aircraft size, and cargo) of concern. Specification 5 employs the GMM procedure where only the lagged dependent variable is instrumented for with the System GMM technique. Finally, specification 6 employs the System GMM procedure to instrument for both the clearly endogenous lagged dependent variable and the potentially endogenous explanatory variables (average aircraft size, cargo volume).

4.2 Hypotheses and regression specification

Our research focus is the effect of regulatory environment changes and private ownership changes on aeronautical charges; yet, here we will discuss *a priori* expectations for both the main explanatory variables and the key control concepts.

The expected effect of private ownership is uncertain due to the potential for multiple causal paths. On one hand, we can expect private owners to exercise their market power, thus yielding higher aeronautical charges.[16] In line with this view, Bel and Fageda (2010) found higher charges at private unregulated airports. On the other hand, we can offer three explanations for a possible negative privatization–charges relationship. First, the general theory of principal-agent relationships in publicly owned enterprises suggests that such managers may have an incentive to emphasize what could be perceived as correlates of social welfare, namely quality (Lindsay, 1976). This could yield overinvestment in quality (manifested through, for instance, keeping traffic low to avoid congestion). In effect, Zhang and Zhang (2003) have shown that a welfare-maximizing airport would add capacity earlier than a privatized airport. As private owners strive to make the airport more (technically) efficient, they may be able to reduce operating costs and pass the savings along to customers in the form of lower aeronautical charges. The second explanation relates to the fact that private ownership brings investment to the airport; hence, the timing of privatization might be related to the airport's need to attract investment. Accordingly, those airports that are in need of investment might be the ones getting privatized; meaning that at the time of privatization these airports are expanding capacity—a capacity expansion that shifts out the supply-curve and logically entails lower prices. A third possible explanation is that a private airport may be more innovative in its approach to, and management of, commercial operations than a public airport. As a result, it would have a higher commercial profit per

[16] Note, however, that privatized airports are not necessarily allowed to act as profit-maximizing monopolies.

passenger than a public airport. Due to this, the private airport would have a greater incentive to lower aeronautical charges so as to attract more passengers and earn greater commercial profit.

In sum, the relationship between privatization and aeronautical charges is complex, and the coefficient estimates for the privatization variable may potentially reflect the net-effect of these different elements. Notice that Table 1 indicates that aeronautical charges are higher at airports with less than 50% privatization (822.53 Euros per movement) than at airports with greater than 50% privatization (663.75 Euros per movement). While this initial look at the data suggests that privatization leads to lower aeronautical charges, it is imperative that we analyze this effect under a rigorous econometric specification.

As far as regulation is concerned, we specifically examine three different dimensions of regulatory policy: price-cap, ex-post and single-till regulation. In order to identify the three regulatory variables and avoid collinearity, we omit the indicators of cost-based regulation and dual-till regulation. Omitting these indicators – and thus setting them up as the empirical benchmark – is in line with cost-based and dual-till regulation representing traditional regulatory practice for airports, while price-cap, ex-post and single-till regulation all represent innovations in regulatory policy. Accordingly, our *a priori* expectation regarding price-cap regulation is for lower aeronautical charges at airports which practice price-cap regulation as compared to cost-based regulation. Price-cap regulation should provide airports with the necessary incentives to increase efficiency, since cost-based regulation has been deemed to lack sufficient incentives. It should be noted, however, that Starkie (2004) suggests an equivalence between price-cap and cost-based regulation; furthermore, Bel and Fageda's (2010) empirical study of aeronautical charges found no difference between these two regulations. Second, we can formulate a clear hypothesis regarding the effect of single-till – as compared to dual-till – regulation on aeronautical charges: we expect lower aeronautical charges at airports introducing single-till regulation as a substitute for dual-till regulation, because airports can cross-subsidize between aeronautical and non-aeronautical activities under single-till regulation. Third, and as already noted, the expected effect of ex-post regulation is *a* *priori* uncertain, as it is an open question as to whether the airports will use their freedom to exert market-power or instead attempt to lower charges in order to attract more traffic.

