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Regulation, Market Structure and Performance in Air Passenger Transportation

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by
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ABSTRACT/RÉSUMÉ

The paper uses a data base on regulation, market structure and performance in the air passenger transportation industry, to analyse the links among liberalisation, private ownership, competition, efficiency and airfares at national and route levels. Covering the 1996-97 travel season, 21 aggregate indicators have been developed for 27 OECD countries, and 23 micro indicators for 102 air routes connecting 14 major international airports. These data, summarised by means of factor analysis show that i) regulations affecting the air industry vary heavily across countries and routes; ii) in most markets, air services are still provided by a few carriers, generally dominated by an incumbent flag-carrier or by an airline alliance between incumbents; iii) only in a few cases new entrant airlines play a significant role; iv) in a large number of airports, a single airline controls more than half of the available slots; v) as a result, few international routes are truly open to competition; vi) regional aviation markets and open sky agreements constitute an important but limited step toward liberalisation. Controlling for market size, network length and other technological and economic differences, and combining national and route-level characteristics, cross-country and cross-route regressions show that i) productive efficiency increases and fares decline when regulations and market structures become friendly to competition; ii) productive efficiency is sensitive to actual competitive pressures, as proxied by low market concentration; iii) fares react to liberalisation independently from market structure, but in liberal environments their decline is amplified by actual competition between carriers; iv) business and economy fares tend to decline when they are liberalised and market concentration is reduced, but tend to increase when markets are dominated by airline alliances on the route; v) discount fares are affected by the overall market environment at route ends, charter regulations and the actual presence of challenger airlines on the route; and vi) airport congestion and dominance tend to increase fares in time-sensitive market segments.

JEL classification: K23, L51, L93, L32, L1.
Keywords: Regulated industries, economics of regulation, air transport, market structure, liberalisation, competition, public enterprise, business strategy.

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Cette étude utilise une base de données concernant la régulation, la structure des marchés et la performance dans le transport aérien de passagers, au niveau national ainsi qu'au niveau des lignes, pour analyser les liens entre d'une part la libéralisation, la privatisation et la concurrence et, d'autre part, l'efficacité de l'industrie et les tarifs des voyages aériens. Pour la saison 1996-97, il a été possible de développer 21 indicateurs agrégés pour 27 pays de l'OCDE et 23 indicateurs détaillés pour 102 lignes aériennes reliant 14 grands aéroports internationaux. Ces données, synthétisées à l'aide de l'analyse factorielle, montrent que i) la régulation de l'industrie du transport aérien varie remarquablement selon les pays et les lignes ; ii) dans la majorité des marchés, les services de transport aérien sont encore fournis par un nombre restreint de vecteurs, qui sont généralement dominés par une compagnie nationale présente depuis longtemps sur le marché ou par une alliance entre plusieurs compagnies ; iii) les cas où les nouveaux entrants jouent un rôle majeur sont largement minoritaires ; iv) dans un grand nombre d'aéroports une seule compagnie contrôle plus de la moitié des créneaux horaires disponibles ; v) par conséquent, très peu de lignes internationales sont vraiment ouvertes à la concurrence ; vi) la création d'espaces aériens régionaux et la signature d'accords "ciel ouvert" constituent des pas importants mais limités dans la direction de l'ouverture des marchés. En contrôlant, pour la dimension des marchés et des réseaux, ainsi que pour d'autres différences de nature technologique et économique, et en tenant compte des interactions entre les caractéristiques des lignes et de l'industrie nationale, les résultats des régressions transversales aux pays et aux routes suggèrent que i) l'efficacité augmente et les tarifs diminuent quand la régulation et la structure de marché deviennent plus favorables à la concurrence ; ii) l'efficacité dans l'utilisation des avions est affectée de façon positive par les pressions concurrentielles, mesurées par un indice de concentration bas ; iii) les tarifs aériens réagissent à la libéralisation indépendamment de la structure du marché mais, quand l'environnement réglementaire est libéral, leur diminution est renforcée par l'existence de concurrents sur la ligne ; iv) les tarifs affichés des classes affaires et économique ont tendance à baisser quand les prix sont libéralisés et la concentration du marché diminue, mais ont tendance à augmenter quand les marchés sont dominés par des alliances entre compagnies aériennes ; v) les tarifs soldés sont affectés par le degré de concurrence globalement présent dans les pays reliés par la ligne ainsi que par les régulations concernant les charters et la présence effective de compagnies challengers sur la ligne ; vi) la congestion et la domination des aéroports par une compagnie aérienne tendent à augmenter les tarifs dans les segments du marché qui sont plus sensibles aux temps de départ et d'arrivée.

Classification JEL : *K23, L51, L93, L32, L1*
Mots-clés : Industries réglementées, économie de la régulation, transport aérien, structure de marché, libéralisation, concurrence, entreprises publiques, stratégie d'entreprise.

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1. Summary and conclusions

1. 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.

2. 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.

3. 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.

4. 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

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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.*, 1984; Bailey *et al.*, 1985; Liu and Lynk, 1999; Reed, 1999).[2] U.S. 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.[3] Only a few quantitative analyses have documented the implications of airline competition for efficiency and air fares in other parts of the OECD, such as the trans-Pacific routes (Gillen *et al.*, 1998; Kissling, 1998) and the European internal market (Marìn, 1995; Morrell, 1998), while a monographic analysis looked at the productivity performances of large-sized international airlines (Oum and Yu, 1998).

5. 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.[4] Results have been less clear-cut outside of the U.S. 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 (Marìn, 1998; Lapautre, 2000). Research also helped identify those structural factors such as airport domination and market concentration which may temper the benefits of reforms.[5] 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.[6] Moreover, no study has looked at the effects on performance of the presence of "flag carrier airlines", often controlled by governments. Finally, few studies have accounted, within a unified framework, for influences on performance originating from regulation, market structure and infrastructure access conditions.

6. 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. [7] The analysis is based on a detailed set of indicators of regulation

2. Derthick and Quirk (1985) provide a detailed account of how economic studies have inspired and contributed to the U.S. air transport reforms.

3. 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.

4. 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).

5. 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).

6. Among the studies focusing on specific kinds of regulatory and market arrangements, Dresner and Tretheway (1992) found that U.S. "open sky" policies reduced air fares in 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 air fares over U.S. routes; and Kim and Singal (1993) suggested that airline mergers increased air fares in U.S. routes in the late eighties.

7. Regulations concerning charter flights affect competition and carrier performance in scheduled operations, as charters frequently substitute for scheduled services in "non-time sensitive" demand segments. Therefore, regulations which govern charter flights are also considered in this study as part of the regulatory framework of scheduled services.

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 air fares. 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.

7. The rest of the paper has three main sections. Section 2 overviews competition issues and regulation trends in OECD air transport, providing the necessary background for the empirical analysis. Section 3 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, Section 4 uses the resulting indicators to estimate the impact of several regulation and market features on industry-wide and route-level performance.

8. The cross-country and cross-route analysis of regulatory and market arrangements highlighted some stylised features of the environment in which air travel services are supplied in the OECD area:

- Despite the wide-ranging reforms implemented by OECD governments in the past two decades, regulations affecting the air travel industry domestically and on individual routes still vary a lot across countries and routes.

- Relatively few international (long-haul) routes are truly open to competition. This inhibits the creation of a global aviation market and hinders network optimisation by air carriers. Because they prevent competition from third party carriers, regional arrangements and open sky policies constitute only a partial step in this direction.

- In many OECD countries and on most of the international routes included in the sample market concentration is significant and a few carriers supply air travel services. This generally occurs in the presence of an incumbent flag-carrier (often controlled by the government) and in only a few cases new entrants (such as third party carriers or challenger carriers) play a significant role. In addition, airline alliances (often between incumbents) have been formed in a large number of routes.

- In a large number of international airports congestion phenomena are reported to exist and a single airline controls more than half of the available slots.

9. The analysis of the linkages between regulatory and market environments, framework conditions and performances at the industry and route level suggests the following main conclusions:

- 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 some evidence that economy and (to a lesser extent) business fares are higher in routes dominated by airline alliances.

- There is some evidence 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.

10. 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.[8]

2. Competition issues and regulation trends in air passenger transportation

11. The technology of the air travel industry involves economies of scale, but increasing returns are exhausted at relatively low levels of output. Economies originate principally from the so-called economies of density, which reflect the diminishing costs of the additional seats, passengers and flights on individual routes. 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.

12. 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 with little cross-substitutability of demand between them. Connections between cities can be further segmented into

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

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.

13. 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. In a hub-and-spoke network, traffic is collected from feeder points and consolidated at a hub before being redistributed by further flights to other destinations (short "spoke" or long "trunk" destinations). One airport, or no more than a small number of airports become the focus of the operations of air carriers, permitting the use of smaller numbers of larger aircraft and more frequent flights (Figure 1). Competition is affected in several ways:

- Higher total traffic on individual spoke and trunk routes raises output levels on the constant-cost segments of supply curves, facilitating entry competition.

- If interconnection at hubs between airlines is effected at low cost and at little consumer inconvenience, competition is further increased.

- Hub-and-spoke networks shift 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]

- However, if transaction costs between airlines are significant, hub-and-spoke generates firm-specific scope economies between routes and may damp competition.

To date, the net effect of these factors has been to increase the degree of competition in the airline industry (US Department of Transportation, 1999).

[Figure 1. Hub-and-spoke infrastructures and economies of density]

14. The inherently competitive character of the airline industry may be threatened by obstacles to airport access and anticompetitive behaviour of incumbent carriers (Pera, 1989). The terms of access of competing airlines to airport and air traffic infrastructures (runways, terminals, air traffic control) may have an important bearing on the degree of competition in downstream airline services (Kahn, 1993; OECD, 1998; Federal Aviation Administration, 1999).[11] The quality of infrastructure access is particularly important for efficiency and competition in hub-and-spoke networks where operations are organised in closely timed “flight banks”, and delays in individual landing or take-off operations perturb and may

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. Fixed ground infrastructures often present natural monopoly characteristics and other forms of market failures (*e.g.* environmental externalities) and generally confer a significant degree of market power to infrastructure operators. However, not all airports are natural monopolies. Costs flatten when traffic attains a threshold of 1.5 to 3 million yearly passengers (Doganis, 1992). Urban areas with intense air traffic, such as New York, Washington, Chicago, Tokyo, London, Paris, and Milan, can bear the efficient operation of more than one airport and may sustain airport competition. Generally, even with limited competition between airports, the pricing of infrastructures, the allocation of access rights under congestion, and the needed capacity extensions need to be appropriately regulated.

paralyse the entire network. 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] 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). 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. (Morrison and Winston, 1999; Esperou and Subremon, 1997).[13]

15. Despite its essentially competitive nature, air transport has been typically subject in OECD countries to strict domestic and international regulations concerning entry and exit, pricing and business operation.[14] The regulation of international exchanges of air transport services is often described by a typology of "freedoms" granted to carriers (Box 1). These international regulations are established and enforced either multilaterally, bilaterally between individual countries, or regionally among groups of countries (Box 2).

