REGULATION, MARKET STRUCTURE AND PERFORMANCE IN AIR PASSENGER TRANSPORTATION

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INTRODUCTION

The airline industry transports passengers and goods within and across national borders on a scheduled and non-scheduled basis. In 1999, the world scheduled air traffic amounted to a total of 1.5 billion passenger journeys and a volume of 26 million tonnes of freight and is growing at a higher rate than world-wide GDP growth. Scheduled transportation accounts for most of passenger traffic, with charter flights representing 15 per cent of total travel output. Even though its share in GDP is limited (between 0.5 and 1 per cent in OECD countries), air transportation provides a critically important infrastructure to the global economy.

Until recently, scheduled passenger transportation has been heavily regulated in most countries at both the domestic and international levels. Domestically, entry into the air passenger business, initiating service on specific routes, operating aircraft above given sizes, reducing or discontinuing services, investing in airlines, establishing and applying various categories of passenger fares have been subject to a detailed set of rules and regulations. International regulations compound these domestic rules. They govern the conditions of entry and ownership, the selection of operable destinations, and the freedoms to set capacity and fares on international routes, which represent more than 60-70 per cent of all passenger-kilometres performed in most countries, with the exception of continental size countries.

The policies and regulations which have governed the air transport industry for several decades have various motivations (including safety, national prestige, national defence, regional and urban development, environmental sustainability, public service and other non-commercial objectives) specific to each country. However, there is growing consensus that unnecessarily restrictive regulations may have led to significant losses of economic efficiency, and thereby failure to secure low-cost air transportation to the largest possible proportion of the population – the ultimate objective of air transport policies. Recognising these shortcomings, several OECD governments have initiated reforms in the past two decades. Their aim was to improve efficiency and reduce airfares by increasing competition, encouraging the rationalisation of air networks, and enhancing airline governance.

A large literature on airline economics has supported reform policies in the past two decades, but cross-country examinations of the relationship between regulatory frameworks, market structures and performance have been relatively

few. Most of the empirical research has concerned the United States, at first inspiring the 1978 domestic airline reforms and later looking at the economic implications of liberalisation and enhanced competition (Caves *et al.*, 1983; Bailey *et al.*, 1985; Liu and Lynk, 1999).[1] US research also demonstrated that certain feared outcomes of liberalisation – such as declines in safety levels, or deprivation of small communities of air service – did not materialise.[2] Only a few quantitative analyses have documented the implications of airline competition for efficiency and airfares in other parts of the OECD, such as the trans-Pacific routes (Gillen *et al.*, 1998; Kissling, 1998) and the European internal market (Marin, 1995; Morrell, 1998), while a monographic analysis looked at the productivity performances of large-sized international airlines (Oum and Yu, 1998).

This body of research has unveiled the peculiar competitive features of air travel markets and documented the efficiency gains and fare changes that followed liberalisation.[3] Results have been less clear-cut outside of the United States perhaps due to more limited liberalisation and the presence of exogenous factors damping competition – such as more intense airport congestion and social and political constraints on airline restructuring (Marin, 1998; Lapautre, 2000). Research also helped identify those structural factors such as airport hub domination and route market concentration which may temper the benefits of reforms.[4] Overall, these analyses focused on the effect of market concentration on performance, side-stepping the role of regulation *per se* and failing to distinguish the influence of various kinds of regulatory and market arrangements.[5] Moreover, no study has looked at the effects on performance of the presence of "flag carrier airlines", often controlled by governments. Ultimately, few studies have accounted, within a unified framework, for influences on performance originating from regulation, market structure and infrastructure access conditions.

This paper attempts to fill some of these gaps by analysing the impact that different types of regulatory and market arrangements have on the efficiency of supply of scheduled air passenger travel services in the OECD area, controlling for "framework conditions" such as airport dominance and the role of government-controlled flag carriers.[6] The analysis is based on a detailed set of indicators of regulation and market structure. It follows a top-down approach looking first at the impact of the overall market and regulatory environment (represented by means of summary indicators) and then turning to the impact of specific regulation and market features, such as rules on prices, capacity and entry on individual routes or the role of challengers, third party carriers and airline alliances. The linkage between regulation, market structure and performance is studied both at the level of national industries supplying domestic and international travel services, and at the level of individual routes, focusing on a large set of international non-stop connections between the airports of the major OECD countries. Interactions between industry and route features, such as pressures for overall network optimisation originating at both the

domestic and route level, are also accounted for. Two important dimensions of air travel performance are considered: productive efficiency (in its two main dimensions of capital use efficiency and efficiency of use of all production factors) and airfares. By distinguishing among different classes of fares (business, standard economy and discount), the disaggregated impacts of route-specific regulations, market structures and performance on business and leisure travel between individual city-pairs are highlighted. While price outcomes are studied in detail, limitations on available data made it impossible to consider the implications of liberalisation for service quality and consumer convenience (*e.g.* differentiation of route supply, flight frequency and time spent on connections).[7]

The rest of the paper has three main sections. The first overviews competition issues and regulation trends in OECD air transport, providing the necessary background for the empirical analysis. The second describes patterns of regulation and market structure in OECD countries and in a large sample of international routes in (or around) 1996, the reference year for subsequent regressions. In this section, detailed information about regulations and market structures is summarised by means of factor analysis techniques. Finally, the third section uses the resulting indicators to estimate the impact of several regulation and market features on industry-wide and route-level performance.

REGULATION TRENDS IN AIR PASSENGER TRANSPORTATION[8]

The technology of the air travel industry involves economies of scale, but increasing returns are exhausted at relatively low levels of output. Research on the economics of air transportation has shown that these economies do not hinder competition within routes (White, 1979; Caves *et al.*, 1984; Liu and Lynk, 1999). Furthermore, when airlines have free access to airports, they can exert potential competition on each other's routes because reallocating existing equipment (aircraft) and personnel (flying crew) to new destinations is relatively easy.

Competition between air carriers takes place in a multiplicity of separate markets. Passenger services between individual cities, and at different times, form a web of markets that are generally characterised by little cross-substitutability of demand. Connections between cities can be further segmented into time-sensitive (*i.e.* business travel) versus non-time-sensitive (*i.e.* tourist travel) services, and operations between individual end-points (*i.e.* airport-to-airport routes).[9] In servicing this web of markets, airlines exploit a wide range of scope economies. The development of "hub-and-spoke" networks over the past two decades, which resulted from the exploitation of both scale and scope economies, has added new dimensions to competition in air transport (US Department of Transportation, 1999). In particular, two phenomena tended to increase the degree of competition in the airline

industry: higher total traffic on short-haul (spoke) and long-haul (trunk) routes raised output levels on the constant-cost segments of supply curves, facilitating entry competition; and hub-and-spoke networks shifted competition from the route level to the network level, with different hubs competing to attract passengers in transit to the same origin and/or destination cities.[10]

Obstacles to airport access and anticompetitive behaviour of incumbent carriers may have restricted competition in the airline industry (Pera, 1989; Kahn, 1993; OECD, 1998; Federal Aviation Administration, 1999). Anticompetitive business practices often involve the use of "slot dominance" in an airport to foreclose competitors or raise rival costs on certain routes (*e.g.* by strategically increasing flight frequencies).[11] The quality of infrastructure access is particularly important for efficiency and competition in hub-and-spoke networks where access problems are compounded when airport runways, terminals and traffic control infrastructures come in short supply and suffer congestion (under existing access rules and prices).[12]

Air transport has been typically subject in OECD countries to strict domestic and international regulations concerning entry and exit, pricing and business operation.[13] The regulation of international exchanges of air transport services is often described by a typology of "freedoms" granted to carriers, which are established and enforced either multilaterally, bilaterally between individual countries, or regionally among groups of countries (see Annex). Domestic and international regulations on entry, pricing and service are often supplemented by restrictions concerning the ownership structures of airlines as well as corporate strategies (such as participation in domestic and international alliances). These restrictions, requiring carriers to be "owned and effectively controlled" by the locals of concerned countries, have been instrumental in creating the "flag carrier" concept where government or nationally-owned airlines gain a *de facto* monopoly on the domestic and international routes they service.

The regulatory straightjacket imposed on domestic and international air travel has affected business strategies, industry organisation and market structures. The lack of competitive pressures often resulted in high operation costs, a low utilisation rate of aircraft capacity, and relatively restricted output growth.[14] In air routes where more than one incumbent competed, "quality of service competition" based on the frequency and comfort of flights was the main outcome of price regulation. Entry, pricing and service regulations also have made the optimisation of networks difficult, because individual airlines could not freely choose their hub locations, route structures and flight frequencies according to economic considerations. Furthermore, government ownership and "national ownership" rules did not permit adjustments in the capital structure of airlines, forcing airline companies to find indirect forms of external growth (not involving capital exchanges), such as commercial alliances and code-sharing agreements.

Reforms introduced in the past two decades aimed at exploiting the potential for free competition in air travel markets, encouraging network rationalisation and opening up the capital structures of airlines. Prominent reforms included the pioneering US domestic deregulation of 1978, the Australia-New Zealand Common Aviation area of 1992, the European Single Aviation Market of 1997 and a number of Open Sky air agreements signed in the course of the 1990s (OECD, 1998; Gaudry and Mayes, 1999). Under these reforms, previously protected national, regional and bilateral markets became potentially open to challenge by new entrants, which in principle may compete on fares, frequency of flights, degrees of comfort, connection paths etc., to the extent permitted by airport availability (US General Accounting Office, 1996*b*).[15] Within liberalised areas, mergers between companies have been facilitated and airline privatisations, often part of liberalisation packages, introduced new flexibility in capital and financing structures.[16]

However, with the bulk of international routes still governed by restrictive bilateral ASAs, liberalisations remained nationally or regionally fragmented relative to the inherently global aviation marketplace. Moreover, "local ownership and control" provisions remained across large regional zones, ruling out possible mergers, acquisitions and equity financing.[17] Even after liberalisation, network rationalisation has been limited outside the United States, either because reforms have covered narrow regional areas (such was the case of the Australia-New Zealand aviation integration) or because international air service agreements (ASAs) continue to constrain network remodelling. Open Sky agreements are in all cases confined to bilateral markets and effects are generally limited to long-haul point-to-point destinations (although consumer welfare gains on these large trunk routes are important), giving limited incentives to cross-country network redesign (for some aspects see Scott, 2000).[18]

Reforms therefore failed to fully exploit the potential for global competition and trade specialisation and their impact on efficiency and welfare was locally (regionally) important but globally limited. In the US, efficiency and fare gains were found to be concentrated on routes where true competition and network optimisation unfolded, free from operational obstacles such as infrastructure congestion, hub domination by incumbent carriers, and mergers foreclosing to competition the low-to-medium density ends of the networks (Morrison and Watson, 1989; Hurdle *et al.*, 1989; Borenstein, 1989; US General Accounting Office, 1996*b*; Kim and Singal, 1993; Liu and Lynk, 1999; US Department of Transportation, 1999). In Europe, the benefits of the European single market fell short of expectations, because of hindrances to the free entry and growth of new competitors (European Commission, 1999), to the reorganisation of incumbent airlines (Marin, 1998; Neven *et al.*, 1998), and to cross-country network optimisation (Lapautre, 2000). Finally, analyses focusing on the effects of the liberal bilateral air agreements indicated that consumer benefits are maximised when true competitors to incumbents can actually enter the markets (Caves and Higgins, 1993; Gillen *et al.*, 1998).