In order to make better causal inferences regarding the above explanatory variables of principal interest, we will introduce a number of control constructs. While not the focus of this study, the influence of these controls on aeronautical charges is also of some interest. The following represent the control variables we employ in all of the reported regression specifications. First, a hub airport dummy: hub status should bring with it a greater demand for flight frequencies and airport services; thus, hub status should translate into higher aeronautical charges. Second, the natural logarithm of non-aeronautical revenue per passenger: we expect the effect of this variable to be negative, due to the potential for cross-subsidization between aeronautical and non-aeronautical revenues. Third, the natural logarithm of real GDP per capita: wealth in an airport catchment area should be associated with higher aeronautical charges, due to the obvious demand-side forces reflected in this variable. Fourth, the natural logarithm of population: akin to GDP per capita, this variable is also likely to be positive due to demand-side forces. Both per capita GDP and population are routinely found to be associated with higher airfares. Fifth, the number of airports serving over 100,000 passengers located within an airport's catchment area: the presence of nearby airports should reduce aeronautical charges.[17] Lastly, we have two measures of airport operational performance: the natural logarithms of the ratio of number of passengers to the number of aircraft movements (which proxies 'average aircraft size'), and volume of cargo transported.[18]

Beyond knowing whether the airport is a hub for a particular airline, we do not have any additional information on the downstream airline market. This is clearly an omission in our study, as van Dender (2007) and Bel and Fageda (2010) have information on the downstream market. Yet, the relevant data for all the years in our sample of

[17] This variable actually exhibits sufficient within-panel variation to identify potential airport competition effects, as we have thirty-one airports in our sample experiencing at least one change in the number of nearby airports. This significant amount of variation could be due to the fact that our period of study is one where European low-cost carriers, in particular Ryanair, experienced rapid growth. These airlines often set up bases at remote – previously unutilized for purposes of commercial passenger transport – airports, and would thus potentially generate increased airport competition for mainline airports.

[18] Some airports in our sample did not handle any cargo operations for certain years, thus in order to be consistent with the other log-based quantity measures, we added one to all the measures of cargo in order to calculate the natural logarithm of the cargo variable and include it in the regressions.

European airports are simply not readily available.[19] This data deficiency also makes it impossible to test the implications of recent airport-pricing theoretical studies that incorporate airline market structure (e.g., Brueckner, 2002). Nevertheless, it is important to underscore that both Bel and Fageda (2010) and van Dender (2007) found airport level HHI to be an insignificant determinant of aeronautical charges.[20] Thus, omitting downstream market structure may not be of serious consequence.

5 Results

Table 2 presents the estimation results for the six regression specifications previously outlined in the methodology sub-section (see 4.1). It is important that the regressions be well-specified in order to yield confidence in interpreting our variables of principal interest. The adjusted R-squares in regression specifications' 1-4 range from .8601 to .9252, thus indicating that the model is reasonably well specified. Another striking result from a first glance at Table 2 is that our key variables of interest (indicators and measures of regulation and privatization) exhibit a substantial degree of consistency when we consider signs and significance across the six different regression specifications. In particular, the coefficient estimates for hub status and airport competition – in addition to price-cap, single-till and ex-post regulation – are generally consistent across the different treatments: i.e., non-dynamic and dynamic panel data models, not-instrumenting and instrumenting (with both IV and GMM) for the two output measures, and not-instrumenting and instrumenting (with GMM) for the lagged dependent variable.

In light of the qualitatively similar findings for our variables of interest in the six different econometric treatments, we take a variable-by-variable approach here to analyzing the results. First, the coefficient estimates for price-cap regulation are statistically insignificant in all six regression specifications, thus suggesting that price-

[19] To measure airline market characteristics, van Dender (2007) used T-100 data collected by the US Department of Transportation, while Bel and Fageda (2010) had access to the Official Airline Guide (OAG) data for one year. The T-100 data is not useful for us since we have a sample of European – not US – airports, and the panel nature of our data would require 'very costly' access to multiple years of OAG data.