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. Other marketing practices may also have potentially anti-competitive effects, such as instantaneous price discounts in response to new entries and certain types of consumer loyalty programmes. Instances where specific price discounts and frequent flyer programmes may hinder competition without being themselves a form of competition are difficult to establish in practice, but clearer competition rules in these areas are important for preserving market contestability (Van Miert, 1998; U.S. Department of Transportation, 1999; OECD, 2000).

14. 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 noticed, 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 Gonenc *et al.*, 2000).

Box 1. **Exchanges of air traffic freedoms**

FIRST FREEDOM

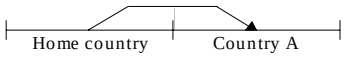
To overfly one country en-route to another

SECOND FREEDOM

To make a technical stop in another country

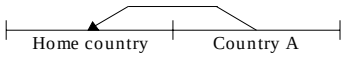
THIRD FREEDOM

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



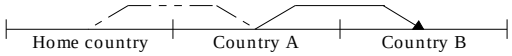
FOURTH FREEDOM

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



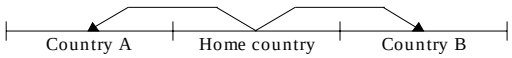
FIFTH FREEDOM

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

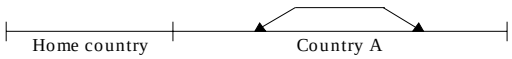
To carry freight and passengers betweeen two countries by an airline of a third country on a route with no connection with its home country

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: Association of European Airlines/European Commission

Box 2. **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).[15] 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 3000 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 Box 1.

- A new generation of ASAs called "Open Skies" have been proposed by the US government in its bilateral agreements as from early 1990s, and there are at present 34 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.

- “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.

16. 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, prescribed by domestic laws, bilateral ASAs or regional market provisions, require that carriers which service air routes within a country, between two countries or in a regional market must be "owned and effectively controlled" by the locals of concerned countries. They 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. International mergers, acquisitions and joint-ventures are therefore difficult, and the growth of firms across national boundaries takes indirect forms not involving capital exchanges, such as commercial alliances and code-sharing agreements.

15. 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.

17. The regulatory straightjacket imposed on domestic and international air travel has affected business strategies, industry organisation and market structures. Government-owned or regulated airlines were sheltered from competition and developed strategies characterised by high operation costs, high quality of services, and relatively restricted output growth.[16] The lack of competitive pressures often resulted in a low utilisation rate of aircraft capacity, wages with a significant rent element, and relatively generous working conditions. In the air routes where prices were regulated but more than one incumbent competed, such as the busiest U.S. routes before deregulation and the busiest international routes, "quality of service competition" based on the frequency and comfort of flights was the main outcome. Entry, pricing and service regulations also have made the optimisation of networks difficult. Individual airlines could not freely choose their hub locations, route structures and flight frequencies according to economic considerations, but generally had to apply operation patterns prescribed by regulatory arrangements (domestic and bilateral route schedules centred on national hubs). Dynamically, they could not adjust their operations to structural and seasonal moves in travel demand, and to the shift of the technical frontier as new vintages of aircraft implied the adaptation of their network,[17] or may have been able to do so only with delay. Furthermore, government ownership and the "national ownership" rules did not permit adjustments in the governance of airlines, and ASA bans on mergers countered the emergence of optimised company boundaries and network structures.[18]

18. Reforms introduced in the past two decades aimed at exploiting the potential for free competition in air travel markets. Prominent reforms included the pioneering U.S. domestic deregulation of 1978, the Australia-New Zealand Common Aviation area of 1992, the European Single Aviation Market of 1997 and a limited number of Open Sky air agreements signed in the course of 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*). In addition, price discrimination became possible, whereby flight fixed costs can be funded according to the price-elasticities of different groups of customers. However, liberalisations remained nationally or regionally fragmented relative to the inherently global aviation marketplace: the bulk of international routes is still governed by highly restrictive bilateral ASAs. Reforms therefore failed to fully exploit the potential for global competition and trade specialisation (Box 3).

16. 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.

17. For instance, the introduction of new generations of larger jet aircraft increases the efficiency of hub-and-spoke technologies (as a topical example, the recently announced 600-800 seat mega carriers are destined to operate on 20 or so international trunk routes), this may conflict with nationally centred route networks.

18. In the absence of stock market listings and takeover threats, incumbent management tends to become non-contestable and restructuring opportunities often go unnoticed.

Box 3. **Potential for global competition and trade**

Global competition and trade in air transportation are restricted by domestic and international regulations. Domestic routes are reserved to national carriers, except in regional aviation agreements which give open access to foreign airlines registered in partner countries. The vast majority of international routes are reserved to the national airlines of route-end countries, except in a small number of markets where third-country airlines may operate consecutive flights to-and-from their home countries. (Boxes 1 and 2).

The limited scope for global competition contrasts with the technological characteristics of the sector, which are pro-trade. Aircraft and aircrew are perfectly mobile and can access any domestic or international market in a matter of hours, which make air transportation services genuinely tradable. Still, limited forms of trade are practised, via international subcontracting arrangements such as code-share and wet-lease agreements. In these arrangements "principal" airlines hire the aircraft and operating personnel of lower cost subcontractors. Code-shares and wet-leases permit the provision of lower-cost air services via the established brands and traffic rights of incumbents. They are more and more accompanied by cross-frontier equity investments which are nevertheless constrained by the prevailing "national ownership and control" rules.

International differences in labour costs hint at an underlying potential for global competition and trade. As major airlines use similar aircraft and technologies, no sustainable sources of long-term productivity differences are likely to compensate for large wage differentials. Labour costs represent up to 30 percent of airlines' operating costs, and the table below documents the magnitude of the wage differentials among countries (Table).

Table Box 3. **Air transport industry wage differentials among OECD countries**

Countries	Wage-reference company	Pilots/ co-pilots	Cabin crew	Ground maintenance	Average air wage index[4]	Pilot wage index	Cabin wage index	Ground wage index
		Average annual remuneration[3] (Dec97, US$)			US International airlines = 100			
Canada	*CANADIAN*	85 017	30 136	46 325	84	67	94	91
Czech Republic	*CZECH AIR*	13 476	4 889	5 192	12	11	15	10
Denmark	*SAS*	159 378	60 224	58 494	143	126	188	115
Finland	*FINAIR*	91 935	28 146	35 452	77	73	88	70
Germany	*LUFTHANSA*	136 774	53 572	n.a	138	108	167	n.a
Italy	*MERIDIANA*	128 591	58 730	45 225	125	102	183	89
Japan	*JAL*	189 525[2]	70 688	n.a	186	150	221	n.a
Korea	*KOREAN*	37 841	15 816	18 300	38	30	49	36
Mexico	*MEXICANA*	88 856	19 583	11 308	51	70	61	22
Norway	*WIDEROE*	102 346	54 831	61 547	124	81	171	121
Portugal	*TAP*	126 650	41 784	33 899	99	100	131	67
Spain	*IBERIA*	165 720[2]	61 695	39 226	134	131	193	77
Sweden	*SAS*	159 378	60 224	58 494	143	126	188	115
Turkey	*THY*	46 896	14 736	17 455	39	37	46	34
United Kingdom	*BA*	119 766	29 957	42 412	91	95	94	83
United States	*5 US airlines*[1]	126 538	32 013	50 888	100	100	100	100

1. Average of *UNITED, AMERICAN, DELTA, TWA, CONTINENTAL* airlines.
2. Other cockpit personnel instead of pilots.
3. Gross wages including payroll taxes, employee benefits and pemnsion contributions.
4. Average of pilot, cabin and ground indexes.
Source: ICAO.

19. Liberalisations also aimed at encouraging network rationalisation by facilitating more extensive recourse to hub-and-spoke. For instance, U.S. airline deregulation unleashed a previously unsuspected

network restructuring potential. Network rationalisation has been comparatively more limited outside the United States, either because reforms have covered limited regional areas (such was the case of the Australia-New Zealand aviation integration) or because ASAs continue to constrain network remodelling. Open Sky air agreements certainly facilitate network optimisation when fifth freedom traffic rights in a succession of countries are available, but perfect matching between independent agreements is rare. On the other hand, Open Sky agreements do not offer seventh and eighth traffic freedoms which are important for network optimisation (See above Boxes 1 and 2). In addition, the persistence of political support for national hubs and their domination by national airlines may have slowed down restructurings in Europe.

20. Finally, reforms have aimed at opening up the capital structures of airlines. Mergers between companies have been facilitated and airline privatisations, often part of liberalisation packages, introduced new flexibility in capital and financing structures. 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 preventing hidden subsidies. The Australia-New Zealand agreement liberalised ownership adjustments between two countries' airlines. However, in all these reforms, "local ownership and control" rules remained and ruled out mergers, acquisitions and equity financings across large regional zones: In the US, 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.

21. The locally (regionally) important but globally limited impact of liberalisation reforms have been born out by a number of studies. In the US, early studies demonstrated that reform in "deregulated islands" such as Texas and California enhanced air service productivity and decreased local fares without affecting national markets (Levine, 1965). Studies after the 1978 reform revealed that efficiency and fare gains were 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 low-to-medium density ends of the networks to competition (Morrison and Watson, 1989; Hurdle *et al.*, 1989; Borenstein, 1989; U.S. General Accounting Office, 1996; Kim and Singal, 1993; Liu and Lynk, 1999; U.S. Department of Transportation, 1999). Research in Europe shows that 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). Analyses of the liberal air agreements indicate that benefits are maximised when true competitors to incumbents can actually enter the markets (Caves and Higgins, 1993; Gillen *et al*., 1998). Liberal 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).

3. Comparing regulations and market structures across countries and routes

22. 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. Detailed information on sources and methodologies is provided in the Annex.[20]

23. 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 (see Box 4).

Box 4. **Using multivariate data analysis to assess regulations and market structures**

Patterns of regulation and market structure in the air transportation industry are summarised by means of factor analysis. Factor analysis is a statistical technique aimed at finding the minimum number of "latent" variables which explain the maximum amount of the overall variance of the observed variables. The factors, which are linear combinations of the observed variables, can be interpreted in economic terms (e.g. entrenchment of a flag carrier or openness of international regulations). Each factor is characterised by a set of coefficients (factor loadings) expressing its correlation with the observed variables and the variables are assigned to the factor in which they are most "loaded". As a result, the regulatory and market structure indicators are split into disjoint sets, each of which is associated with one factor. The estimated factor loadings applied to the country-specific or route-specific regulation and market structure indicators make it possible to "score" countries and routes according to each of the factors, so that rankings of countries and routes can be obtained in terms of factor-specific scores. It is standard practice to retain a number of factors that cumulatively explain a substantial part of the overall variance. For more details on the use of multivariate data analysis techniques for studying patterns in regulation and market structure see Nicoletti *et al*. (1999).