COMPARING REGULATIONS AND MARKET STRUCTURES ACROSS COUNTRIES AND ROUTES

Air transportation reforms have been implemented at different times and unevenly across OECD countries and routes. Therefore, the variability of recent regulatory arrangements and market structures is large. To describe this variety of country and route-level situations and investigate their impact on efficiency in the provision of air services, it is useful to focus on a set of regulatory and market structure indicators for which comparative cross-country or cross-route information is available. Using a variety of sources (including the replies of OECD countries to an *ad hoc* questionnaire) a total of 21 indicators have been developed at the aggregate level for 27 OECD countries, and a total of 23 additional indicators at the micro level for a set of 102 air routes connecting 14 major international airports.[19] Underlying data for different indicators and countries generally refers to the 1996-1997 air travel season.

Three main areas were covered by the indicators: *regulation* (including government control), *market structure* and *infrastructure access*. Regulatory indicators focus on entry conditions (including for charters), pricing rules and government control (focusing on public ownership, subsidies and governance rights). Market structure indicators cover market concentration at the route and country levels, the presence of challenger and/or third party carriers, and the role of alliances. Indicators of infrastructure access conditions take into account both slot dominance and congestion. To make the analysis of differences in regulatory and market environments manageable, the large set of cross-country and cross-route indicators was summarised by means of statistical techniques. Summary information on the methods used to describe and synthesise regulatory and market structures in different countries and routes is provided in the Annex to Boylaud and Nicoletti in this issue.[20]

Regulatory and market features of air passenger transport at the country level

The regulatory and market environment of scheduled air passenger transportation was measured along multiple dimensions (Table 1). Regulations included both domestic and international provisions (such as regional and/or open sky agreements) and government involvement in carriers' operations (such as government ownership, subsidies and public service obligations). The time elapsed since liberalisation, a proxy for the degree of maturation of its effects, was also taken into account. Regulatory information at the country level did not include pricing provisions, as these vary across routes. Market structure indicators included both the domestic and international dimensions, attempting to catch the overall competitive pressures impinging on national carriers. All indicators have been expressed on a decreasing (1-0) scale where competition-friendly

Table 1. **Country-level indicators of regulation and market structure**

Regulation and government control	Market structure
***Domestic regulation*:**	
Existence of a domestic air liberalisation programme	Number of registered (ICAO-reporting) scheduled passenger airlines
***International regulation*:**	Number of major airlines (carrying more than 400 000 passengers per year)
Participation in a regional single aviation market	Market share of the largest carrier in the domestic market
Maturation of the regional aviation market	Market share of the largest carrier in the international market
Establishment of an "Open Sky" air service agreement with the United States	Carrier concentration on domestic market (Herfindahl index)
Maturation of the "Open Sky" agreement	Carrier concentration on international market (Herfindahl index)
***Government control*:**	Proportion of the 100 busiest international routes serviced by more than 2 carriers
Share of government in the equity capital of the largest national airline	
Presence of a special government voting right (*i.e.* golden share) in a major national airline	
Government loss make-ups in airlines in the past five years	
Public service obligations of large national airlines	

Source: OECD.

regulations and market structures reflect in smaller indices. Details on how these regulatory and market dimensions were mapped into quantitative indicators are provided in Gönenç and Nicoletti (2000).

Based on these regulatory and market structure indicators, factor analysis identified three main discriminating factors, which were interpreted as: *i*) the overall market environment, *ii*) the entrenchment of a flag carrier, and *iii*) the openness of international regulations (Table 2). Flag carrier entrenchment covers both the openness of domestic markets (to domestic entrants) and government control over a large-sized incumbent carrier. A summary indicator of the country-level environment of air transport industries was computed as a weighted average of the score of each country on discriminating factors (weighted according to the contribution of each factor to the overall variance of country-level characteristics). The summary indicator shows that the United States and, to a lesser extent, the United Kingdom and the Netherlands are the OECD countries offering the most liberal environment, and some Southern European and new Member countries the most protected ones (Figure 1). Country scores on individual factors are broadly consistent with the overall rankings, with the exception of smaller-sized countries which may present a concentrated industry structure even when their regulations are relatively liberal (due to minimum efficient size effects) and the United States whose international regulations appear imperfectly open as this country does not participate in any

Table 2. **Country-level regulation and market structure: the discriminating factors**
Rotated factors loadings

	Market environment	Entrenchment of a flag carrier	Openess of international regulations
Number of major airlines	0.96	0.08	0.08
Number of registered airlines	0.90	0.12	0.17
Domestic market concentration	0.89	0.19	–0.06
Proportion of 100 busiest routes serviced by more than two competitors	0.72	0.13	–0.05
International market concentration	0.60	0.55	–0.42
Domestic regulation	–0.06	0.78	0.11
Market share of largest national carrier in international market	0.23	0.64	–0.46
Market share of largest national carrier in domestic market	0.40	0.49	0.03
Government control of the largest national carrier[1]	0.19	0.48	0.18
International regulation[1]	–0.06	0.36	0.89
Participation in a single regional aviation market	0.16	–0.07	0.85

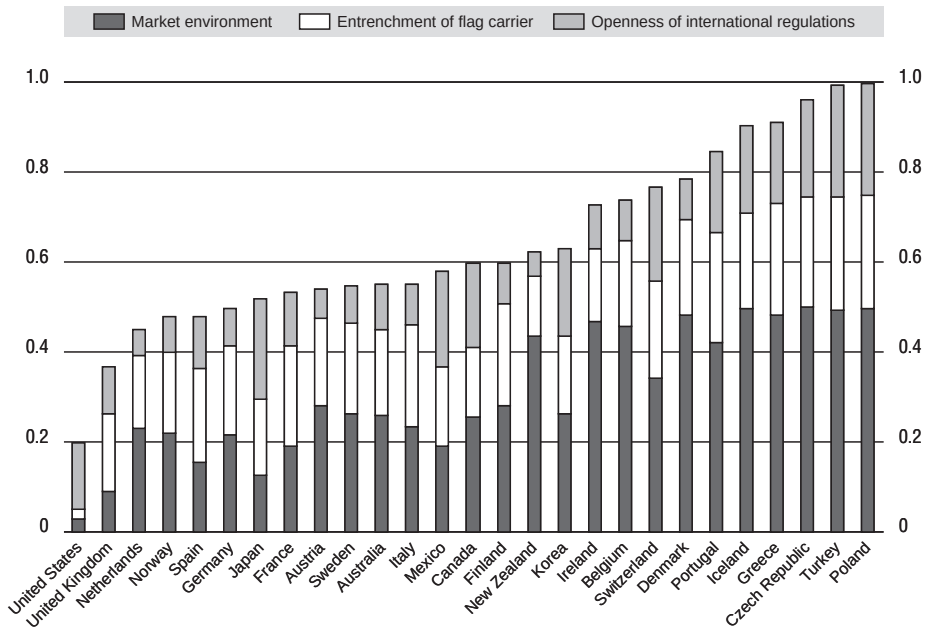
Notes: Extraction method: Principal component analysis.
Rotation method: Varimax with Kaiser normalisation.
Rotation converged in 6 iterations.
1. Synthesis of several indicators, see Table 1 and Annex.

integrated regional aviation market. Apart from the United States, where several equally-sized incumbents coexist, in virtually all countries a flag carrier is strongly entrenched in domestic and international markets.

Figures 2 and 3 present country clusters along pairs of discriminating factors. Figure 2 suggests that flag-carrier entrenchment is not necessarily synonymous with lack of competition. There is an important distinction between countries which have nurtured a dominant carrier within competitive market conditions (where one large-sized airline may thrive on efficiency grounds, such as in the United Kingdom or Japan) and countries in which national airlines operate in sheltered markets (where the national carrier dominates as a result of policy design). Figure 3 indicates that for a majority of countries, a liberal regulatory environment on international routes is associated with a relatively competitive overall market structure (and vice versa). However, there are sets of countries in which the international regulatory stance bears little relationship with market structure. A dose of competition may be sustained within protected industries (Japan, Mexico, Canada and Korea seem to present such a pattern of "managed competition"), while in some small countries international openness has not resulted in low market concentration (probably due to minimum size effects).

Figure 1. **Summary indicator of regulatory and market environment at country level, 1996/97**

Increasingly anticompetitive

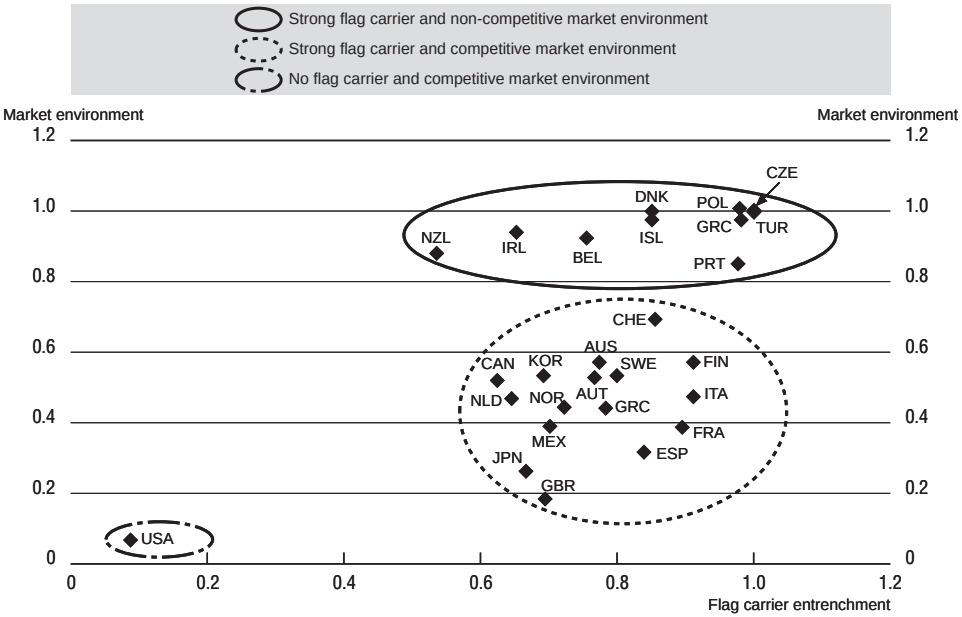


Source: Rauf Gönenç and Giuseppe Nicoletti, "Regulation, market structure and performance in air passenger transport", OECD Economics Department Working Papers, 2000.