[20] Van Dender (2007) did, however, find that higher concentration yields higher aeronautical charges when Southwest Airlines is the largest airline serving a particular airport—a result which can be potentially explained by the fact that Southwest Airlines uses larger aircraft as compared to its competitors at the airports where it dominates. The Southwest Airlines' fleet consists of Boeing–737 airplanes, and the use of larger aircraft (e.g., Boeing–757 and wide-body aircraft) is not so widespread in US domestic aviation.

cap regulation is not superior to cost-based regulation when it comes to aeronautical charges. Second, the coefficient estimates for single-till regulation are negative and statistically significant in all six regression specifications, thus it appears that the onset of single-till regulation leads to lower aeronautical charges. Third, the coefficient estimates for ex-post regulation are negative in all six specifications and significant in every specification except for regressions' 3 and 5, thus it does appear that rescinding ex-post regulation increases aeronautical charges. Fourth, the coefficient estimates for privatization are negative and significant in all six regression specifications, thus privatization appears to lead to lower aeronautical charges. Fifth, the coefficient estimates for the Hub variable are positive and significant in all six regression specifications, thus it does appear that de-hubbing an airport will lead to lower prices. Sixth, the coefficient estimates for the number of airports in the catchment area are insignificant in all six regression specifications, thus the presence of competitor airports does not seem to influence aeronautical charges.

While the effects of the privatization and regulation measures are qualitatively consistent, we should point out that their magnitudes vary across the six regression specifications. In particular, the introduction of dynamic panel data analysis leads to diminishing magnitudes for the effects of our key drivers of aeronautical charges. Specifically, single-till regulation yields a 12 percent decrease in aeronautical charges in the base model specifications (#1 & #2), but only a 7.7 to 9.5 percent decrease in charges when considering the System GMM specifications (#5 & #6). Ex-post regulation shows a remarkable 25 percent decrease in average aeronautical charges in the base model (specifications' #1 & #2), but the size of that effect is brought down to a more modest 7-17 percent once a dynamic structure is introduced. Moreover, proper interpretation of the coefficient estimate for ex-post regulation requires a closer look at the data, as our estimation technique relies on within airport variation. In our empirical context, we have zero (three) airports experiencing a move toward (away from) ex-post regulation during the 1990-2007 period. Thus, the identification of our coefficient estimate derives from the *removal* of ex-post regulation in three particular airports (Amsterdam, Brussels and Malta International) which in turn suggests that we should modestly interpret the findings for this variable and make no strong claims with respect to any inconsistency with Bel and Fageda's finding that airports under ex-post regulation charge higher aeronautical fees.

With respect to the magnitude of the privatization effect on aeronautical charges, our results imply that an increase in private ownership share by 10 percentage points will lead to a decrease in aeronautical charges of somewhere between 1 and 3 percent. At the sample mean, this corresponds to lower aeronautical charges somewhere between €7.30 - €21.50 per aircraft movement in year 2000 prices. Given the median of 75,000 aircraft movements per year for our sub-sample of airports with non-zero private ownership, a 10 percentage point increase in private ownership share saves all airlines serving such an airport upwards of €1.65 million per year—again in year 2000 prices while employing the least conservative coefficient estimate from Regression 2. Thus while not huge, this amount is not trivial as these savings could be an important amount in light of the airline industries generally thin profit margins.

We now take a similar variable-by-variable approach to consider the impact of the additional control variables on aeronautical charges. First, all six regression specifications yield no support for 'non-aeronautical revenue per passenger' and 'the number of nearby airports' having a significant impact on aeronautical charges. The latter finding is somewhat counter-intuitive and differs with Bel and Fageda's (2010) finding, but could be driven by our focusing on within-airport variation.[21] As previously noted, within variation in the number of nearby airports is most likely driven by the expansion of low cost carriers into smaller airfields—airfields which have previously not been utilized by commercial airlines. As airlines operating in 'traditional' airports do not typically respond to such low-cost carrier expansion by moving their operations to smaller airports, the pressure on established airports to lower their aeronautical charges in response to low-cost carrier entry into the nearby airfield may be limited.[22]

[21] It should be noted that unreported regressions employing an OLS-like approach (where between-airport variation is key) do find the presence of nearby airports to negatively correlate with aeronautical charges. These results are available from the authors upon request.

[22] As noted by an anonymous referee, this result may also be driven by airports in a geographic area actually serving different routes and therefore different markets to some extent. This lack of direct airline service competition may curtail the degree of effective competition between the airports from the consumer's perspective. Moreover, finding what may be driving this result (the limited impact of nearby airports on aeronautical charges) would be an interesting future research topic.