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

24. 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 length of application of liberalisation policies, a proxy for the degree of maturation of their economic 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 regulations and market structures

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. General information on the OECD International Regulation Database, which includes the data used in this paper, and on statistical methodology for aggregating basic data on individual regulatory provisions into summary indicators can be found in G. Nicoletti *et al* (1999). The database and its documentation are accessible on the OECD Website at http://www.oecd.org/subject/regdatabase/.

reflect in smaller indices. Details on how these regulatory and market dimensions were mapped into quantitative indicators are provided in the Annex.

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

25. 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 carriers) and government control over a large-size 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 individual 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 2). Country scores on individual factors are broadly consistent with the overall rankings, with the exception of smaller-size 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 to any 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.

[Table 2. Country-level regulation and market structures: the discriminating factors]

[Figure 2. Summary indicators of regulatory and market environment at country-level]

26. Figures 3 and 4 present country clusters along “pairs of factorial axes”. Figure 3 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 economic grounds, such as in the United Kingdom or Japan) and countries in which national airlines operate in relatively closed markets (where the national carrier seem to dominate as a result of policy design). Figure 4 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 (perhaps due to minimum size effects).

[Figure 3. Flag carrier entrenchment and market environment]

[Figure 4. Market environment and international regulations]

3.2 Regulation and market structure at the route-level

27. 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 air fares 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 role of government. *Market 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-size 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, to measure *infrastructure access* conditions, data were included on the degree of congestion and slot concentration by incumbent carriers at route-end airports.[22]

28. 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 (see Annex for details).

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

29. 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.

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

30. 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 5).[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 potentially competitive routes grant little room for third-party competition (such as several intra-European routes where access by carriers of a third country is 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).

[Figure 5. Route characteristics]

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.

4. Evaluating the effects of regulatory reform on performance in air passenger transport

31. 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 air fares 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.

32. 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.

33. 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 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.

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

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

4.1 Effects on the efficiency of the domestic air transport industry

35. 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[25] 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, a non-parametric procedure that estimates a global measure of static efficiency in production accounting for multiple inputs and outputs. The present analysis has total passengers transported and total passenger-kilometres as outputs, and total personnel, capacity, fleet, fuel and average stage length as inputs (Box 5). 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).

Box 5. **Measuring air transport efficiency by Data Envelope Analysis**

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).[26] The estimation is based on observations concerning multiple inputs and outputs of different decision units. 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 program).[27] Comparisons between efficiencies of different units are made by rescaling 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.

Here, the method has been applied to analyse the relative efficiency of the air travel industries of OECD countries. 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.

36. A useful starting point for the empirical analysis is to relate the summary indicator of the overall regulatory and market environment (see Figure 2 above) to industry efficiency across countries. Figure 6 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

25. 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.

26. For an extensive discussion of the concept and empirical relevance of x-efficiency, see Frantz (1997).

27. For a survey of developments in DEA methodology, see Charnes, A., *et al.* (1978), and the papers in *The Journal of Productivity Analysis* (1996).

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.

[Figure 6. Industry efficiency and the regulatory and market environment]

37. 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.[28] 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).

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

38. 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.

[Table 6. Performance of the airline industry at the country-level and the regulatory and market environment]

Results of cross-country OLS regressions

4.2 Effects on performance at the route level

39. 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 complement at unity of the load factor (inoccupancy rate). Three types of fares referring to the 1998/99 air travel season were considered: business, standard economy and discount fares. Figure 7 suggests some positive correlation between the overall route-specific regulatory and market environment (*i.e.* the "openness to competition" indicator of Figure 5) and air fares in a cross-section of 100 routes connecting the main hubs of the 12 largest OECD countries. Competitive routes tend to be associated with lower fares. By contrast, no bi-variate 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.

28. 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.

[Figure 7. Performance on routes and the regulatory and market environment]

40. To put some structure on the specification of the multivariate model, air fares 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.[29] 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.

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

41. 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.

42. 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 air fares:

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

$$P = c_0 + c_1 SIZE + c_2 AGE + c_3 PROAIR + c_4 STAGE + c_5 PPP + c_6 AIRPORT + \quad [3]$$

$$+ \sum_i c_{7i} REG_i + \sum_j c_{8j} MKT_j + c_9 GOV + c_{10} COMP + \eta$$

43. Equations [1] and [3] were estimated by OLS based on the sample of international routes (see the Annex 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.[30] 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. 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.

44. Table 8 presents the results of regressions for load factors and the three types of air fares when the regulatory and market environment on the route is summarised by means of the openness to competition indicator shown in Figure 5 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 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 R^2s 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.

[Table 8. Efficiency, fares and the regulatory and market environment: overall route-specific effects]
Results of cross-route OLS regressions

45. 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.

46. A route-specific environment friendly to competition also tends to reduce 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

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

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).

47. 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.

[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

48. 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 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.

49. 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.

50. 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.[31] To explore the potentially different impact of various combinations of regulation and market structure characteristics, two kinds of fare regressions were performed: (i) with

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

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).[32]

[Table 10. Efficiency, fares and the regulatory and market environment: exploring the effects of different regulatory and market conditions]

Summary of results of cross-route OLS regressions

51. 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 in which the impact of regulatory reforms on market structure has matured and carrier competition is effective, raising rival costs and 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.

52. 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 can only affect 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.

53. 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.

54. 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 lower

32. 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 were isolated by using dummies identifying the two groups of countries.

extent) business fares are more significant when the regulatory environment encourages entry and price competition.[33] 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 improve efficiency in aircraft use and moderate prices in market segments that are not time-sensitive.

33. 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 U.S. routes.

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TABLES AND FIGURES

Tables

Figures

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:	
Participation in a regional single aviation market Maturation of the regional aviation market	Number of major airlines (carrying more than 400 000 passengers per year)
Establishment of an 'Open Sky' air service agreement with the United States Maturation of the 'Open Sky' agreement	Market share of the largest carrier in the domestic market Market share of the largest carrier in the international market Carrier concentration on domestic market (Herfindahl index)
Government control:	Carrier concentration on international market (Herfindahl index)
Share of government in the equity capital of the largest national airline	Proportion of the 100 busiest international routes serviced by more than 2 carriers
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	

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 Normalization.
Rotation converged in 6 iterations.

1. Synthesis of several indicators, see Table 1 and Annex.

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 seven freedom) carriers	
	Seat capacity share of third party carriers	
	Number of international airline alliances	
	Seat capacity share of international airline alliances	

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 Normalization.
Rotation converged in 6 iterations.

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.

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	-0.51	-0.32	-0.31
	-5.45	*-5.32*	*-1.97*	*-1.9*
Average aircraft age in fleet	-0.03	-0.03	0.08	0.07
	-0.29	*-0.28*	*0.44*	*0.39*
Propensity to air travel[4]	-0.43	-0.43	-0.31	-0.34
	-4.65	*-4.11*	*-1.94*	*-1.87*
Overall regulatory and market environment	0.53		0.49	
	5.18		*2.78*	
Regulatory environment		0.25		0.16
		2.08		*0.79*
Market environment		0.36		0.39
		3.25		*2.03*
Statistics:				
Observations	27	27	27	27
Degrees of freedom	22	21	22	21
R2	0.83	0.83	0.48	0.48
Adj. R2	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 italics.
3. All regressions also include a constant term. Regulatory and market environment indicators are expressed on a decreasing (1-0) scale, from most to least restrictive 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).

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
Highest 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_j	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_j	-	100	0.13	1.00	0.44	0.19	0.43	+
Capacity share of challenger carriers on route	MKT_j	-	100	0.77	1.00	0.97	0.06	0.06	+
Capacity share of airline alliances on route	MKT_j	-	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.

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]	**Highest 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	0.18	-0.25	-0.63
	-3.27	*1.83*	*-2.5*	*-7.17*
Purchasing power at route ends		0.23	0.20	-0.07
		2.47	*2.08*	*-0.79*
Route-specific regulatory and market environment	0.25	0.37	0.22	0.16
	2.27	*4.02*	*2.25*	*1.91*
Market environment at route ends	0.25	-0.35	-0.01	0.29
	2.34	*-3.88*	*-0.08*	*3.52*
Infrastructure access conditions at route ends (airport dominance and congestion)	0.01	0.16	0.19	0.01
	0.1	*1.6*	*1.85*	*0.14*
Government control over route carriers	-0.13	0.32	0.05	-0.15
	-1.01	*3.32*	*0.45*	*-1.66*
Statistics:				
Observations	97	100	100	100
Degrees of freedom	90	93	93	93
R2	0.2	0.32	0.27	0.44
Adj. R2	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 italics.
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.

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]	**Highest 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	0.15	-0.27	-0.64
	-2.32	*1.52*	*-2.63*	*-7.14*
Purchasing power at route ends		0.22	0.19	-0.07
		2.41	*2.02*	*-0.82*
Route-specific regulatory environment	-0.41	0.45	0.26	0.17
	-3.28	*3.75*	*2.07*	*1.53*
Route-specific market environment	0.7	-0.01	-0.01	0.02
	6.22	*-0.1*	*-0.05*	*0.2*
Market environment at route ends	-0.15	-0.23	0.06	0.32
	-1.3	*-2.14*	*0.51*	*3.19*
Infrastructure access conditions at route ends	-0.06	0.19	0.21	0.02
(airport dominance and congestion)	*-0.58*	*1.97*	*2.02*	*0.26*
Government control over route carriers	-0.21	0.38	0.08	-0.13
	-1.95	*3.75*	*0.72*	*-1.41*
Statistics:				
Observations	97	100	100	100
Degrees of freedom	89	92	92	92
R2	0.41	0.35	0.28	0.44
Adj. R2	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 italics.

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.

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]	**Highest 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	-0.18	-0.18	0.15	0.15	0.25	0.25
	-1.05	*-1.71*	*-1.68*	*1.37*	*1.36*	*2.65*	*2.76*
Infrastructure access conditions at route ends (airport dominance and congestion)	0.07	0.14	0.16	0.17	0.17	-0.01	0.03
	0.65	*1.51*	*1.69*	*1.68*	*1.64*	*-0.08*	*0.38*
Government control over route carriers	-0.24	0.4	0.34	0.12	0.11	-0.12	-0.17
	-2.13	*3.91*	*3.02*	*1.09*	*0.95*	*-1.34*	*-1.93*
Carrier designation rules on route	0.14						
	1.18						
Fare regulations on route		0.46	0.67	0.29	0.29		
		4.24	*2.86*	*2.6*	*1.21*		
Access rights for charters on route	-0.3					0.19	0.91
	-2.51					*2.12*	*3.02*
Capacity concentration on route	0.55	0.11		0.05			
	5.35	*1,1*		*0.43*			
and strict fare regulations			0.05		0.34		
			0.32		*0.73*		
and lax fare regulations			0.33		0.29		
			1.49		*0.77*		
Role of challenger carriers on route	0.22					0.14	
	2.2					*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	0.18	0.23	0.23	-0.08	-0.05
		1.85	*1.79*	*2.19*	*2.17*	*-0.93*	*-0.63*
Statistics:							
Observations	97	100	100	100	100	100	100
Degrees of freedom	87	91	90	91	90	91	90
R2	0.4	0.38	0.39	0.33	0.33	0.48	0.51
Adj. R2	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 italics.