Regulation and market structure at the route level

Differences in regulation and market structure at the route level are particularly strong in international air transport due to the overlap of domestic, bilateral and multilateral provisions. The main data source for *regulation* are bilateral air agreements applicable on the 102 routes included in the sample in (or around) 1996. These provided detailed information about regulations concerning: the designation of carriers authorised to service the routes, route capacity limitations, the setting of airfares and the authorisation of charter flights on the route.[21] The regulatory information has been supplemented with data on the combined market share of publicly-controlled carriers on each route (defined as those in which the government owns more than a third of the shares), as an indicator of the direct

Figure 2. **Flag carrier entrenchment and market environment, 1996/97**

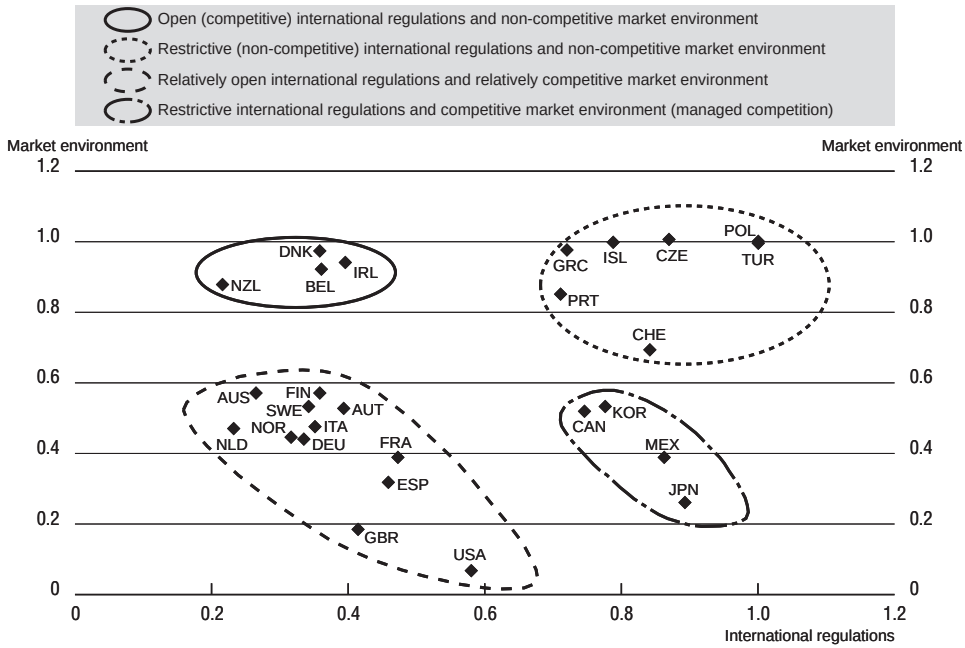


Source: OECD.

role of government. M*arket structure* on each route has been analysed from the viewpoint of both the concentration of supply and its distribution between different categories of carriers. The taxonomy stresses different types and degrees of competitive pressures exerted by different types of airlines and market arrangements: "challengers" (or limited-sized incumbents) are those which were not traditional incumbents on a route, entered relatively recently, and succeeded in carving out a minimum market share; "third party" carriers are those that do not belong to any of the countries signatories of the ASA on a particular route; airline alliances are captured by the combined route market share of the airlines participating in a strategic alliance. Finally, *infrastructure access* conditions included data on the degree of congestion and slot concentration by incumbent carriers at route-end airports.[22]

Table 3 summarises these route-level indicators. Following the same approach adopted for ranking countries, indicators are expressed on a decreasing (1-0) scale where more liberal regulatory and market arrangements generate smaller indices (for details, see Gönenç and Nicoletti, 2000).

Figure 3. **Market environment and international regulations, 1996/97**



Source: OECD.

Route-level regulations and market structures were summarised by factor analysis. Government control patterns and airport characteristics, which are not truly route-specific but reflect national characteristics of the industry at route ends were maintained as stand-alone indicators. Four main factors explained most of the cross-route variance in the data (Table 4): *i*) route regulations; *ii*) route market structure; *iii*) the role of third-party carriers; and *iv*) the role of challenger airlines.

Combining the "scores" of each route on the four factorial axes (weighted by the contribution of each factor to the variance of route characteristics) generates an indicator of "openness to competition", which summarises the regulatory and market environment on the route. City-pairs can then be characterised by "high competition", "limited competition" and "low competition" (Figure 4).[23] For illustrative purposes, the figure reports a selection of route names (their key can be found in the Annex). The scores of routes along the four individual axes are generally consistent with their overall ranking, with important exceptions: certain

Table 3. **Route-level indicators of regulation, market structure and infrastructure access**

Regulation and government control	Market structure	Infrastructure access
Regulation		
Designation of authorised carriers	Number of route carriers	Congestion at departure airport
Capacity regulations	Seat capacity share of the largest carrier	Congestion at arrival airport
Fare regulations	Seat capacity concentration (Herfindahl index)	Slot concentration at departure airport
Authorisation of charter flights	Number of "challengers" (limited size incumbents)	Slot concentration at arrival airport
Government control	Seat capacity share of "challengers"	
Route market share of government-controlled carriers	Number of third party (fifth and seventh freedom) carriers	
	Seat capacity share of third party carriers	
	Number of international airline alliances	
	Seat capacity share of international airline alliances	

Source: OECD.

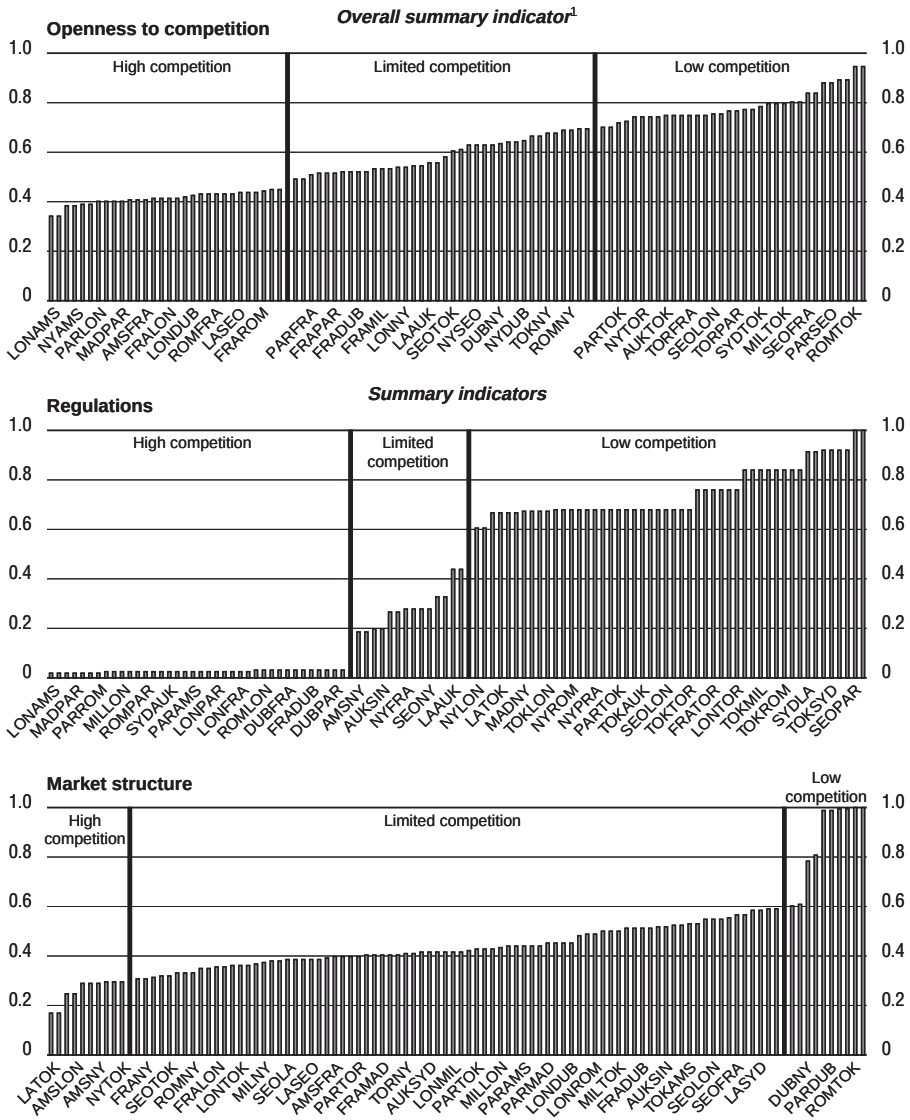
Table 4. **Route-level regulation and market structure : the discriminating factors**

Rotated factors loadings

	Factor 1	Factor 2	Factor 3	Factor 4
	Route regulations	Route market structure	Role of third-party carriers	Role of challenger airlines
Designation of authorised carriers	0.88	0.15	–0.02	0.06
Capacity regulation	0.89	–0.04	0.07	0.06
Fare regulation	0.93	–0.12	0.08	0.17
Authorisation of charters	0.85	0.02	0.25	0.15
Seat capacity concentration	–0.04	0.97	0.19	0.08
Seat capacity share of largest carrier	0.04	0.96	0.11	–0.05
Number of route carriers	0.02	0.90	0.24	0.24
Seat capacity share of the third-party carriers	0.06	0.22	0.95	–0.06
Number of third-party carriers	0.23	0.24	0.92	–0.06
Number of challengers	0.17	0.05	0.02	0.95
Seat capacity share of challengers	0.14	0.13	–0.12	0.93

Notes: Extraction method: Principal component analysis.
Rotation method: Varimax with Kaiser normalisation.
Rotation converged in 6 iterations.

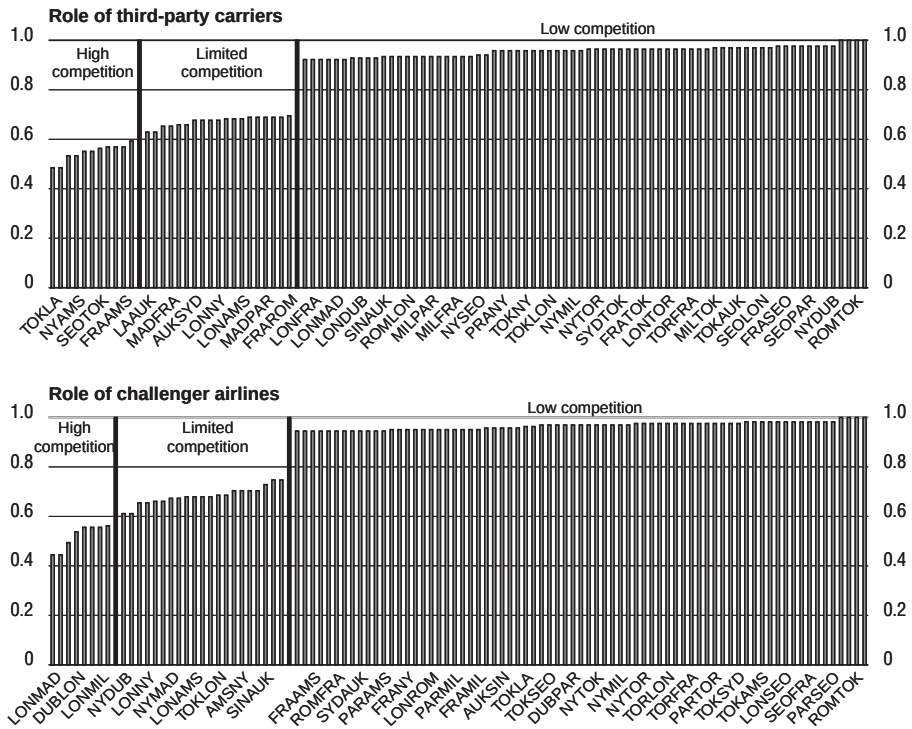
Figure 4. **Route characteristics, 1996/97**



1. Weighted average of the four route-level summary indicators (regulations, market structure, role of third-party carriers, role of challenger airlines) according to the contribution of each corresponding factor to the total variance of route characteristics.

Source: OECD.

Figure 4. **Route characteristics, 1996/97** *(cont.)*



Source: OECD.

competitive routes grant little room for third-party entry (such as several intra-European routes where services by carriers of a third country are still rare), and there are routes open to only moderate competition which nevertheless host significant third-party airlines (such as certain Asian routes where fifth traffic freedoms are available).

EVALUATING THE EFFECTS OF REGULATORY REFORM ON PERFORMANCE IN AIR PASSENGER TRANSPORT

The effects of the regulatory and market environment on the efficiency of provision of air passenger services are analysed at both the country and route level. At the country level, the focus is on government control of domestic carriers

and the openness and competitive stance of domestic and international markets. These features of the domestic industry are related to proxies for overall industry efficiency. Route-level analysis is richer and more pertinent because data availability makes it possible to concentrate on relevant markets (individual markets with little cross-substitutability of demand, where carriers are direct competitors), and the price dimension is also brought into the picture. Therefore, the effects of route market structure and route regulations on route efficiency and airfares in different market segments (such as leisure and business travel) are looked at in more detail: potentially important external influences, such as airport dominance at route ends, are taken into account, and the differential impact of several kinds of regulations (price-setting rules, charter rights) or market arrangements (airline alliances, presence of challenger carriers) is measured.