Second, GDP per capita and population are generally associated with higher aeronautical charges; though, these coefficient estimates are insignificant in many specifications. While studies of the airline industry routinely detect positive relationships between these measures of potential market size and airfares, it is important to point out that our employing a panel-data methodology omits the between-panel variation that may drive that standard result. Third, the two measures of airport operating performance (average aircraft size and air cargo volume) yield mixed results (differences in both signs and significance) across the six regression specifications. In part, these mixed results indicate the potential endogeneity in these variables, and suggest the advisability of not interpreting these coefficient estimates with any degree of confidence. Note, however, that consistency in the coefficient estimates for the variables of principal concern suggests that any endogeneity in these output measures does not spillover and affect the inferences on our constructs of principal interest. Finally, the coefficient estimates in regression specifications' 3-6 do indeed suggest that previous levels of aeronautical charges (the lagged dependent variable) influence current levels of aeronautical charges.

While this analysis represents the first comprehensive empirical study (comprehensive in that we have a sample involving heterogeneity in regulation and privatization, employ panel data techniques, and factor the potential for inertia in the regulation process by using dynamic panel data models) of the factors driving aeronautical charges, it is important to compare our results with the pre-existing empirical literature (e.g., van Dender, 2007; Bel and Fageda, 2010). A comparison of the above results with the prior empirical literature on airport pricing yields the following initial observations. First, our finding a statistically significant negative relationship between single-till regulation and aeronautical charges confirms Bel and Fageda's similar (though insignificant) empirical finding. Second, our finding that price-cap regulation is equivalent to cost-based regulation when it comes to setting aeronautical charges confirms Bel and Fageda's similar finding. Third, our finding hub airports to have higher aeronautical charges is clearly intuitive, yet it is a novel result in the sense that Bel and Fageda did not include this variable in their regression specification and van Dender's study did not find hub airports to generally have higher charges. Fourth, our finding that both privatization and ex-post regulation lead to lower aeronautical charges differs from

Bel and Fageda's (2010) results which suggested that privatized/non-regulated airports have higher charges.

When comparing our results concerning privatization and ex-post regulation with those of Bel and Fageda (2010), a few caveats – based on the two studies employing different datasets, different econometric methods and different variable constructs – should be considered. First, we need to be cautious in making causal interpretations based on our ex-post regulation variable, as this coefficient is based on only three airports experiencing a move away from ex-post regulation. Second, Bel and Fageda employ a combined privatized/non-regulated variable, while we have two separate variables to capture both elements. Third, our sample only includes forty of the one-hundred airports in Bel and Fageda's study, thus despite the common focus on European airports the samples are somewhat different. This sample difference is borne out by the fact that average aeronautical charges are around 2000 Euros in Bel and Fageda's sample, but only 750 Euros in our sample—differences that may also be due to differences in the charge calculation methodology.[23]

Lastly, it should be reiterated that in contrast to the previous literature, we employ panel data (not cross-sectional) econometric methods. Thus, panel-data (more specifically, fixed effects) methods rely on within-airport variation – rather than between-airport variation – in order to identify the coefficient estimates in our regression equations. Once this difference in empirical approaches is fully understood, the differences between our results and previous results can be more easily reconciled. For instance, our finding that higher levels of private ownership lead to lower aeronautical charges does not indicate that privatized airports necessarily have lower aeronautical charges as compared to non-privatized airports (the variation that cross-sectional methods concentrate on), but that aeronautical charges generally became lower at airports which experienced higher levels of private ownership. Moreover, the large upside of focusing on within-airport variation is that we can make stronger causal inferences that are more immune to endogeneity bias—a bias which is rife in cross-sectional studies.[24]

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[23] Recall that Bel and Fageda (2010) computed total charges for an A-320, whereas we simply divided aeronautical revenue by the number of aircraft movements.

[24] We invite further debate on the important issue of whether and when privatization of airports leads to reduced aeronautical charges. A study that merges our dataset with that of Bel and Fageda (2010) might be

6 Conclusions

This study examines the impact of airport regulatory policy and airport privatization on the prices that airports charge their customers (i.e., the aeronautical charges faced by airlines). In particular, we are able to explore the effects of privatization and different regulatory policies on European airports using a new panel dataset collected by the German Airport Efficiency Project. The European context is the ideal environment in which to study these relationships, as a substantial degree of variation exists in both the regulatory framework and the degree of privatization found in Europe as compared to US airports. Accordingly, the strength of our analysis resides in our ability to comprehensively analyze the impact of varied regulatory policies and different degrees of privatization on aeronautical charges. In addition, our study is able to employ panel data methods and thus elicit stronger causal inferences that are less subject to the usual endogeneity concerns.