3. Load factors and fares adjusted for stage length.

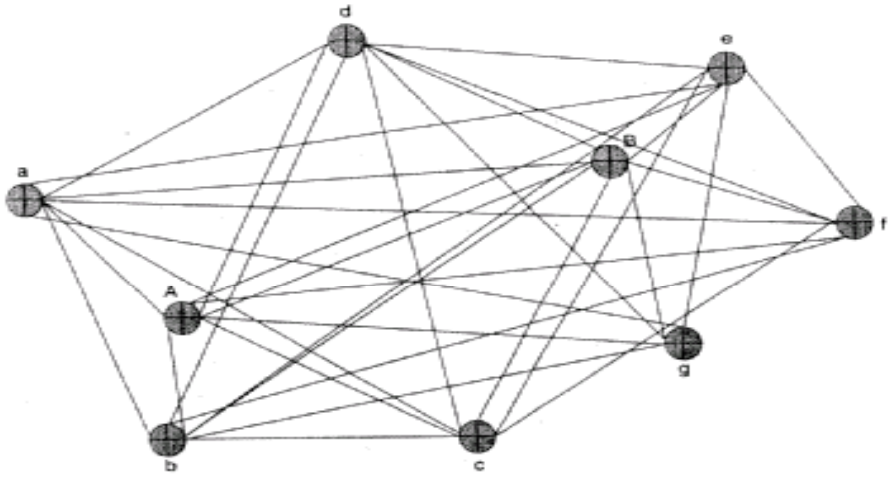
4. The inoccupancy factor is the complement to the load factor (number of seats occupied in a plane).

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.

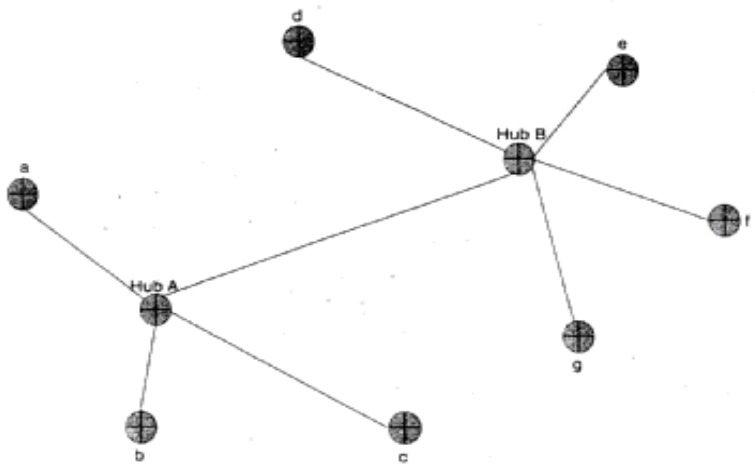
6. Regulatory and market environment indicators are expressed on a decreasing (1-0) scale, from most to least restritive of competition.

Figure 1. **Hub-and-spoke infrastructures and economics of density**

City-pair network[1]



Hub-and-spoke network[2]



1. 9 cities connected by bilateral routes = 36 routes
Total traffic = T, density of passengers per route = T/36

2. 9 cities connected by hub-and-spoke network = 8 routes
Total traffic = T, density of passengers per route = T/4 (assuming that all passengers connect through a hub)

Figure 2. **Summary indicator of regulatory and market environment at country level, 1996/97**
(increasingly anticompetitive)

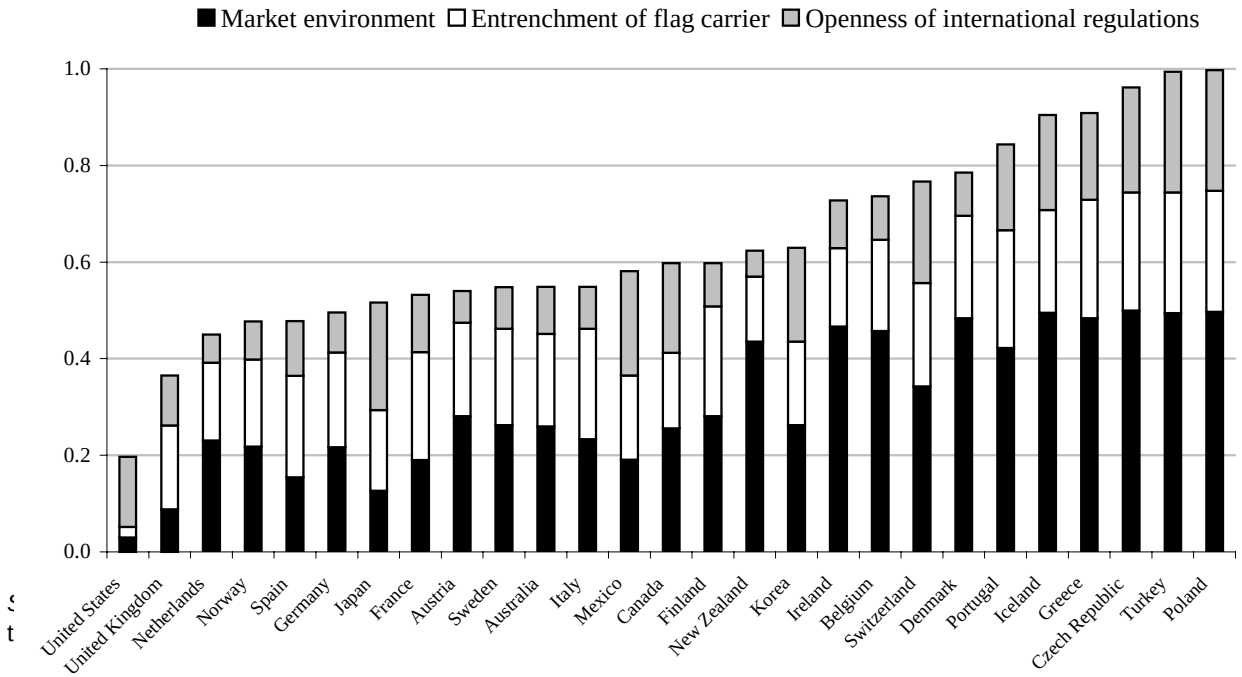


Figure 3. **Flag carrier entrenchment and market environment, 1996/97**

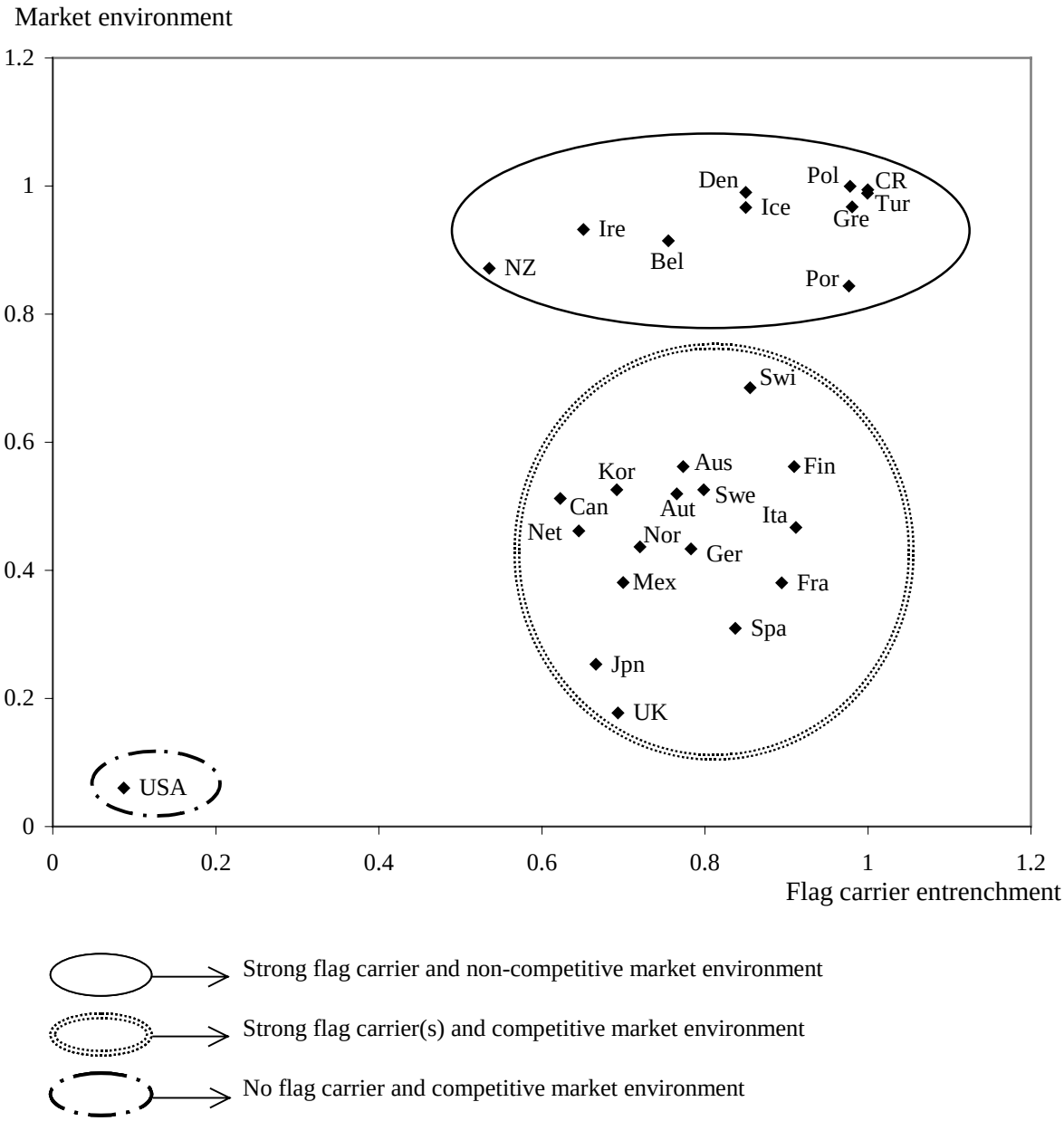
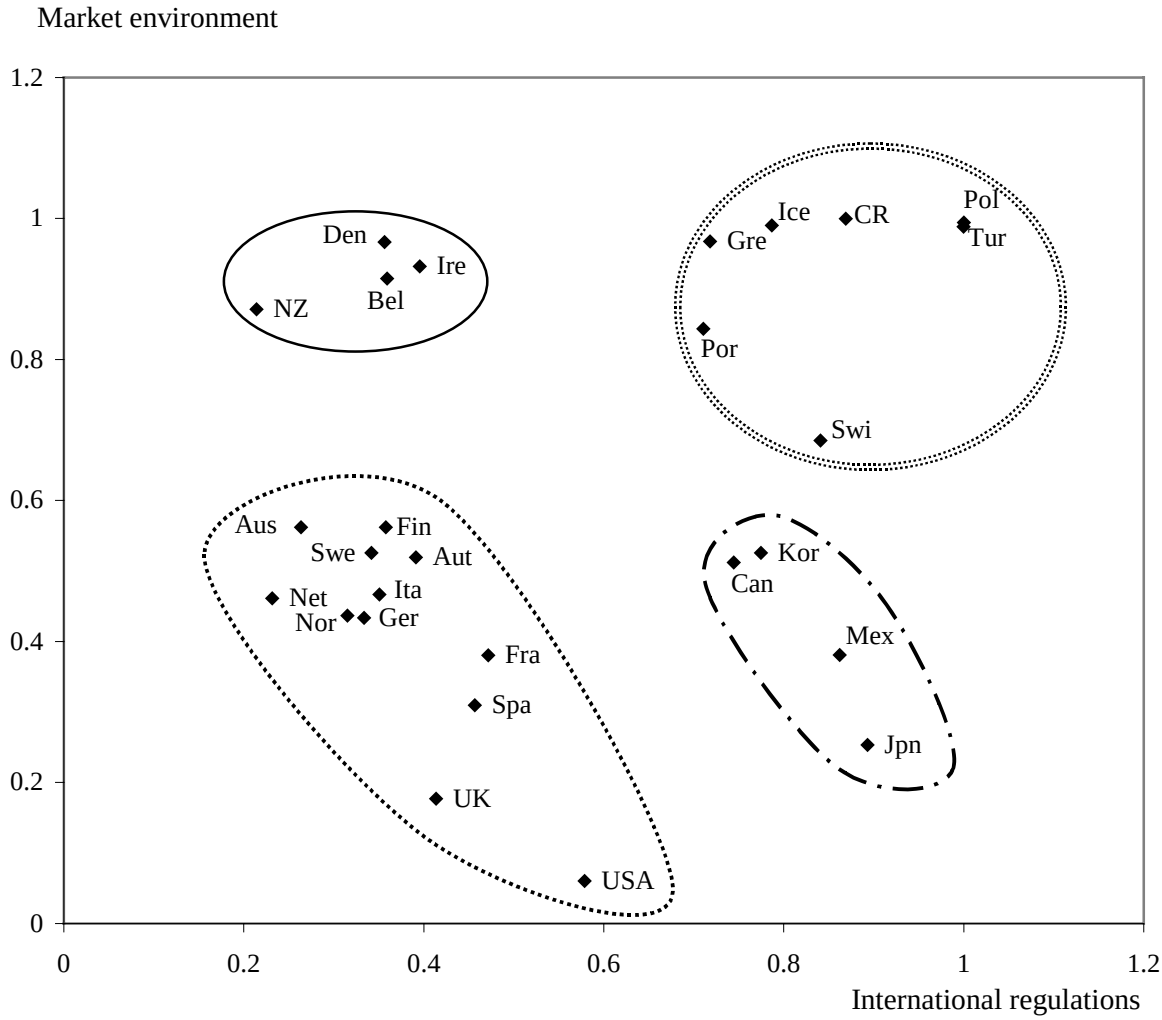