The econometric analysis followed a top-down approach. The effects of regulation and market structure on performance were first sought at the country level and, subsequently, at the route level. The analysis is based on ordinary least squares on a cross-section of 27 OECD countries or 100 major international routes in (or around) the 1996/1997 air travel season.[24] At both the country and route levels regulatory and market environments are summarised by the indicators described in the previous section. The summary indicators constructed by means of factor analysis are particularly appropriate for econometric analysis because they make it possible to specify parsimonious regression models, with synthetic explanatory variables that approximate well the cross-country variance originally present in the detailed regulatory and market structure data. Summary indicators are subsequently unbundled into their main components to check the differential impact of various regulatory and market arrangements on route performance.

Interactions between country and route-level regulatory and market influences are accounted for in the analysis. On the one hand, country-level factors such as public ownership of carriers, propensity of the population to travel by air or fleet structure can have an impact on airline performance on individual routes; on the other hand, route-specific factors, such as competitive pressures faced by domestic carriers on individual international routes, can contribute to shape the organisation of the domestic industry (*e.g.* overall network features, technology choices, etc.). Empirically, the following interactions are accounted for: the combined effects of regulations concerning international routes on domestic industry efficiency; the combined effects of government control over route carriers on route efficiency and prices; the combined effects of the market environment faced by air transport industries in countries at route ends on route efficiency and prices; the combined effects of economic and fleet structure in industries at route ends on route efficiency and prices.

To facilitate the understanding of the empirical results, the discussion focuses on the distance of the country-level and route-level efficiency proxies from best practice. In this way, both the performance and the regulatory and market

environment variables are cast on a decreasing scale. Higher values reflect low efficiency and restrictive environments, lower values reflect high efficiency and liberal environments. All estimated relationships between the indicators of performance and regulatory and market structure are therefore expected to be positive if competition is to have beneficial effects on the air travel industry.

Effects on the efficiency of the domestic air transport industry

A useful starting point for the empirical analysis is to relate the summary indicator of the overall regulatory and market environment (see Figure 1 above) to two different proxies of industry efficiency across countries (see Box). Figure 5 shows that a strong positive correlation exists between this indicator and both the average aggregate inoccupancy factor and the distance from the production efficiency frontier. Thus, the air travel industries of countries in which the regulatory and market environment is relatively friendly to competition appear to be more efficient than industries facing a more protected environment.

To explore further this relationship, a reduced form multivariate model was estimated on the cross-section of countries, relating the two measures of industry efficiency to their potential determinants (Table 5). The inoccupancy rate and the distance from the efficiency frontier were related to the regulatory and market structure indicators as well as to a set of control variables expressing economic structure and industry structure. Economic and industry structures were proxied by the propensity of the population to travel by air, the average age of the fleet and the average size of planes in the fleet. Air travel propensities and fleet characteristics can be assumed to be exogenous to industry efficiency at any point in time, but they may be related to the regulatory and market structure indicators due to the likely time-series correlation of regulatory and market arrangements.[25] To avoid excessive multicollinearity and given the few degrees of freedom available, a parsimonious specification was chosen. Policy and market influences were therefore proxied by the overall indicator of the regulatory and market environment (regression A) or by separate indicators for regulation and market structure (regression B).

The regression results suggest the presence of strong economies of scale and density related to market and aircraft size, respectively, and a significant impact of the market and regulatory environment on industry efficiency (Table 6): the more competitive this environment, the higher is industry efficiency – however measured. The market environment alone has a significant impact in both regressions, with more competition (at home and on international routes) being associated with higher efficiency. Regulations on domestic and international routes *per se* play a lesser role and their effect is significant only in regressions based on the DEA measure of efficiency.

Box. **Measuring air transport efficiency**

At the country level, efficiency of the air travel industry is measured in two ways. A simple (partial) measure is the average aggregate load factor[1] of the major domestic carriers (airlines carrying more than 400 000 passengers per year) on international routes. This can be taken to measure the capital productivity of the air travel industry on international markets served by domestic carriers. A more adequate proxy is the efficiency in the use of all factors of production. This is measured by means of Data Envelope Analysis, which yields a global measure of static efficiency in production accounting for multiple inputs and outputs.

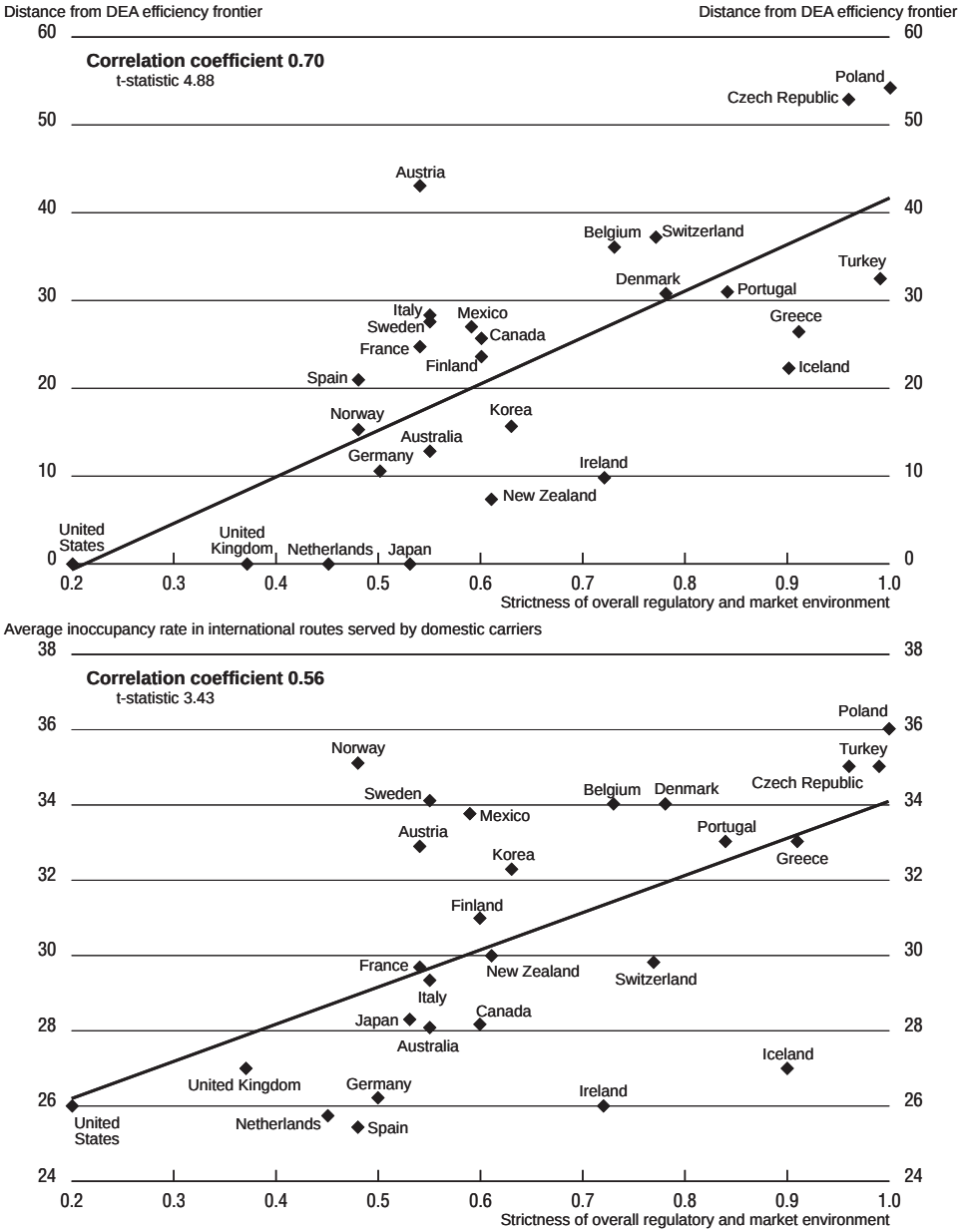
Data Envelope Analysis (DEA) is a non-parametric procedure that estimates the distance of the input-output choices of a decision unit from the production efficiency frontier (so-called X-efficiency).[2] Using linear programming techniques efficiency is estimated by comparing the output(s) of the decision unit to its inputs. Each output and each input is assigned a weight and the ratio of weighted outputs to weighted inputs is maximised under a set of linear constraints, the maximand being the weights. The procedure can accommodate variable returns to scale and restrictions on outputs and inputs in order to avoid corner solutions (in which some outputs or inputs are not produced or used in the optimal programme).[3] Comparisons between efficiencies of different units are made by re-scaling their inputs (or outputs) and checking how much inputs (or outputs) of less efficient units should decrease (or increase) to make the unit efficient. The DEA methodology is particularly attractive for measuring efficiency in service sectors where production technologies and organisational forms vary widely, and inputs and outputs can be better approximated by a collection of physical indicators than by value added statistics.

In the present analysis, the method has been applied to analyse the relative efficiency of the air travel industries. To this end, decision units are identified with domestic industries, outputs include total passengers transported and total passenger-kilometres, and inputs include total personnel, capacity, fleet, fuel and average stage length. Meaningful DEA efficiency comparisons require that the same technology is available to all decision units, which seems a reasonable assumption in cross-country comparisons of air travel industries. The production possibilities frontier is determined by the best performing countries, which dominate the other countries operating within the frontier. The data concerned around 100 major OECD carriers in 1996 and the DEA results suggest that the US, the UK and Japan were best practice countries, followed closely by the Netherlands and New Zealand, while efficiency was particularly low in the Eastern European countries, Austria, Switzerland and Belgium.

The distance of country-level efficiency from best practice is measured by the reciprocals of the two efficiency proxies: the average aggregate inoccupancy rate (defined as the complement at unity of the average aggregate load factor) and the distance of the domestic industry from the efficiency frontier (defined as the percentage gap of the DEA-indicator of each country from that of best-practice countries).

1. For each carrier, aggregate load factors (as opposed to route load factors) are defined as the percentage share of seats occupied per year in total aircraft seat capacity on international routes served by the carrier. The average aggregate load factor of the domestic industry is the weighted average of carriers' aggregate load factors.
2. For an extensive discussion of the concept and empirical relevance of x-efficiency, see Frantz (1997).
3. For a survey of developments in DEA methodology, see the papers in *The Journal of Productivity Analysis* (1996) and Cooper *et al.* (1999).

Figure 5. **Industry efficiency and the regulatory and market environment**



Source: OECD.

Table 5. **Empirical measures of country-level efficiency and its potential determinants**

Variable[1]	Definition/Comment	Number of observations	Minimum	Maximum	Mean	Standard deviation	Coefficient of variation	Expected sign in regression
Distance of domestic industry from efficiency frontier	Percentage gap from the efficiency frontier estimated using Data Envelope Analysis	27	0.00	54.22	22.79	14.99	0.66	
Average inoccupancy rate on international routes served by domestic carriers	The inoccupancy rate is the complement to the load factor	27	25.45	36.00	30.59	3.46	0.11	
Average aircraft size in national fleet	–	27	104.00	257.62	163.11	39.35	0.24	–
Average aircraft age in national fleet	–	27	6.20	14.10	10.45	2.42	0.23	+
National propensity to air travel	Total number of air passengers per year over total population	27	0.00	4.54	1.09	1.03	0.94	–
Overall regulatory and market environment	Overall indicator based on factor analysis	27	0.20	1.00	0.64	0.20	0.31	+
Regulatory environment	Summary indicator based on factor analysis	27	0.06	1.00	0.62	0.29	0.46	+
Market environment	Weighted average of summary indicators based on factor analysis	27	0.33	1.00	0.67	0.18	0.27	+

1. Regulatory and market environment indicators are expressed on a decreasing (1-0) scale, from most to least restritive of competition.
Source: OECD.