Our empirical results can be summarized as follows: single-till regulation, privatization, and ex-post regulation all tend to lower aeronautical charges at airports. Interestingly, we do not find price-cap regulation to substantially decrease aeronautical charges. In addition to the above core results concerning regulation and privatization, we find that hub airports tend to have higher aeronautical charges, while the presence of competing airports in the catchment area does not significantly affect airport charges.

Accordingly, our empirical results suggest the following interpretations and implications. First, price-cap regulation does not appear to generate lower aeronautical charges as compared to cost-based regulation: while this result is somewhat surprising, it is in line with Starkie's (2004) ideas concerning the equivalence of cost-based and price-cap regulation, and with the empirical results of Bel and Fageda (2010). Second, the regulatory practice of single-till regulation – as opposed to dual-till regulation – appears to lead to lower aeronautical charges, as the consideration of non-aeronautical revenues lowers the optimal aeronautical charge due to the potential for cross-subsidization of non-aeronautical revenues via increased aeronautical traffic. Third, the presence of ex-post

in order, as this could help further pin down the relationship between privatization and aeronautical charges.

regulation generates lower aeronautical charges; thus, it appears that airports generally resist the lure of fully exerting their market-power when liberalized from regulation. However, this result is driven by only three particular moves away from ex-post regulation in our sample, thus we caution against making strong generalizations, as clearly the link between ex-post regulation and aeronautical charges deserves – and requires – further theoretical and empirical exploration. Fourth, our results suggest that privatized airports do not tend to increase aeronautical charges, but rather tend to decrease aeronautical charges. Accordingly, it appears that airport privatization may lead to efficiency gains which are passed off to airlines in the form of lower aeronautical charges, and/or may allow airport managers to be more innovative in attracting additional customers via lower aeronautical charges.[25] Given the fact that Bel and Fageda (2010) employ a different cross-sectional dataset with a methodology based on between-airport variation and find a different result, we believe further investigation of the impact of privatization on aeronautical charges is certainly in order. Fifth, hub airports – per expectation – involve higher aeronautical charges than non-hub airports; though, it should be noted that we have only a few instances of airports changing from hub to non-hub status in our sample. Finally, our results indicate that any changes in the number of nearby airports competing with the focal airport do not significantly affect aeronautical charges; thus, competition between airports does not seem to involve pricing discipline during the surveyed period in our sample of airports.

In terms of future work, we see a few different areas for potential extensions of this study. For one, the lower aeronautical charges associated with ex-post regulation is one finding that merits further investigation, as a study that conceptually and empirically identifies the actual mechanisms via which ex-post regulation might lead to lower charges would be of significant merit. A second area of fruitful research may be in further understanding the impact of privatization on aeronautical charges. As noted, the privatization/aeronautical-charges relationship is complicated due to it potentially involving multiple effects; thus, there may be merit in uncovering and identifying these different effects and determining the conditions which explain when one effect dominates

[25] It should be noted, however, that we cannot control for airport capacity; thus, privatization may also be associated with periods when airports are undertaking capacity expansion which leads to lower aeronautical charges due to increased capacity.

other effects. For instance, under what conditions might privatization lead to higher aeronautical charges? Furthermore, it might also be useful to breakdown privatization data on the share of private ownership into different privatization types – e.g., sell-offs and concession agreements – and thus investigate the impact of different privatization forms on aeronautical charges. A third area for future empirical work could be in extending this analysis to Oceania and Asia where – like in Europe – a degree of policy experimentation has been undertaken concerning airports.