Figure 4. **Market environment and international regulations, 1996/97**



Open (competitive) international regulatory environment and non-competitive market environment.

Restrictive (non-competitive) international regulations and non-competitive market environment.

Relatively open international regulations and relatively competitive market environment.

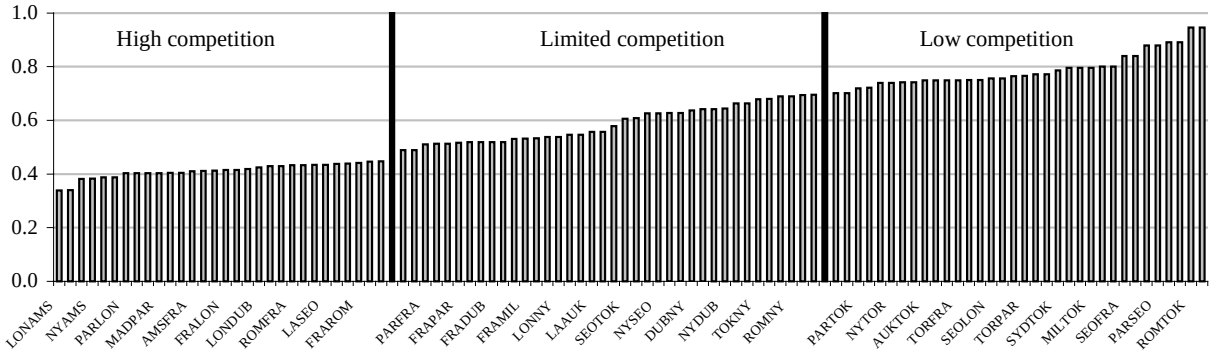
Restrictive international regulations and competitive market environment (managed competition).

Figure 5. **Route characteristics, 1996/97**

Summary indicators based on factor analysis

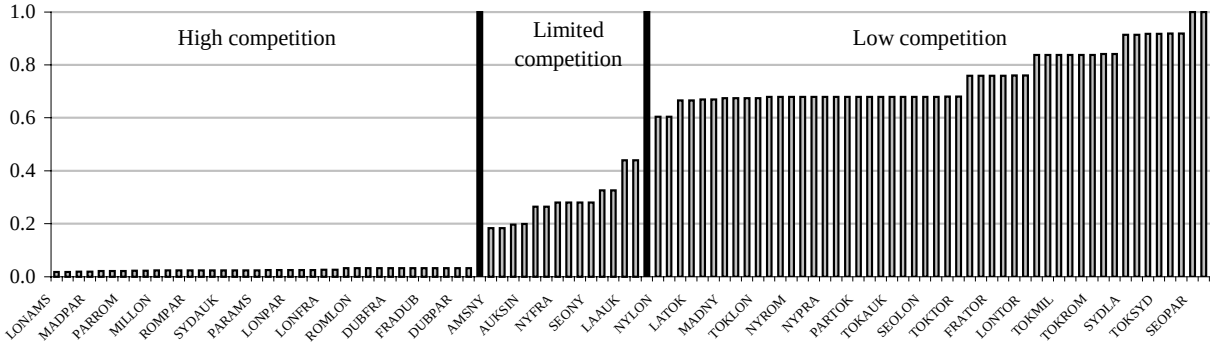
Overall summary indicator [1]

Openess to competition

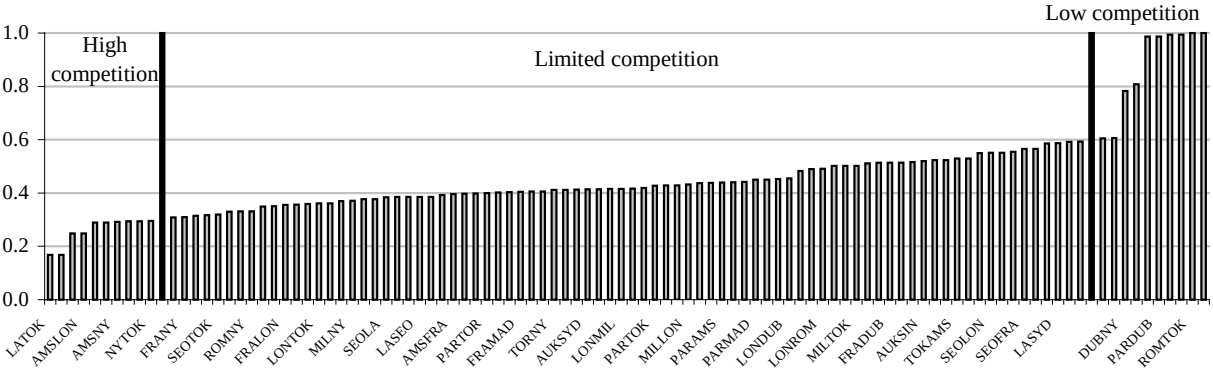


Summary indicators

Regulations



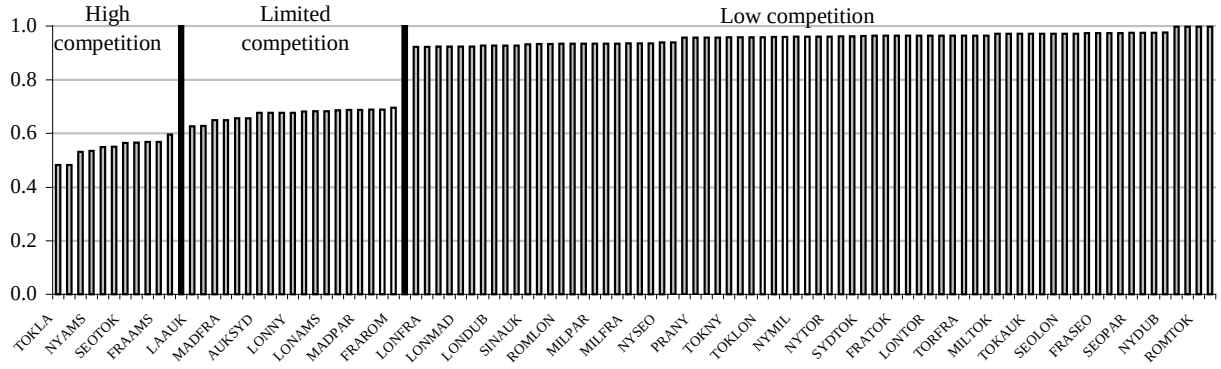
Market structure



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.

Figure 5. **Route characteristics, 1996/97** (continued)