Table 6. **Performance of the airline industry at the country level and the regulatory and market environment**

Results of cross-country OLS regressions[1, 2]

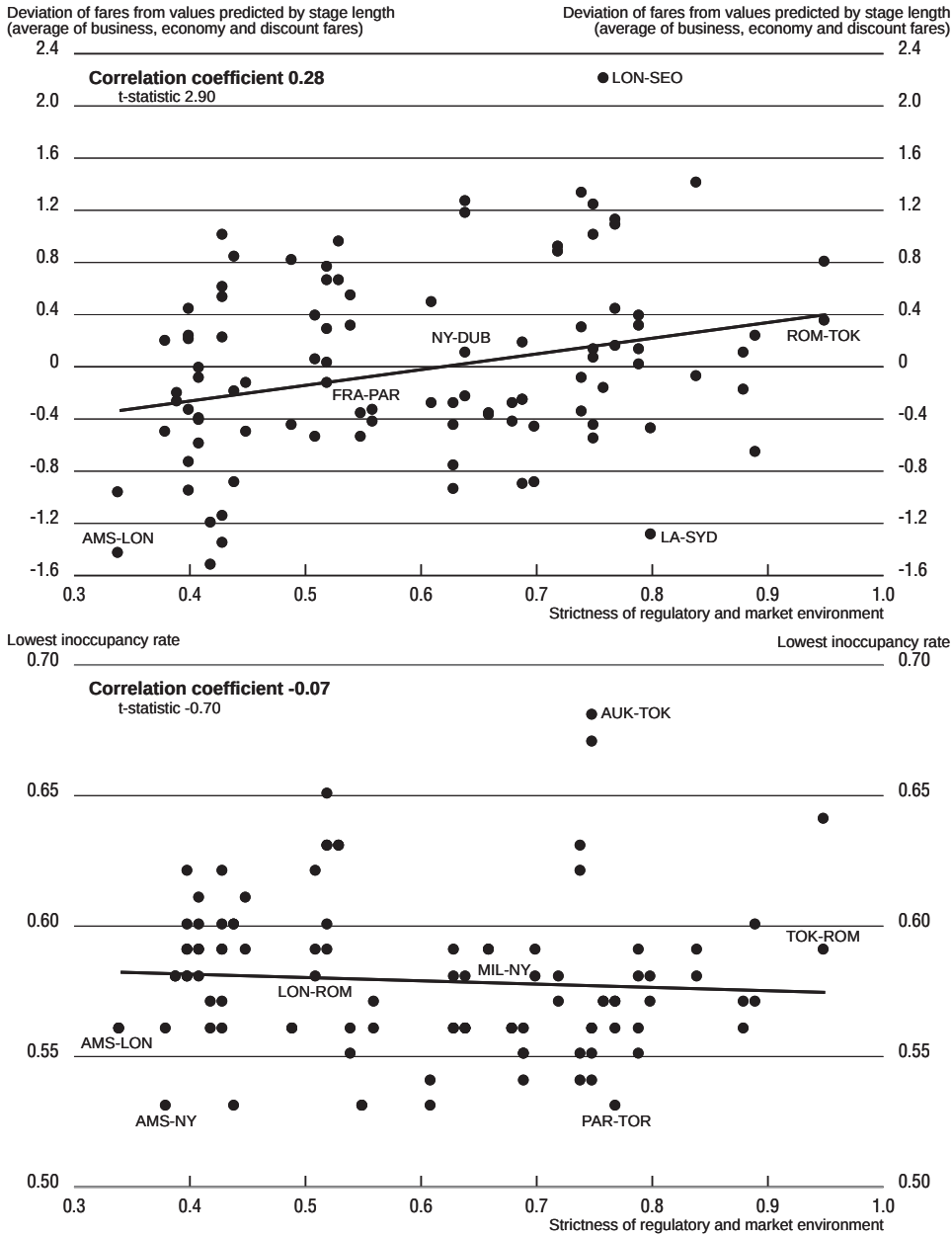
Dependent variable	Distance of domestic industry from efficiency frontier (DEA measure)		Average inoccupancy rate on international routes served by domestic carriers[5]	
Regressions	A	B	A	B
Explanatory variables[3]				
Average aircraft size in fleet	–0.51 **–5.45**	–0.51 **–5.32**	–0.32 **–1.97**	–0.31 **–1.9**
Average aircraft age in fleet	–0.03 **–0.29**	–0.03 **–0.28**	0.08 **0.44**	0.07 **0.39**
Propensity to air travel[4]	–0.43 **–4.65**	–0.43 **–4.11**	–0.31 **–1.94**	–0.34 **–1.87**
Overall regulatory and market environment	0.53 **5.18**		0.49 **2.78**	
Regulatory environment		0.25 **2.08**		0.16 **0.79**
Market environment		0.36 **3.25**		0.39 **2.03**
Statistics:				
Observations	27	27	27	27
Degrees of freedom	22	21	22	21
R^2	0.83	0.83	0.48	0.48
Adj. R^2	0.79	0.79	0.38	0.36
F	26.12	19.95	5.04	3.89

1. The reference period for the cross-sections is 1996/1997.
2. t-statistics in **bold**.
3. Regulatory and market environment indicators are expressed on a decreasing (1-0) scale, from most to least restritive of competition.
4. Total number of air passengers per year over total population.
5. The inoccupancy rate is the complement to the load factor (percentage of seats occupied in a plane).

Effects on performance at the route level

At the route level, standard measures of performance are load factors and fares. Load factors express the efficiency in the use of aircrafts on each route. Following the same approach as for the country-level analysis, the distance of aircraft efficiency from best practice on the route is proxied by the inoccupancy rate. Three types of fares referring to the 1998/99 air travel season were considered: business, standard economy and discount fares.[26] Figure 6 suggests some positive correlation

Figure 6. **Performance on routes and the regulatory and market environment**



Source: OECD.

between the overall route-specific regulatory and market environment (*i.e.* the "openness to competition" indicator of Figure 4) and airfares (adjusted for stage length) in a cross-section of 100 routes connecting the main hubs of OECD countries. Competitive routes tend to be associated with lower fares. By contrast, no bivariate correlation can be observed between the openness to competition indicator and inoccupancy rates. However, inoccupancy rates and fares are affected by a number of different factors and these need to be captured by multivariate analysis.

To put some structure on the specification of the multivariate model, airfares can be assumed to depend on marginal costs and mark-ups (for a similar specification, see Graham *et al.*, 1983). Marginal costs depend on the costs of inputs and various kinds of route-specific and industry-level economies (or diseconomies) proper to air transport, while mark-ups mainly depend on route-specific factors – such as regulatory restrictions, competitive pressures, and airport conditions at route ends. A number of empirical proxies were chosen for these variables (Table 7). The costs of inputs were proxied by inoccupancy rates (productivity of capital), stage length (fuel) and an overall measure of the purchasing power of the currencies at route ends, which controls for exchange rate effects on input costs.[27] No reliable data were available for labour costs at the route level. Economies (or diseconomies) of scale were assumed to act through both capital productivity (see below) and other (unmeasured) cost components. Therefore, proxies for economies of scale (the propensity to travel by plane at route ends), economies of density (the average size of aircrafts in fleets at route ends) and diseconomies (difficulties of airport access, as reflected in the degree of slot concentration by incumbents and congestion) were included in the fare equation. Route regulations and market structures were summarised by the indicators described in the previous section. To account for the influence on mark-ups of the potential limitations to competition implied by government ownership of incumbents, a summary measure of the share of the city-pair market jointly held by government-controlled carriers was also included in the model.

Inoccupancy rates were assumed to depend on the structure of the fleet (average size and age of planes), on economies of scale, density and stage length, and on policy and market influences shaping the x-efficiency of carriers. Influences on x-efficiency operate mainly by affecting competitive pressures and the governance of firms (Frantz, 1997). In a network industry such as air transport, the efficient use of capital depends not only on competitive pressures at the route level but also, more generally, on pressures exerted at the industry level, which may enhance network design and the allocation of capital over the network. For this reason, inoccupancy rates are assumed to depend on both route-specific regulations and market structures and the overall market environment faced by carriers in home industries at route ends. The influence of governance on x-efficiency is proxied by the share of the city-pair market jointly held by publicly-controlled carriers.

Table 7. **Empirical measures of route-level performance and its potential determinants**

Variable[1]	Code	Definition/Comment	Number of observations	Minimum	Maximum	Mean	Standard deviation	Coefficient of variation	Expected Sign in regression
Lowest inoccupancy rate on route	LF	Complement to highest load factor, adjusted for stage length	100	0.53	0.68	0.58	0.03	0.05	
Business fare	P	Adjusted for stage length	100	–0.54	0.74	–0.04	0.29	–7.07	
Standard economy fare	P	Adjusted for stage length	100	–0.53	0.69	–0.01	0.28	–19.75	
Discount fare	P	Adjusted for stage length	100	–0.62	0.97	0.04	0.35	9.71	
Average aircraft size in fleets at route ends	SIZE	Simple average of variables at route ends	100	151.27	250.80	185.80	23.01	0.12	–
Average aircraft age in fleets at route ends	AGE	Simple average of variables at route ends	100	8.22	13.85	11.17	1.32	0.12	+
Propensity to travel at route ends	PROAIR	Simple average of variables at route ends	100	0.47	2.35	1.15	0.49	0.42	–
Purchasing power at route ends	PPP	Simple average of variables at route ends	100	0.83	1.25	1.04	0.10	0.10	+
Route-specific regulatory and market environment	REG_i	Overall indicator based on factor analysis	100	0.34	0.95	0.60	0.16	0.27	+
Market environment at route ends	COMP	Simple average of factor analysis indicators at route ends	100	0.12	0.70	0.37	0.13	0.35	+
Infrastructure access conditions at route ends (airport dominance and congestion)	AIRPORT	Composite indicator (see Table 3 and Annex)	100	0.12	0.81	0.57	0.16	0.28	+
Government control over route carriers	GOV	Capacity share of government-controlled carriers	100	0.00	1.00	0.29	0.32	1.10	+
Route-specific regulatory environment	REG_i	Summary indicator based on factor analysis	100	0.02	1.00	0.42	0.35	0.84	+
Route-specific market environment	MKT_i	Summary indicator based on factor analysis	100	0.48	1.00	0.69	0.12	0.17	+
Carrier designation rules on route	REG_i	See Annex	100	0.00	1.00	0.33	0.34	1.04	+
Fare regulations on route	REG_i	See Annex	100	0.00	1.00	0.55	0.48	0.87	+
Access rights for charters on route	REG_i	See Annex	100	0.00	1.00	0.50	0.50	1.01	+
Capacity concentration on route	MKT_i	–	100	0.13	1.00	0.44	0.19	0.43	+
Capacity share of challenger carriers on route	MKT_i	–	100	0.77	1.00	0.97	0.06	0.06	+
Capacity share of airline alliances on route	MKT_i	–	100	0.00	0.90	0.20	0.29	1.50	+

1. Regulatory and market environment indicators are expressed on a decreasing (1-0) scale, from most to least restritive of competition.
Source: OECD.