Understanding the link between changes in airport regulation and privatization is crucial from a policy perspective, as regulatory authorities throughout the world are increasingly experimenting with both the form of ownership and the form of regulation for airports. Despite this experimentation, a particular concern has been whether liberalization of regulatory policy and ownership conditions might lead to airports increasingly exercising their market power vis-à-vis the airlines which use airport facilities and services. Such an exercising of market power would clearly be at the ultimate detriment to the travelling public. The empirical results we present suggest that experimentation in airport regulation and privatization has not come at the expense of increased market power and lower social welfare. For one, far from charging higher prices for aeronautical services, airports undertaking privatization in our sample tend to indicate lower aeronautical charges. Furthermore, while our evidence suggests that experiments with price-cap regulation have not led to significantly lower aeronautical charges, the single-till and ex-post regulatory innovations have succeeded in that they have generally lead to lower aeronautical charges. These results suggest that airport regulatory authorities might not need to consider social welfare losses via higher aeronautical charges as a necessary tradeoff when allowing private sector investment and altered regulatory frameworks. Thus, these early empirical lessons yield important first-order policy implications as airport authorities continue to search for the optimal mix of public policies concerning regulation and privatization.

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Table 1 Descriptive Statistics

	Mean	Median	Maximum	Minimum	Std. Dev.
Aeronautical Revenue, 000's of year 2000 Euros	103,907	39,385	1,287,187	3,633	176,848
Non-aeronautical Revenue, 000's of year 2000 Euros	77,286	28,151	889,370	627	144,556
Passengers	9,084,926	4,439,804	67,869,000	419,680	12,340,683
Cargo Volume (metric tons)	135,769	19,678	2,190,461	0	318,072
Aircraft Movements	110,819	69,600	492,569	4,113	108,939
Cost-Based regulation	0.35	0.00	1.00	0.00	0.48
Price-Cap regulation	0.17	0.00	1.00	0.00	0.38
Single-Till regulation	0.34	0.00	1.00	0.00	0.47
Ex-Post regulation	0.48	0.00	1.00	0.00	0.50
Private Ownership Share	38.38	8.00	100.00	0.00	42.79
Hub	0.11	0.00	1.00	0.00	0.31
Real GDP Per Capita	24,610	24,359	49,330	4,467	7,475
Population	3,371,000	1,029,000	8,278,000	259,000	491,298
Aeronautical Revenue per Aircraft Movement in Full Sample (N=748)	755.45	681.91	3005.96	136.47	414.76
Aeronautical Revenue per Aircraft Movement for Airports with Less than 50% Privatization (N=432)	822.53	731.27	3005.96	136.47	475.11
Aeronautical Revenue per Aircraft Movement for Airports with More than 50% Privatization (N=316)	663.75	631.55	1716.74	142.58	290.68

Note: aeronautical revenue per aircraft movement is expressed in year 2000 Euros

Table 2 Estimation Results

	Base Model		Dynamic Panel Data Model		System GMM Dynamic Panel Data Model	
Regression Specification:	#1 FE	#2 FE + IV	#3 FE	#4 FE + IV	#5 IV for Y_{t-1}	#6 IV for Y_{t-1} and more
Price-Cap regulation	0.0030 (0.0322)	0.0290 (0.0397)	-0.0019 (0.0195)	0.0121 (0.0281)	0.0228 (0.0724)	0.0719 (0.0871)
Single-Till regulation	-0.1223** (0.0500)	-0.1288** (0.0598)	-0.0719** (0.0257)	-0.0844** (0.0317)	-0.0993** (0.0465)	-0.0765* (0.0476)
Ex-Post regulation	-0.2592** (0.0957)	-0.2703** (0.1112)	-0.0719 (0.0853)	-0.1679** (0.0698)	-0.0858 (0.0557)	-0.1493** (0.0543)
Private Ownership Share	-0.0027** (0.0004)	-0.0029** (0.0005)	-0.0009** (0.0003)	-0.0014** (0.0005)	-0.0009** (0.0003)	-0.0014** (0.0005)
Hub	0.1308** (0.0547)	0.1880** (0.0483)	0.0523** (0.0218)	0.1095** (0.0339)	0.1000** (0.0489)	0.1242* (0.0702)
Nearby Airports	0.0067 (0.0322)	-0.0030 (0.0353)	0.0206 (0.0255)	0.0040 (0.0308)	0.0117 (0.0109)	0.0261 (0.0372)
Log(non-aeronautical revenue per pax)	0.1367 (0.0888)	0.3721** (0.1393)	-0.1481** (0.0617)	0.0362 (0.1304)	-0.0999 (0.0644)	-0.0024 (0.0954)
Log(Real GDP per capita)	0.2212* (0.1170)	0.2355** (0.0946)	0.1527* (0.0865)	0.0760 (0.1838)	0.1156 (0.0726)	0.0596 (0.0823)
Log(Population)	0.0199 (0.0776)	0.3093** (0.0718)	0.1622** (0.0414)	0.1781** (0.0476)	-0.0861 (0.0579)	0.1589* (0.0819)
Log(Passengers/ Aircraft Movements)	0.2002** (0.0942)	0.2280* (0.1345)	-0.1971** (0.0835)	0.0700 (0.1838)	-0.1535** (0.0365)	-0.2211** (0.0538)
Log(Cargo Volume)	-0.0046 (0.0092)	0.0303* (0.0176)	-0.0003 (0.0060)	0.0230* (0.0135)	0.0003 (0.0034)	0.0146* (0.0090)
Lagged Dependent Variable	---	---	0.7683** (0.0397)	0.6241** (0.1346)	0.7459** (0.0448)	0.7188** (0.0602)
Constant	3.1311** (1.4333)	-2.2924* (1.3155)	-1.6019** (0.7948)	-1.6119* (0.8707)	---	---
Observations	672	614	672	614	611	553
Adjusted R-squared	0.8601	0.8659	0.9252	0.9194	---	---
Durbin-Watson statistic	0.8654	0.9851	---	---	---	---
Hansen J statistic (p-value)	---	---	---	---	35.80 (0.9969)	32.77 (0.9969)