Role of third-party carriers



Role of challenger airlines

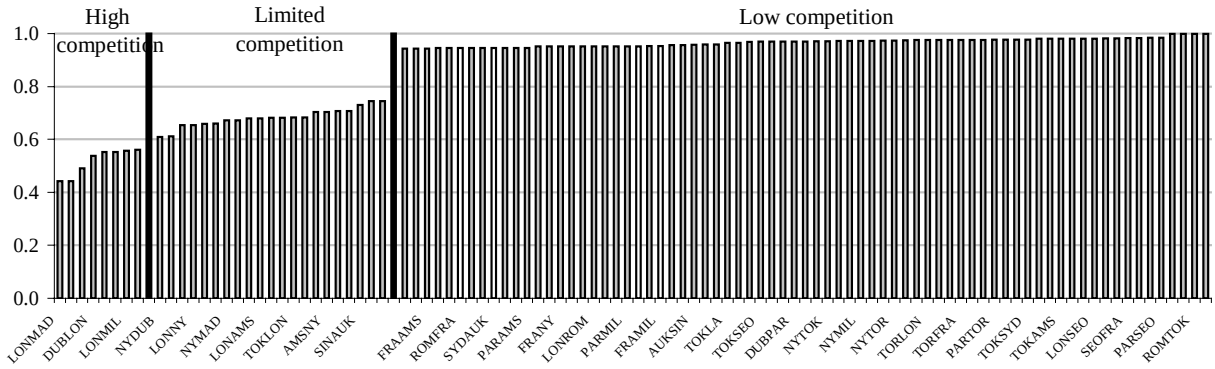
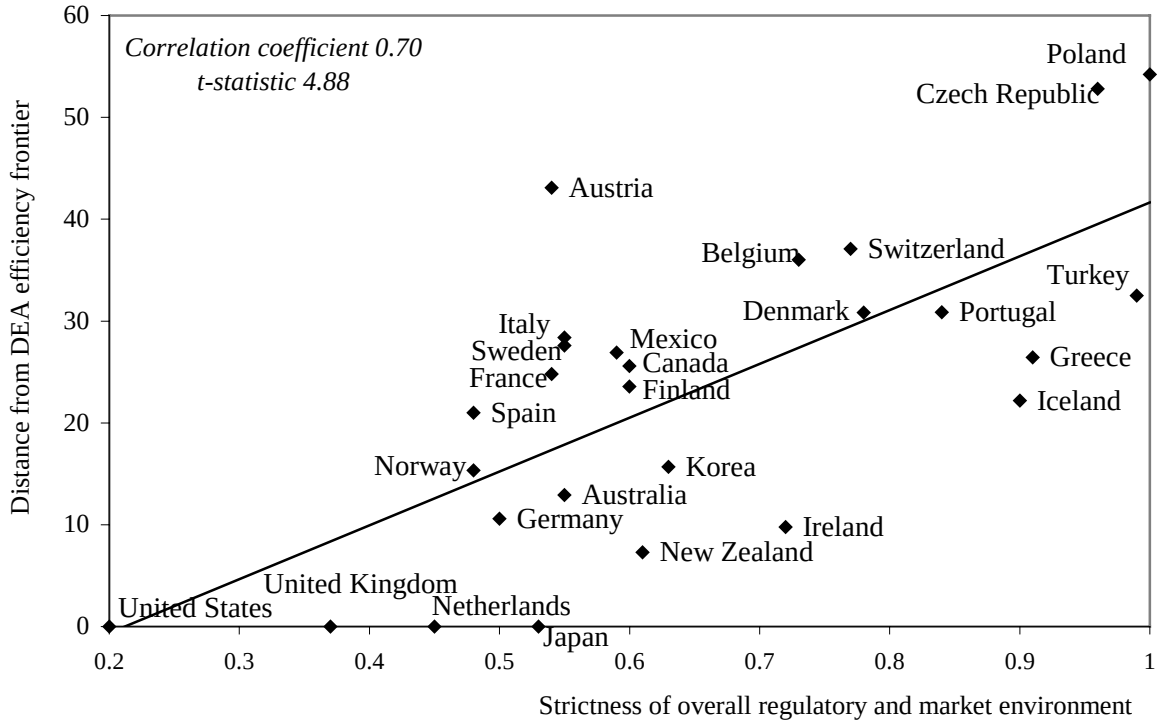


Figure 6. **Industry efficiency and the regulatory and market environment**



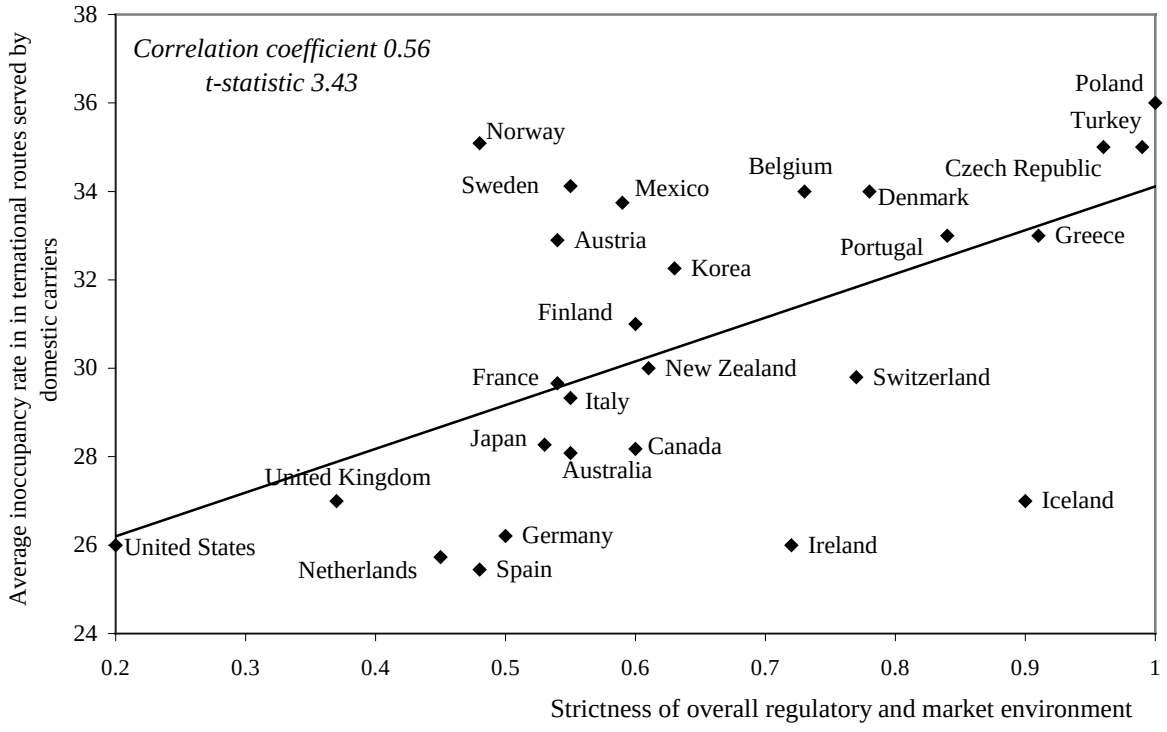
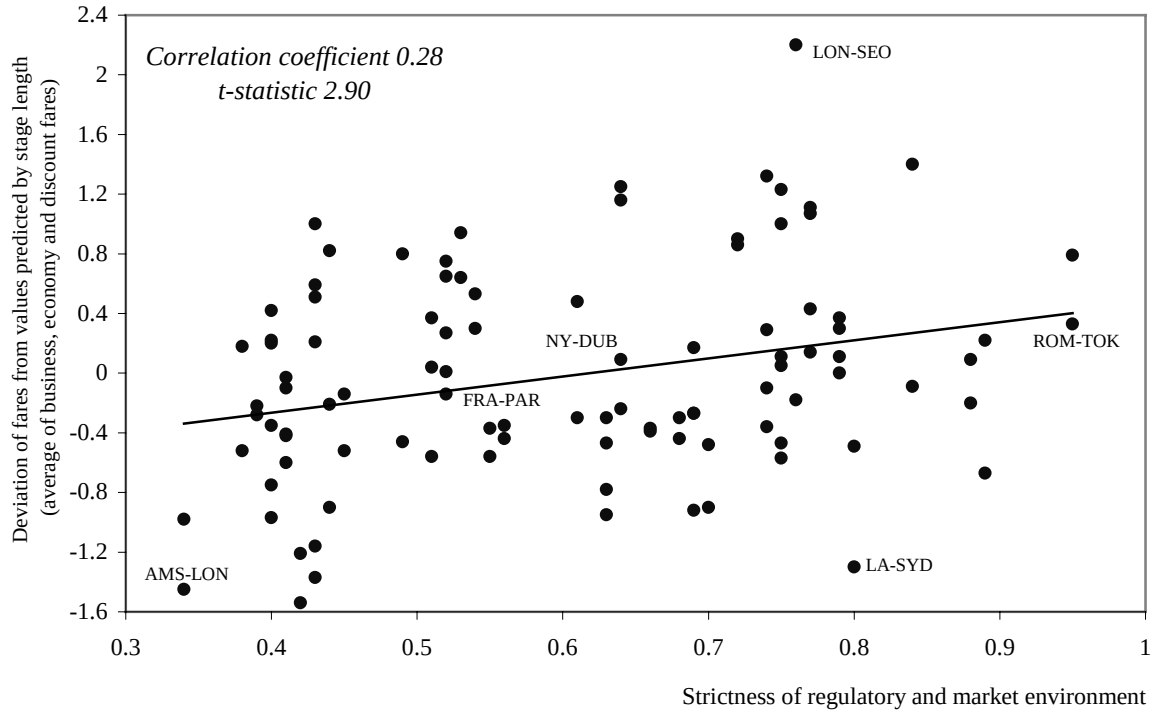
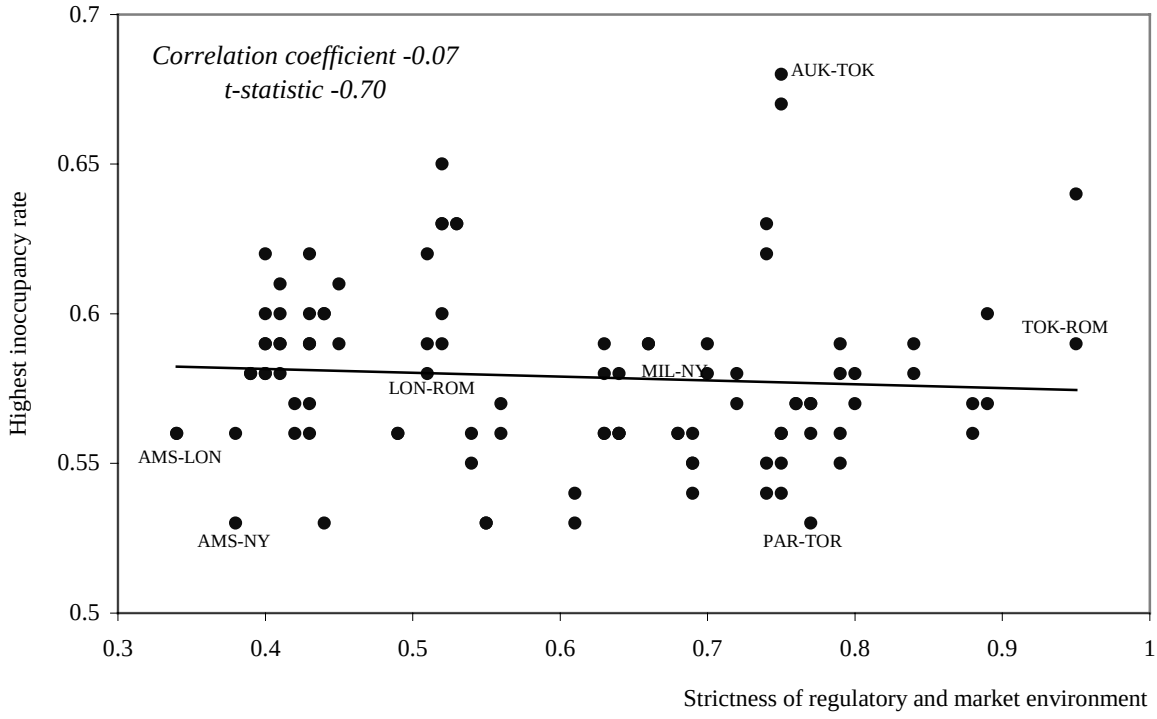


Figure 7**. Performance on routes and the regulatory and market environment**





ANNEX

KEY TO INDICATORS USED IN EMPIRICAL ANALYSIS

1.1 Basic regulation and market structure indicators

REGULATION

National level

DOMESTIC REGULATORY FRAMEWORK

R2d: Existence of a domestic (pure domestic) air liberalisation reform package (yes = 0, no = 1)[34]

INTERNATIONAL REGULATORY FRAMEWORK

R2i: Openness of international market to competition: ((R2os+Tos)+(R2reg+Treg))/2:
R2os: Existence of an 'Open Skies' air service agreement with the US (yes = 0, no = 1).
R2reg: Existence of a Regional Single Aviation Market (yes = 0, no = 1, cabotage exception = 0.5)[35]
Tos and **Treg**: maturation mark-ups (= 0 if R2os and R2reg established before 1993, = 1 if established after 1993, = 2 if no liberalisation yet)[36]

Route level

ROUTE-LEVEL REGULATORY FRAMEWORK[37]

Rrd (*designation of carriers on the route*): single designation = 3; multiple designation with route limitation = 2; multiple designation = 1; free entry (no designation) = 0;
Rrc (*capacity regulation on the route*): predetermination = 3; hybrid = 2; Bermuda I = 1; free/no clause = 0;

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34. EU countries' domestic markets were not considered fully deregulated until 1997 (entry into force of cabotage freedoms within the European single aviation market). *For econometric tests* (not in the database) in a case (Australia) where domestic deregulation did not lead to a change in market structure R2d was established at 1.