These assumptions led to the following two equations for inoccupancy rates (IR) and fares (P):

$$IR = a_0 + a_1 SIZE + a_2 AGE + a_3 PROAIR + a_4 STAGE + a_5 AIRPORT + \sum_i a_{6i} REG_i + \sum_j a_{7j} MKT_j + a_8 GOV + a_9 COMP + u \quad (1)$$

$$P = b_0 + b_1 IR + b_2 SIZE + b_3 PROAIR + b_4 STAGE + b_5 PPP + b_6 AIRPORT + \sum_i b_{7i} REG_i + \sum_j b_8 MKT_j + b_9 GOV + v \quad (2)$$

where STAGE is the average stage length, u and v are stochastic disturbances and all other variables are defined as in Table 7. Using equation (1) to substitute for IR in equation (2) leads to the following reduced-form equation for airfares:

$$P = c_0 + c_1 SIZE + c_2 AGE + c_3 PROAIR + c_4 STAGE + c_5 PPP + c_6 AIRPORT + \sum_i c_{7i} REG_i + \sum_j c_{8j} MKT_j + c_9 GOV + c_{10} COMP + \eta \quad (3)$$

Equations (1) and (3) were estimated by OLS based on the sample of international routes (see Gönenç and Nicoletti, 2000, for details on data, sources and methodologies). To avoid endogeneity problems (*e.g.* between fares and propensity to travel by air) the data on fares refers to the 1998-99 air travel season, while the other data (load factors, economic and industry structure, regulation and market structure) refers to the 1996-97 air travel season.[28] Given current regulatory arrangements at the international level, the likelihood that a route is governed by restrictive bilateral air service agreements increases with stage length.[29] Since this leads to strong collinearity between stage length and the regulatory and market indicators used in the analysis, it was decided to adjust both fares and load factors by stage length prior to estimation. Therefore, these variables were redefined in terms of deviations from values predicted by stage length to improve the quality of the regressions. The estimation strategy was to explore the impact of route-specific regulations and market structures (the REG_i and MKT_j variables) at increasing levels of disaggregation, looking first at the overall indicator of regulatory and market environment and next at its various components.

Table 8 presents the results of regressions for load factors and the three types of airfares when the regulatory and market environment on the route is summarised by means of the openness to competition indicator shown in Figure 4 above. In estimating model [1], three observations were dropped because they were identified as outliers by standard statistical procedures. In estimating model [3], the variables expressing average aircraft age and size at route ends have been omitted because they were highly collinear with other explanatory

Table 8. **Efficiency, fares and the regulatory and market environment: overall route-specific effects**

Results of cross-route OLS regressions[1, 2]

Dependent variable[3]	Lowest inoccupancy rate on route[4]	Business fare	Standard economy fare	Discount fare
Explanatory variables[5, 6]				
Average aircraft size in fleet at route ends	–0.35 **–2.41**			
Propensity to air travel at route ends[7]	–0.45 **–3.27**	0.18 **1.83**	–0.25 **–2.5**	–0.63 **–7.17**
Purchasing power at route ends		0.23 **2.47**	0.20 **2.08**	–0.07 **–0.79**
Route-specific regulatory and market environment	0.25 **2.27**	0.37 **4.02**	0.22 **2.25**	0.16 **1.91**
Market environment at route ends	0.25 **2.34**	–0.35 **–3.88**	–0.01 **–0.08**	0.29 **3.52**
Infrastructure access conditions at route ends (airport dominance and congestion)	0.01 **0.1**	0.16 **1.6**	0.19 **1.85**	0.01 **0.14**
Government control over route carriers	–0.13 **–1.01**	0.32 **3.32**	0.05 **0.45**	–0.15 **–1.66**
Statistics:				
Observations	96	100	100	100
Degrees of freedom	90	93	93	93
R^2	0.2	0.32	0.27	0.44
Adj. R^2	0.15	0.28	0.23	0.4
F	3.71	7.4	5.79	12.12

1. The reference periods for the cross-sections are 1996/1997 for regulation, market structure and efficiency indicators, and 1998/1999 for air fares.
2. t-statistics in **bold**.
3. Load factors and fares adjusted for stage length.
4. The inoccupancy rate is the complement to the load factor (percentage of seats occupied in a plane).
5. All equations also include a constant term. Variables that are not route-specific are computed as the average of the values at route ends.
6. Regulatory and market environment indicators are expressed on a decreasing (1-0) scale, from most to least restritive of competition.
7. Total number of air passengers per year over total population.

variables and their contribution to the model fit was insignificant. The included variables are jointly strongly significant, as implied by the F-tests. However, the fit of the models is relatively poor (adjusted R2s range from 0.2 to 0.4), reflecting the very high volatility of the price data and suggesting that some important route-specific effects are not captured by the explanatory variables.

In general, regression results suggest that *a*) scale economies are a significant phenomenon in air travel; and *b*) the effects of regulation and market structure (at both the route and industry levels) are at least as significant. The efficiency in the use of capital increases with average aircraft size and the size of the market, and as the route-specific and country-specific regulatory and market environment faced by route carriers becomes friendlier to competition. By contrast, there is no evidence of adverse effects on productive efficiency of airport conditions at route ends or public control of route carriers.

A route-specific environment friendly to competition also tends to lower all categories of fares, with the strongest effects observed in the business segment. However, the various types of fares react somewhat differently to the other economic and policy factors. As the size of the market expands, airlines use scale economies for decreasing economy and discount fares, but at the same time business fares rise, increasing price discrimination on the route. Similarly, a competitive national market environment *at route ends* pushes up business fares, possibly because (mostly domestic) competitive pressures force airlines to shift the bulk of price discrimination onto international business travel, where competition is weaker. By contrast, competitive pressures on industries at route ends are the single most significant influence that reduces discount fares, possibly because these pressures force airlines to adopt better yield management strategies in a segment of the market where demand is highly elastic and competition by charters may be vibrant. Fares also seem to react differently to airport conditions at route ends. Airport dominance and congestion appear to push up prices in time-sensitive business and standard economy travel (although at 10 per cent significance levels), while no effect can be detected on discount travel, which is not time-sensitive. Finally, government control over route carriers tends to push up business fares, perhaps because (mostly public-owned) flag carriers are often more prone to compete for business travellers by increasing service quality, while it tends to reduce discount fares (also at 10 per cent significance levels).

To explore further the separate contributions of the market structure and regulation variables to explaining differences in performance across routes, Table 9 shows the estimates of models [1] and [3] when the regulation component (*i.e.* the first factorial axis) of the overall route-specific summary indicator is isolated. The market structure components (market structure, role of third party carriers and role of challenger carriers) are summarised by a single indicator obtained by weighting the corresponding route scores by the contribution of each factorial axis to the overall variance of the data.

Overall the effects of the variables that are not route-specific are generally consistent with the previous regression, with the exception of the influence of the national market environment at route ends on inoccupancy rates, which is now

Table 9. **Efficiency, fares and the regulatory and market environment: separating the effects of route-specific regulation and market structure**

Results of cross-route OLS regressions[1, 2]

Dependent variable[3]	Lowest inoccupancy rate on route[4]	Business fare	Standard economy fare	Discount fare
Explanatory variables[5, 6]				
Average aircraft size in fleet at route ends	–0.2 **–0.58**			
Propensity to air travel at route ends[7]	–0.28 **–2.32**	0.15 **1.52**	–0.27 **–2.63**	–0.64 **–7.14**
Purchasing power at route ends		0.22 **2.41**	0.19 **2.02**	–0.07 **–0.82**
Route-specific regulatory environment	–0.41 **–3.28**	0.45 **3.75**	0.26 **2.07**	0.17 **1.53**
Route-specific market environment	0.7 **6.22**	–0.01 **–0.1**	–0.01 **–0.05**	0.02 **0.2**
Market environment at route ends	–0.15 **–1.3**	–0.23 **–2.14**	0.06 **0.51**	0.32 **3.19**
Infrastructure access conditions at route ends (airport dominance and congestion)	–0.06 **–0.58**	0.19 **1.97**	0.21 **2.02**	0.02 **0.26**
Government control over route carriers	–0.21 **–1.95**	0.38 **3.75**	0.08 **0.72**	–0.13 **–1.41**
Statistics:				
Observations	97	100	100	100
Degrees of freedom	89	92	92	92
R^2	0.41	0.35	0.28	0.44
Adj. R^2	0.36	0.3	0.23	0.4
F	8.8	7	5.11	10.37

1. The reference periods for the cross-sections are 1996/1997 for regulation, market structure and efficiency indicators, and 1998/1999 for air fares.
2. t-statistics in **bold**.
3. Load factors and fares adjusted for stage length.
4. The inoccupancy rate is the complement to the load factor (percentage of seats occupied in a plane).
5. All equations also include a constant term. Variables that are not route-specific are computed as the average of the values at route ends.
6. Regulatory and market environment indicators are expressed on a decreasing (1-0) scale, from most to least restritive of competition.
7. Total number of air passengers per year over total population.

captured by the route-specific market structure. The regression results suggest that a competitive route market structure is of the outmost importance for improving efficiency in the use of aircrafts, but there is an inverse significant relationship between the route-specific regulatory indicator and inoccupancy rates. Thus, relaxing route regulations appears to impact negatively on the efficiency of aircraft use. Perhaps this reflects the effect of strategic behaviour of incumbents, which react to liberalisation by increasing flight frequencies to pre-empt new entry on the route. At the same time, the inverse relationship between government control over route carriers and inoccupancy rates is more difficult to explain.

Fares appear to be affected only by the route regulatory environment and the national market environment at route ends. The summary indicator of route-specific market structure is insignificant in all fare regressions. This is consistent with the so-called "potential entry" hypothesis, whereby route liberalisation *per se* submits incumbent carriers to the competitive pressure of other carriers that could easily enter the route. Another possible interpretation is that the presence of several airlines on a route is effective in reducing fares only if route regulations allow competitive pressures to unfold.

The conjectures about the differential effects of regulation and market structure on productive efficiency and different types of fares can be partially checked by looking at the effects on performance of individual components of the regulatory and market environment. The specific role of different regulatory provisions and market characteristics is highlighted in Table 10, which reports a selection of the results obtained in regressions that include the detailed indicators of regulation and market structure among the explanatory variables. Due to high collinearity between the detailed indicators, the strategy was to focus on the most significant regulatory and market influences on each of the performance measures. For brevity, the table omits the results concerning the variables expressing economic structure, which remained consistent with previous regressions.[30] To explore the potentially different impact of various combinations of regulation and market structure characteristics, two kinds of fare regressions were performed: *i*) with separate regulatory and market structure indicators (regression A); and *ii*) with an interaction term that allows for different effects of market structure in strict and lax regulatory environments (regression B).[31]

While the efficiency of aircraft use is improved by both low concentration of capacity on the route and the presence of challenger airlines, the only significant regulatory influence is the extent of access rights for charters, with more extensive rights leading to lower capital efficiency. This result tends to corroborate the hypothesis that the negative relationship between liberalisation and efficiency in aircraft use is driven by the strategic reaction of incumbents to potential entry (such as charters). On routes where the impact of regulatory reforms on market structure has matured and carrier competition is effective, raising rival costs and

Table 10. **Efficiency, fares and the regulatory and market environment: exploring the effects of different route-specific regulatory and market conditions**

Results of cross-route OLS regressions[1, 2]

Dependent variable[3]	Lowest inoccupancy rate on route[4]	Business fare		Standard economy fare		Discount fare	
Regressions		A	B	A	B	A	B
Explanatory variables[5, 6]							
National market environment at route ends	–0.12 **–1.05**	–0.18 **–1.71**	–0.18 **–1.68**	0.15 **1.37**	0.15 **1.36**	0.25 **2.65**	0.25 **2.76**
Infrastructure access conditions at route ends (airport dominance and congestion)	0.07 **0.65**	0.14 **1.51**	0.16 **1.69**	0.17 **1.68**	0.17 **1.64**	–0.01 **–0.08**	0.03 **0.38**
Government control over route carriers	–0.24 **–2.13**	0.4 **3.91**	0.34 **3.02**	0.12 **1.09**	0.11 **0.95**	–0.12 **–1.34**	–0.17 **–1.93**
Carrier designation rules on route	0.14 **1.18**						
Fare regulations on route		0.46 **4.24**	0.67 **2.86**	0.29 **2.6**	0.29 **1.21**		
Access rights for charters on route	–0.3 **–2.51**					0.19 **2.12**	0.91 **3.02**
Capacity concentration on route	0.55 **5.35**	0.11 **1.1**		0.05 **0.43**			
– and strict fare regulations			0.05 **0.32**		0.34 **0.73**		
– and lax fare regulations			0.33 **1.49**		0.29 **0.77**		
Role of challenger carriers on route	0.22 **2.2**					0.14 **1.55**	
– and strict charter regulations							–0.35 **–1.2**
– and lax charter regulations							0.42 **2.56**
Role of airline alliances on route		0.19 **1.85**	0.18 **1.79**	0.23 **2.19**	0.23 **2.17**	–0.08 **–0.93**	–0.05 **–0.63**
Statistics:							
Observations	97	100	100	100	100	100	100
Degrees of freedom	87	91	90	91	90	91	90
R^2	0.4	0.38	0.39	0.33	0.33	0.48	0.51
Adj. R^2	0.34	0.33	0.33	0.27	0.26	0.43	0.46
F	6.54	7.03	6.36	5.63	4.95	10.47	10.53

1. The reference periods for the cross-sections are 1996/1997 for regulation, market structure and efficiency indicators, and 1998/1999 for air fares.
2. t-statistics in **bold**.
3. Load factors and fares adjusted for stage length.
4. The inoccupancy factor is the complement to the load factor (number of seats occupied in a plane).
5. All equations also include a constant term. Variables that are not route-specific are computed as the average of the values at route ends.
6. Regulatory and market environment indicators are expressed on a decreasing (1-0) scale, from most to least restritive of competition.