Notes:

1. Dependent variable is natural logarithm of aeronautical revenue per aircraft movement.
2. All independent variables are lagged one year.
3. White robust standard errors in parentheses.
4. Year dummies included in all regressions, but not reported.
5. In regression specifications' 2, 4, and 6, twice-lagged aircraft movements, cargo, and passengers were used to instrument for the same once-lagged explanatory variables.
6. In regression specification 5, the second-to-last lags of the dependent variable were used as instruments for the lagged dependent variable; in regression specification 6, third-to-last lags were used as instruments for the lagged dependent variable.
7. Significance: * = 10 percent; ** = 5 percent.

Appendix – List of Airports

IATA Code	Airport / Country	IATA Code	Airport / Country
ABZ	Aberdeen, UK	LHR	London Heathrow, UK
AHO	Alghero, Italy	LIL	Lille, France
AMS	Amsterdam, The Netherlands	LJU	Ljubljana, Slovenia
ATH	Athens, Greece	LPL	Liverpool, UK
BFS	Belfast, UK	LTN	London Luton, UK
BHX	Birmingham, UK	LYS	Lyon, France
BLQ	Bologna, Italy	MAN	Manchester, UK
BRE	Bremen, Germany	MLA	Malta International, Malta
BRS	Bristol, UK	MME	Durham Tees Valley, UK
BRU	Brussels, Belgium	MRS	Marseille, France
BTS	Bratislava, Slovakia	MUC	Munich, Germany
CAG	Cagliari, Italy	NAP	Naples, Italy
CGN	Cologne/Bonn, Germany	NCE	Nice, France
CPH	Copenhagen, Denmark	NCL	Newcastle, UK
CTA	Catania, Italy	NUE	Nuremberg, Germany
CWL	Cardiff, UK	OLB	Olbia, Italy
DTM	Dortmund, Germany	OSL	Oslo, Norway
DUS	Düsseldorf, Germany	PMO	Palermo, Italy
EDI	Edinburgh, UK	PSA	Pisa, Italy
EMA	East Midlands, UK	RIX	Riga, Latvia
FLR	Florence, Italy	SCN	Saarbruecken, Germany
FRA	Frankfurt, Germany	SOU	Southampton, UK
GLA	Glasgow, UK	STN	London Stansted, UK
GOA	Genoa, Italy	STR	Stuttgart, Germany
GVA	Geneva, Switzerland	SZG	Salzburg, Austria
HAJ	Hanover, Germany	TRN	Turin, Italy
HAM	Hamburg, Germany	TRS	Trieste, Italy
LBA	Leeds Bradford, UK	VCE	Venice, Italy
LCY	London City, UK	VIE	Vienna, Austria
LEJ	Leipzig, Germany	ZRH	Zurich, Switzerland
LGW	London Gatwick, UK		