35. Norway is considered entirely integrated to the EU single aviation market, via its flag carrier SAS. Switzerland, Iceland, Czech Republic, Hungary and Poland have not been considered as full participants to the single European aviation market. R2reg for Portugal and Greece are established at 0.5 because of cabotage exceptions to single aviation market in 1997 (Açores and Agean Islands).

36. When a long-term commitment to Open Sky policy is demonstrated, Tos is established at 0 for economic tests. This is the case of New Zealand which signed several Open Sky agreements in the 1990s (with Singapore, Malaysia, Brunei and United Arab Emirates) and "Open Sky plus" (a unique Open Sky agreement including 7th right freedoms) with the United States in 1997.

37. Route-level regulation indicators have been established on the basis of International Civil Aviation Organisation (ICAO): Digest of Bilateral Air Service Agreements, 1998 edition and 1995 update. When information on post-1995 changes to bilateral agreements were available, this recent data has been used. For bilateral aviation relations of European countries, the provisions of the Third Aviation Package have been used (1997).

Rrp (*price regulation on the route*): double approval = 3; country of origin approval = 2; double disapproval = 1; free = 0;
Rrch (*authorisation of charter flights on the route*): no formal provision and traffic rights for charter services = 1; explicit provisions and traffic rights for charter services = 0

OWNERSHIP AND GOVERNANCE

National level

OWNERSHIP AND GOVERNANCE OF NATIONAL AIRLINES

O(comp): A composite "continuous" indicator which cumulates (from 0 to 4):
= 4 if Ogs>50% (effective government control of the largest airline),
= Ogs+Ggs+Ogd+Opso otherwise
Ogs: Share of government in the equity capital of the largest airline (<1)
Ggs: Presence of a special voting right (*i.e.* golden share) for government in a major airline (no = 0, yes = 1)
Ogd: Government loss make-ups in major airlines in the past five years (no = 0, yes = 1)
Opso: Formal public service obligations of the largest airline (no = 0, yes = 1)

Route level

ROLE OF GOVERNMENT-CONTROLLED AIRLINES ON A ROUTE

Orr = indicator of government control over route carriers:
= Route market share of airlines with significant (>30%) government ownership (<1)

MARKET STRUCTURE[38]

National level

OPENNESS OF DOMESTIC MARKET TO COMPETITION

Mna: 1/Number of ICAO-reporting scheduled passenger airlines (<1)
Mma: 1/Number of major airlines carrying more than 500 000 passengers per year (<1)
Mhed: Carrier concentration on domestic market (Domestic Herfindahl)

38. Air industry market structure indicators have been calculated from International Civil Aviation Organisation Sources. Notably: ICAO, Traffic: Commercial Air Carriers, 1993-1997, Series T57; and ICAO, On-Flight Origin and Destination Statistics, 1996, Series OFOD80. Capacity and traffic data apply to 1996 unless indicated otherwise. When applicable, market structure indicators have been calculated by consolidating the capacity and traffic of large size "flag carriers" with their subsidiary companies. Capacity and traffic on certain routes had to be estimated: the capacity of Air New Zealand on its routes was estimated as being equal to the capacity of its main competitor on each route. The capacity of continental on Milan-New York-Milan and the capacity of Air New Zealand on Sydney-Los Angeles-Sydney could not be estimated and were not taken into account. Domestic market concentration indexes of countries with no sizeable domestic markets (Belgium, Netherlands) were considered equal to their international market concentration indexes.

OPENNESS OF INTERNATIONAL MARKET TO COMPETITION

Mitr: 1-share of the 100 busiest international routes serviced by more than 3 carriers (<1)
Mhei: Carrier concentration on international market (International Herfindahl)

INFLUENCE OF FLAG CARRIERS

Mdsm: Market share of largest (national) carrier in domestic market (<1)
Mism: Market share of largest (national) carrier in international market (<1)

Route level[39]

OPENNESS OF ROUTE MARKET TO COMPETITION

Mrn: 1/number of main carriers on the route (with >5% market share) (<1)
Mrsm: capacity share of the largest carrier on the route (<1)
Mrhf: Herfindahl index of capacity concentration on the route (<1)

ROLE OF CHALLENGER AIRLINES ON THE ROUTE

Mrnc: 1/(1+number of challenger airlines) on the route (<1)
Mrsc: 1/(1+capacity share of challenger airlines) on the route (<1)

ROLE OF THIRD-PARTY CARRIERS ON THE ROUTE

Mrnt: 1/(1+number of third party (fifth and seven freedom) carriers) on the route (<1)
Mrst: 1/(1+capacity share of third party carriers) on the route (<1)

ROLE OF AIRLINE ALLIANCES ON THE ROUTE[40]

Mrna: number of airline alliances on the route
Mrsa: capacity share of alliances on the route (<1)

AIRPORT SITUATION (BOTTLENECKS) ON THE ROUTE

Ai(comp): a composite indicator of slot availability on the route = Ardc+Arac+Ards+Aras

39. Route traffic and market structure data is derived from International Civil Aviation Organisation (ICAO), Traffic by Flight Stage, Series TF111, 1996.

40. Airline alliances are a new form of market organisation. However, there is no formal definition of alliances and no formal lists. Certain carriers are involved in more than one alliance, it is then difficult to locate them in a given strategic family. For the purposes of this study, four main alliances have been distinguished: i) The "Star" group: United Airlines, Lufthansa, SAS, Air Canada, Thai, Varig, Air New Zealand, Singapore Airlines, All Nippon Airways; ii) The "OneWorld" group: American Airlines, British Airways, Qantas, Iberia, Finnair, US Airways, Japan Airlines; iii) The "Delta" constellation (formerly "Qualiflyer"): Delta Airlines, Swissair, Sabena, Austrian Airlines, Turkish Airlines, Air France (the arrival of Air France may subsequently change the structure of this group); iv) The "KLM/Northwest" group: Northwestern Airlines, KLM, Alitalia, Braathens, Continental Airlines, Japan Air System (this group also manifests signs of re-composition in 2000).

AIRPORT CONGESTION ON THE ROUTE[41]

Ardc: reported congestion in departure airport (no = 0, yes = 1)
Arac: reported congestion in arrival airport (no = 0, yes = 1);

AIRPORT SLOT CONCENTRATION ON THE ROUTE[42]

Ards: largest carrier's share of slots in the departure airport (<1)
Aras: largest carrier's share of slots in arrival airport (<1)

1.2 Factor-analysis based indicators

National level

NFScomp: Overall regulatory and market structure score of countries according to factor analysis
NFS1: Score of countries on axis 1 (Market structure)
NFS2: Score of countries on axis 2 (Entrenchment of flag carriers)
NFS3: Score of countries on axis 3 (International regulations)

Route level

NRFScomp: Overall regulatory and market structure score of air routes according to factor analysis
NRFS1: Score of air routes on axis 1 (Route regulations)
NRFS2: Score of air routes on axis 2 (Route market structures)
NRFS3: Score of air routes on axis 3 (Third party presence)
NRFS4: Score of air routes on axis 4 (Presence of challenger airlines)

1.3 Performance indicators

National level

PRODUCTIVE EFFICIENCY

P(DEA-s2) = The percentage score-gap of each country from the most DEA-efficient country(ies) (adjusted for average stage length, defined as simple average stage length of domestic carriers).

CAPITAL USE EFFICIENCY

P(il): International inoccupancy rate: 100-average % international load factor.

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41. Airport congestion has been identified on the basis of a list of airports reported as "congested" to the International air Transport Association. There may be a reporting bias in these reports as there is no formal definition and formal test congestion.

42. Data on slot concentration have been extracted from multiple country-specific and international sources. They refer to the share of the largest carrier in the total number of departure flights from an airport. There are differences in definition and in some periods - in certain airports only the concentration of international flights are reported. Slot share may be underestimated in certain airports when there is double-counting due to code-share flights.

Route level

PRICE PERFORMANCE[43]

PPrb: rate of deviation of announced business fare (- or +) from benchmark (>-1, <1)
PPre: rate of deviation of announced economy fare (- or +) from benchmark (>-1, <1)
PPrd: rate of deviation of announced discount fare (- or +) from benchmark (>-1, <1)

CAPITAL USE EFFICIENCY[44]

Pcra: 1/(1+average passenger load factor) on the route (0 to 1)
Pcre: 1/(1+highest-load factor) achieved on the route (0 to 1)

D.Pcra: Deviation of average capital productivity from value predicted by stage length: 1/(1+(average load factor-expected average load factor)/expected average load factor).
D.Pcre: Deviation of best practice capital productivity from value predicted by stage length: 1/(1+(best load factor-expected best load factor)/expected best load factor).

1.4 Economic Structure And Technology

National level

Curr: Currency index = Overvaluation (deviation) of exchange rate from its PPP level (GDP(current)/GDP(ppp))
Proair: Propensity of the population to travel by air = Total number of air passengers transported per year/total population.
ASL1: Network size index = Average stage length of national air carriers (Total number of kilometres flown/total number of departures; non-ponderated average of all carriers).
Flstu: Technology/Fleet structure index = Average aircraft size (distribution of the commercial fleet between aircraft <100seats, 100-200 seats, 200-300 seats, >300 seats; ponderated average of all carriers.
Flage: Technology/Fleet age index = Average aircraft age (distribution of the commercial fleet between aircrafts in different age brackets; ponderated average of all carriers.

43. 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 biggest number of flights on each route, as of 1 September 1999. A price function over stage-length (distance) has been derived for each category of fare and the deviation of each route's fares from expected value has been calculated. One missing tariff has been estimated (discount tariff on Singapore-Auckland).

44. Route-level load factors are estimates for certain carriers and on certain routes. On Dublin-Paris-Dublin, the load factor is estimated by taking into account the load factor of the largest carrier on routes to London and Frankfurt. Domestic load factors of countries with no large-size domestic markets are assumed equal to their international load factor.