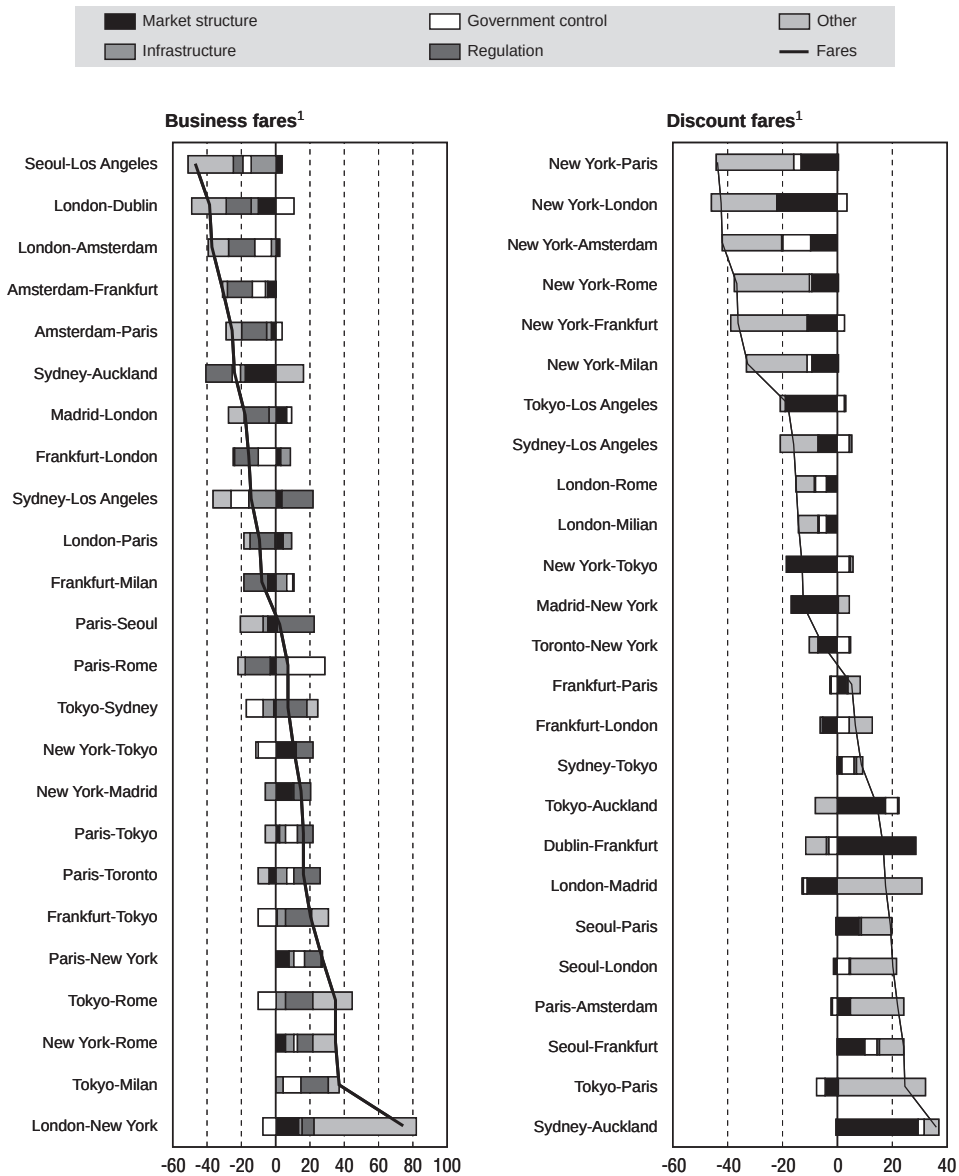
foreclosure (*e.g.* through the increase in flight frequencies) turn out to be more difficult strategies and incumbents must compete on costs, including through a better use of aircraft capacity.

Both business and economy fares are affected by fare regulations. By hindering price competition, pricing rules requiring the double approval of the governments involved in bilateral air service agreements or the approval of the country to which the carrier belongs are conducive to higher fares. At the same time, the route-specific market environment has an impact through airline alliances, which also tend to increase fares (especially standard ones) as the market share they cover on the route becomes larger. Apart from this effect, market structure appears to have no independent effect on fares. When the interaction between market structure and fare regulations is accounted for, the regressions for business fares provide only very weak evidence that a low capacity concentration on the route may have a sobering effect on fares when it is associated with a relatively liberal price setting environment. Thus, the conjecture that market structure affects business and economy fares when genuine price competition is possible and the coexistence between several airlines on a route is not "managed" by the signatories of bilateral or multilateral service agreements is not clearly supported by the data.

In the regressions allowing for specific regulatory and market structure effects, overall competitive pressures in countries at route ends continue to exert significant market influence on discount fares. However, route-specific regulations concerning access rights for charters and (to a lesser extent) the presence of challengers on the route also play a role (Regression A). Charters are the main competitors of incumbents in the market for leisure travel and, therefore, it is not surprising that liberal charter rights exert a downward pressure on discount fares. In addition, there is a close relationship between charter activity and the role of challengers on a route: challenger carriers may operate in the charter market in order to compete with incumbents and, conversely, charter companies sometimes establish themselves as challenger carriers over time. The existence of this relationship is confirmed by the results of the regression for discount fares that accounts for the interaction between the role of challengers and the extent of access rights for charters (Regression B). Challengers bring about a significant reduction in discount fares only when regulations concerning charters are relatively liberal.

On the whole, the route-level empirical results can be summarised as follows. Actual competition at route ends and on the route is essential for improving efficiency and lowering discount-fares. Potential competition is helpful in disciplining business and economy fares, but its effects are dampened as the role of airline alliances on the route increases. The effects of actual competition on discount and (to a much weaker extent) business fares are more significant when the regulatory

Figure 7. **The contribution of regulation, government control and market structure to air fares in selected routes**



1. Percentage deviations of fares from sample average (100 routes), taking into account route stage length.
Source: OECD.

environment encourages entry and price competition.[32] There is some evidence that difficulties in accessing infrastructures related to airport dominance and congestion, as well as government control over route carriers increases fares in time-sensitive market segments. However, government control tends to increase seat occupancy and moderate prices in market segments that are not time-sensitive. Perhaps this reflects management policies targeting capacity utilisation rather than profitability in non time-sensitive segments.

Based on the regression results shown in Table 9, the potential impact of regulatory reform on airfares is illustrated graphically in Figure 7 for a selection of international routes. In each route, the deviations of business and/or discount fares (adjusted by stage length) from their average values in the sample are decomposed into the effects of regulation, market structure (including both the route-specific and route-end dimensions), government control, infrastructure access and other factors (including both economic structure and the unexplained residual). In any given route, the sign and the size of the contribution of each of these elements to fares depends on its regression coefficient estimate and its position relative to the sample average.

In the routes selected, the combined impact of regulation and market structure is generally comparable to that of all other route characteristics taken together. However, the effects of economic structure and unexplained factors are sizeable in many individual countries, especially in the non-time sensitive segment of the market where the fit of the regression is weaker. The figure points out that on certain routes (such as several Northern European routes and some competitive Asian and Pacific routes) the combination of liberal regulatory environments and low government control (sometimes supplemented by relative ease of access to ground infrastructures) yields business fares that are between 20 and 40 per cent lower than expected based on stage length. Conversely, restrictive ASAs, government control of route carriers and infrastructure access problems appear to push fares more than 20 per cent above their expected levels in many Atlantic and Europe-Asia routes. Discount fares are significantly affected by the degree of competition at route ends: fares on routes originating or ending in the United States or in the United Kingdom, where competition is stronger, are in general lower (relative to expected levels) than fares in other European and Asian or Pacific routes.

CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

Despite the wide-ranging reforms implemented by OECD governments in the past two decades, regulations affecting the air travel industry still vary a lot across countries and routes. Until recently, most international (long-haul) routes were

exposed to very limited competition. This inhibited the creation of a global aviation market and hindered network optimisation by air carriers. Because they continue to prevent competition from third party carriers, regional arrangements and open sky policies constitute only a step towards a true opening of markets.

At both the national and route level there is clear evidence that productive efficiency and fares are affected by regulatory and market arrangements. Overall efficiency and the rate of occupancy of aircraft seats tend to increase and all categories of fares tend to decline as the regulatory and market environment becomes friendlier to competition. Industry and route (productive) efficiency is particularly sensitive to actual competitive pressures (as proxied by low market concentration on individual routes and at the national level), while fares react to changes in regulation independently from market structure, suggesting that potential entry has a disciplining role on prices. However, the effect of liberalisation on certain categories of fares is amplified by the existence of competitive market conditions. In addition, both route efficiency and certain categories of fares are also affected by overall market conditions prevailing in industries at route ends.

Different categories of fares are sensitive to different types of regulations and market arrangements. Business and economy fares are particularly sensitive to pricing regulations and (when price competition is possible) market concentration, while discount fares are affected mainly by charter regulations and (when charter rights are extensive) the presence of challenger airlines, possibly reflecting the use of these rights as an entry device for competitors wishing to establish themselves on a route. There is also some evidence that economy and (to a lesser extent) business fares are higher in non-stop routes dominated by airline alliances and that airport congestion and dominance tend to raise fares in the time-sensitive segments of the city-pair markets. The effects of government control are ambiguous at both the industry and route level: business fares and the rate of occupancy of aircraft seats tend to increase with the role of government-controlled carriers, while discount fares tend to decrease.

On the whole, these results confirm that air transport reforms aimed at liberalising entry (*e.g.* by eliminating bilateral designation rules or extending charter rights) and prices involve significant benefits for all categories of travellers. The empirical relevance of scale effects and the finding that both route and industry environments matter for performance point to the potential gains to be obtained from the simultaneous liberalisation of domestic/regional markets and international (long-haul) routes, which encourages network optimisation and cost-efficiency while reducing price-cost margins. For these policies to fully bear their fruits, however, constraints on airport access must be relaxed and strategic behaviour by incumbents (*e.g.* through alliances and slot dominance) must be kept in check by appropriate competition policies.[33]

These conclusions could be refined by extending the analysis in two main directions. First, the inclusion of indirect routes into the sample would make it possible to study more accurately the potential benefits of network competition, possibly providing deeper insights on the role of Open Sky agreements in fostering competition (through fifth freedom provisions) and clarifying the implications of airline alliances for efficiency and airfares (which could be held back if network economies were passed on to consumers). Second, the inclusion of proxies for service quality (such as flight frequency and time spent on connections) would provide a more complete picture of the repercussions of entry and price liberalisation on consumer welfare.

NOTES

1. Derthick and Quirk (1985) provide a detailed account of how economic studies have inspired and contributed to the US air transport reforms.
2. Certain negative effects were handled by pro-competitive regulations. Research showed that air services were discontinued in certain very small communities, inspiring a budget-funded "essential air services" programme. Surveys also helped detect the unsatisfactory safety performances of financially-strained small size airlines, justifying additional safety policies directed to this category of carriers.
3. Several studies were devoted to testing versions of the "contestable markets" hypothesis (for instance, Graham *et al*, 1983; Hurdle *et al.*, 1989). Other studies showed that price differentials between business and discount fares widen under competition, raising in certain cases business fares and previously cross-subsidised short-distance fares to above pre-deregulation levels, but provoking a substantial overall decrease in total travel costs for all passengers (see, among others, Borenstein, 1992; Evans and Kessides, 1993; Morrison and Winston, 1999).
4. The effects of hub dominance on airfares are highlighted by Kahn (1993) and documented empirically by Abramowitz and Brown (1993), Kim and Singal (1993) and US Department of Transportation (1999).
5. Among the studies focusing on specific kinds of regulatory and market arrangements, Dresner and Tretheway (1992) found that US "open sky" policies reduced airfares on North Atlantic routes; Hurdle *et al.* (1989) highlighted the role of "likely potential entrants" (carriers whose entry in a route is not deterred by economies of scale and scope) in moderating airfares over US routes; and Kim and Singal (1993) suggested that airline mergers increased airfares in US routes in the late 1980s.
6. Regulations concerning charter flights affect competition and carrier performance in scheduled operations. Charters substitute for scheduled services in certain "non-time sensitive" demand segments, especially in European markets. Therefore, regulations which govern charter flights are also considered in this study as part of the regulatory framework of scheduled services.
7. The exclusive focus on non-stop routes, which was dictated by data availability, also precludes the analysis of the network-enhancing benefits of competition (*e.g.* multiplication of alternative indirect routes).
8. A fuller discussion of competition issues in air travel can be found in Gönenç *et al.* (2000).
9. Transportation of business travellers from New York JFK to London Heathrow and transportation of tourists from New York-New Jersey (Newark) to London Stansted via Amsterdam do not take place in the same market.

10. Kleit and Maynes (1992) underscore this new dimension of airline competition and explore its implications for the definition of relevant antitrust markets and competition policy.
11. They also arise under privileged vertical relations between airlines and ancillary upstream and downstream services, such as computer reservation systems, travel agents, ground handling services etc. (Esperou and Subremon, 1997; Morrison and Winston, 1999).
12. The common international practice is to give incumbent carriers "grandfather" rights (*i.e.* the right to maintain control over slots that were controlled by them in previous years). Remaining rights are sometimes reserved to new entrants and the trade of existing rights may or may not be authorised. For instance, the United States and EU Members reserve a quota of spare slots for new entrants; the United States authorises slot trading in some airports, and the EC only slot barters. In all instances incumbent airlines usually continue to control the wide majority of the airport utilisation rights.
13. This paper is not concerned with regulations addressing the external effects of air transportation, such as exhaustion gases, noise impacts, traffic congestion and air accidents. It should be noted, however, that these are often handled in OECD countries in ways that may curb competition. For instance, quantitative ceilings on airport movements (aimed at containing pollution, congestion and safety risks) often favour incumbents and hinder new entry. The use of economic instruments, such as slot pricing and taxes and tradable permits for gas and noise emissions, is still rare even though they are likely to be more competitively neutral policies (see Gönenç *et al.*, 2000).
14. As a by-product, OECD-area airlines have continuously focused on the safety and reliability of their services, making high safety standards a positive legacy of the regulated era.
15. In addition, price discrimination became possible, whereby flight fixed costs can be funded according to the price-elasticities of different groups of customers.
16. In the United States, the wave of new entries, mergers and acquisitions which followed the 1978 deregulation brought about shake-ups in the ownership and governance of US airlines (including a number of bankruptcies), and led to sharp improvements in performance (Kole and Lehn, 1999). In Europe, privatisations and the establishment of the "community carrier" status waived national ownership constraints and opened the way to trans-European mergers. The European Commission required that equity injections to government-owned airlines be subject to the "private market investor principle" whereby investments are not cleared when they are not justified from a business perspective – therefore containing hidden subsidies. The Australia-New Zealand agreement liberalised ownership adjustments between two countries' airlines.
17. In the United States, foreign investors are not authorised to acquire more than 25 per cent of the voting capital of airlines and carrier boards must be controlled by US citizens. European Union Member countries, and Australia-New Zealand, as well as all other OECD countries have similar foreign investment restrictions, generally at higher thresholds such as 49 per cent.
18. Open Sky air agreements may facilitate network optimisation when (standard) fifth freedom traffic rights in connecting countries are available, but perfect matching between independent agreements is rare. Furthermore, Open Sky agreements do not offer seventh and eighth traffic freedoms that are important for network optimisation.
19. The data set includes the routes between the main national hub of 12 OECD countries to the main hub of the United States, Japan, Germany, France and United Kingdom, with route additions for the United States and Italy which have more than one national hub.

20. More detailed information on the OECD I*nternational* R*egulation* D*atabase*, which includes the data used in this paper, and on the statistical methodology for aggregating basic data on individual regulatory provisions into summary indicators can be found in Nicoletti *et al.* (1999). The database and its documentation are accessible on the OECD Website at *www.oecd.org/subject/regdatabase/*.

21. Designation rules may provide for either single or multiple carriers, with or without route restrictions. Route capacity limitations may predetermine total capacity on the route, or stipulate free capacity with *ex post* monitoring by signatory governments (as originally in Bermuda I agreements between the United Kingdom and the United States). Price setting rules may provide for free pricing or define approval procedures by the signatory governments (double approval, country of origin approval, double disapproval).

22. It is particularly difficult to measure congestion empirically. For the purposes of this paper an airport was tagged as "congested" when it was reported as such to IATA by national authorities.

23. The classification was determined by looking for "breaks" between route clusters in the sample distribution of the indicators. The identification of breaks remains, however, somewhat arbitrary.

24. In cross-route regressions, two Asian routes were dropped due to missing data.

25. Standard empirical tests (based on variance inflation factors) did not provide evidence of this possible source of multicollinearity, which however may have biased downwards the significance of the coefficient estimates of the regulatory and market structure indicators.

26. Price data have been extracted from on line air ticket reservation systems, and cover the business, fully flexible economy-class and Apex-type discount fares of the carrier operating the largest number of flights on each route, as of 1 September 1999. These fares do not include corporate contract fares nor do they take account of frequent flyer programme redemptions.

27. Fares are expressed in US$ at current exchange rates and therefore are affected by deviations of national currencies from their PPP values.

28. If these variables are autocorrelated over time, the introduction of a time lag only partially avoids this possible source of endogeneity bias.

29. For instance, the correlation between stage length and the summary indicator of route regulations is close to 80 per cent.

30. Full regression results are available from the authors upon request.

31. For each kind of regulation and in each route, interaction terms were constructed by subdividing countries into a "liberal" group and a "protectionist" group. The effect of market structure in the two regulatory environments was isolated by using dummies identifying the two groups of countries.

32. Thus the results are consistent with those of Hurdle *et al.* (1989), who find that the presence of competitors reduces fares over and above the mere effect of potential entry in a study concentrating on liberalised US routes.

33. To be effective, these policies may involve co-operation and co-ordination at the international level.

Annex

MULTILATERAL REGULATIONS, BILATERAL AIR SERVICE AGREEMENTS AND REGIONAL AVIATION MARKETS

International regulations in civil aviation are determined either multilaterally at the global level, regionally among groups of countries, or bilaterally between pairs of governments.

Certain international rules for civil aviation, especially those concerning the professional licensing of air crews and the safety certification of aircraft, and their gas and noise emission effects, are settled *multilaterally*, in the International Civil Aviation Organisation (ICAO).* Several OECD governments stress today the need for a more dependable enforcement of multilateral standards, their adaptation to growing air traffic and multiplication of market participants, and to new aviation technologies – such as computer and software-based navigation which necessitate new maintenance procedures (Olster *et al.*, 1992; Savage, 1999; ICAO, 1999).

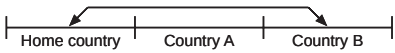
The rules which most directly affect the organisation of the industry, such as the designation of authorised carriers, their entry on specific routes, their freedom to establish capacity and prices, and the authorisation of charter flights are embedded in *bilateral* "air service agreements" (ASAs) between governments. There are at present more than 3 000 of them in application. They spell-out the traffic rights between the two underwriting countries and describe in detail the air routes operable, the names of carriers allowed to enter, the aircraft types and flight frequencies authorised, the types of fares applicable, and the mechanisms available for fare settlement. ASAs traditionally granted only the first four traffic freedoms described in the Box.

A new generation of ASAs called *Open Sky agreements* have been proposed by the US government bilaterally as from early 1990s, and there are at present 47 of them in application. They imply: *i*) no limits on the number of airlines that may be designated by either country; *ii*) unrestricted capacity and frequencies on all routes; *iii*) full fifth-freedom and sixth-freedom rights and unlimited "change of gauge" (change of aircraft type) on all routes; and *iv*) full pricing freedom unless fares are contested simultaneously by both governments (double disapproval regime). However, these agreements do not trigger full international competition because carriers continue to be designated by their respective governments, cross-country equity investments are not liberalised, and seventh (right of one country's airlines to carry independent traffic between two other countries) and eighth (consecutive service into domestic market) traffic freedoms, which are essential for network optimisation, are generally not available.

* In the past certain international fare structures, fare levels and service norms were established by the trade association of international airlines (IATA), to which governments delegated authority and granted anti-trust immunities. This role of IATA has declined in the recent period in most of the OECD area.

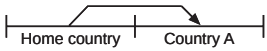
Box. **Exchanges of air traffic freedoms**

FIRST FREEDOM
To fly over one country en-route to another

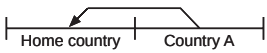


SECOND FREEDOM
To make a technical stop in another country

THIRD FREEDOM
To carry freight and passengers from the home country to another country



FOURTH FREEDOM
To carry freight and passengers to the home country from another country



FIFTH FREEDOM
To carry freight and passengers between two countries by an airline of a third country on route with origin/destination in its home country

SIXTH FREEDOM
To carry freight and passengers between two countries by an airline of a third country on two routes connecting in its home country

SEVENTH FREEDOM
To carry freight and passengers between two countries by an airline of a third country on a route with no connection with its home country

EIGHTH FREEDOM OR CABOTAGE
To carry freight and passengers within a country by an airline of another country on a route with origin/destination in its home country

TRUE DOMESTIC
To carry freight and passengers within a foreign country with no connection with the home country

Source: European Commission (1997).

Regional aviation markets are a recent innovation in international civil aviation. They are aviation equivalents of free-trade areas and transform sub-sets of bilateral air routes between participating countries into domestic routes within the common aviation area. Two prominent regional aviation markets are the Australia-New Zealand Common Aviation Market established in 1992, and the European Single Aviation Market completed in 1997. The European Single Aviation Market started from a cargo service liberalisation agreement in 1987 and gradually extended to the total liberalisation of pricing, new entry, capacity, cross-investment and cabotage freedoms on intra-European routes for European-owned airlines.

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