Route level

Rstag: Route stage length (‘000 kms)
N.M(comp): Composite market structure index of route-end countries (average of two countries)
N.Curr: Average deviation of route-end countries’ exchange rates from their PPP level (average of two countries)
N.Proair: Average air travel propensity index of route-end countries (average of two countries)
N.Flstu: Average fleet structure of route-end countries = Average aircraft size (distribution of the commercial fleet between aircraft <100seats, 100-200 seats, 200-300 seats, >300 seats; ponderated average of all carriers.
N.Flage: Average fleet age of route-end countries = Average aircraft age (distribution of the commercial fleet between aircrafts in different age brackets; ponderated average of all carriers.

ANNEX TABLES

Table A.1 **National regulations and government ownership, 1998**

	Domestic market deregulated	"Open Sky" agreement with United States	"Open Sky" agreement older than 6 years	Regional aviation market	Regional aviation market older than 6 years	Government ownership in largest airline (%)	Government golden share in a major airline	Government loss make-ups in major airlines in the past 5 years	The largest airline has public service obligations
Austria	Yes	Yes	No	Yes	No	0.52	No	No	No
Australia	Yes*	No	-	Yes	Yes	0.00	No	No	Yes
Belgium	Yes	Yes	No	Yes	No	0.34	Yes	No	No
Canada	No	Yes	No	No	-	0.00	No	No	No
Czech Republic	No	Yes	No	No	-	0.87	No	No	No
Denmark	Yes	Yes	No	Yes	No	0.50	No	No	No
Finland	Yes	Yes	No	Yes	No	0.60	No	No	No
France	Yes	No	-	Yes	No	0.95	No	Yes	No
Germany	Yes	Yes	No	Yes	No	0.00	No	No	No
Greece	No	No	-	Yes[1]	No	1.00	No	Yes	Yes
Hungary	No	No	-	No	-	0.65	No	No	No
Iceland	Yes	Yes	No	No	No	0.00	No	No	No
Ireland	Yes	No	-	Yes	No	1.00	No	Yes	No
Italy	Yes	Yes	No	Yes	No	0.86	No	Yes	Yes
Japan	No	No	-	No	-	0.00	No	No	No
Korea	No	Yes	No	No	-	0.00	No	No	No
Mexico	No	No	-	No	-	0.55	No	Yes	No
Netherlands	Yes	Yes	Yes	Yes	No	0.25*	Yes	No	No
New Zealand	Yes	Yes	No*	Yes	Yes	0.00	Yes	No	No
Norway	Yes	Yes	No	Yes	No	0.50	No	No	No
Portugal	No	No	-	Yes[1]	No	1.00	No	Yes	Yes
Poland	No	No	-	No	-	1.00	No	No	No
Spain	Yes	No	-	Yes	No	0.94	Yes	Yes	No
Sweden	Yes	Yes	No	Yes	No	0.50	No	No	No
Switzerland	No	Yes	No	No	-	0.07*	No	No	No
Turkey	No	No	-	No	-	0.98	No	No	Yes
United Kingdom	Yes	No	-	Yes	No	0.00	No	No	Yes
United States	Yes	Yes	Yes	No	-	0.00	No	No	No

*Coefficient adjusted in econometric tests.

1. Cabotage exception.

Table A.2 **Route regulations and the role of government-controlled carriers**[1]

Departure city	Arrival city	Authorisation of carriers	Regulation of capacity	Regulation of prices	Authorisation of charter flights	Direct government role (share of government-controlled airlines)
Frankfurt	New-York	Several carriers	Free capacity	Approval by country of origin	Charter rights	0.12
New-York	Frankfurt	Several carriers	Free capacity	Approval by country of origin	Charter rights	0.12
Frankfurt	Tokyo	Single carrier	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Tokyo	Frankfurt	Single carrier	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Frankfurt	Paris	Free entry	Free capacity	Free fares	Charter rights	0.45
Paris	Frankfurt	Free entry	Free capacity	Free fares	Charter rights	0.43
Frankfurt	London	Free entry	Free capacity	Free fares	Charter rights	0.00
London	Frankfurt	Free entry	Free capacity	Free fares	Charter rights	0.00
Paris	New York	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.48
New York	Paris	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.48
Paris	Tokyo	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.48
Tokyo	Paris	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.50
Paris	London	Free entry	Free capacity	Free fares	Charter rights	0.27
London	Paris	Free entry	Free capacity	Free fares	Charter rights	0.27
London	New York	Several carriers with route limitations	Hybrid ex ante and ex post regulation	Approval by both countries	Charter rights	0.06
New York	London	Several carriers with route limitations	Hybrid ex ante and ex post regulation	Approval by both countries	Charter rights	0.07
London	Tokyo	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Tokyo	London	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Tokyo	New York	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
New York	Tokyo	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Tokyo	Los Angeles	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.12
Los Angeles	Tokyo	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Rome	New York	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.35
New York	Rome	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.35
Rome	Tokyo	Single carrier	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Tokyo	Rome	Single carrier	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Rome	Frankfurt	Free entry	Free capacity	Free fares	Charter rights	0.56
Frankfurt	Rome	Free entry	Free capacity	Free fares	Charter rights	0.58

1. 1995 and beyond for air service agreement provisions, 1996 for route-market shares.

Table A.2 **Route regulations and the role of government-controlled carriers**[1] (continued)

Departure city	Arrival city	Authorisation of carriers	Regulation of capacity	Regulation of prices	Authorisation of charter flights	Direct government role (share of government-controlled airlines)
Rome	Paris	Free entry	Free capacity	Free fares	Charter rights	0.93
Paris	Rome	Free entry	Free capacity	Free fares	Charter rights	0.93
Rome	London	Free entry	Free capacity	Free fares	Charter rights	0.56
London	Rome	Free entry	Free capacity	Free fares	Charter rights	0.56
Toronto	New York	Several carriers with route limitations	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
New York	Toronto	Several carriers with route limitations	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Toronto	Tokyo	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Tokyo	Toronto	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Toronto	Frankfurt	Several carriers with route limitations	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Frankfurt	Toronto	Several carriers with route limitations	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Toronto	Paris	Several carriers	Ex ante regulation	Approval by both countries	No formal charter traffic	0.43
Paris	Toronto	Several carriers	Ex ante regulation	Approval by both countries	No formal charter traffic	0.43
Toronto	London	Several carriers	Hybrid ex ante and ex post regulation	Approval by both countries	No formal charter traffic	0.00
London	Toronto	Several carriers	Hybrid ex ante and ex post regulation	Approval by both countries	No formal charter traffic	0.00
Amsterdam	New York	Several carriers	Free capacity	Free fares unless disapproved by both countries	Charter rights	0.27
New York	Amsterdam	Several carriers	Free capacity	Free fares unless disapproved by both countries	Charter rights	1.00
Amsterdam	Tokyo	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Tokyo	Amsterdam	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Amsterdam	Frankfurt	Free entry	Free capacity	Free fares	Charter rights	0.06
Frankfurt	Amsterdam	Free entry	Free capacity	Free fares	Charter rights	0.06
Amsterdam	Paris	Free entry	Free capacity	Free fares	Charter rights	0.40
Paris	Amsterdam	Free entry	Free capacity	Free fares	Charter rights	0.40
Amsterdam	London	Free entry	Free capacity	Free fares	Charter rights	0.00
London	Amsterdam	Free entry	Free capacity	Free fares	Charter rights	0.00
Madrid	New York	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.32
New York	Madrid	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.33
Madrid	Frankfurt	Free entry	Free capacity	Free fares	Charter rights	0.39
Frankfurt	Madrid	Free entry	Free capacity	Free fares	Charter rights	0.39
Madrid	Paris	Free entry	Free capacity	Free fares	Charter rights	0.99
Paris	Madrid	Free entry	Free capacity	Free fares	Charter rights	0.99
Madrid	London	Free entry	Free capacity	Free fares	Charter rights	0.37
London	Madrid	Free entry	Free capacity	Free fares	Charter rights	0.37

1. 1995 and beyond for air service agreement provisions, 1996 for route-market shares.

Table A.2 **Route regulations and the role of government-controlled carriers**[1] (continued)

Departure city	Arrival city	Authorisation of carriers	Regulation of capacity	Regulation of prices	Authorisation of charter flights	Direct government role (share of government-controlled airlines)
Seoul	New York	Several carriers	Ex post surveillance	Free fares unless disapproved by both countries	Charter rights	0.00
New York	Seoul	Several carriers	Ex post surveillance	Free fares unless disapproved by both countries	Charter rights	0.00
Seoul	Los Angeles	Several carriers	Ex post surveillance	Free fares unless disapproved by both countries	Charter rights	0.16
Los Angeles	Seoul	Several carriers	Ex post surveillance	Free fares unless disapproved by both countries	Charter rights	0.16
Seoul	Tokyo	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Tokyo	Seoul	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Seoul[2]	Frankfurt[2]	Single carrier	Hybrid ex ante and ex post regulation	Approval by both countries	No formal charter traffic	0.00
Frankfurt[2]	Seoul[2]	Single carrier	Hybrid ex ante and ex post regulation	Approval by both countries	No formal charter traffic	0.00
Seoul	Paris	Single carrier	Ex ante regulation	Approval by both countries	No formal charter traffic	0.33
Paris	Seoul	Single carrier	Ex ante regulation	Approval by both countries	No formal charter traffic	0.32
Seoul	London	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
London	Seoul	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Sydney	Los Angeles	Single carrier	Hybrid ex ante and ex post regulation	Approval by both countries	No formal charter traffic	0.00
Los Angeles	Sydney	Single carrier	Hybrid ex ante and ex post regulation	Approval by both countries	No formal charter traffic	0.00
Sydney	Tokyo	Single carrier	Hybrid ex ante and ex post regulation	Approval by both countries	No formal charter traffic	0.00
Tokyo	Sydney	Single carrier	Hybrid ex ante and ex post regulation	Approval by both countries	No formal charter traffic	0.00
Sydney	Auckland	Free entry	Free capacity	Free fares	Charter rights	0.15
Auckland	Sydney	Free entry	Free capacity	Free fares	Charter rights	0.15
Auckland	Los Angeles	Several carriers with route limitations	Ex post surveillance	Approval by both countries	Charter rights	0.00
Los Angeles	Auckland	Several carriers with route limitations	Ex post surveillance	Approval by both countries	Charter rights	0.00

1. 1995 and beyond for air service agreement provisions, 1996 for route-market shares.
2. Provisions of the Germany-Korea agreement being unavailable, the terms of the Netherlands-Korea agreement have been used as a proxy.

Table A.2 **Route regulations and the role of government-controlled carriers**[1] (continued)

Departure city	Arrival city	Authorisation of carriers	Regulation of capacity	Regulation of prices	Authorisation of charter flights	Direct government role (share of government-controlled airlines)
Auckland	Tokyo	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Tokyo	Auckland	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.00
Milan	New York	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.41
New York	Milan	Several carriers	Ex post surveillance	Approval by both countries	No formal charter traffic	0.41
Milan	Tokyo	Single carrier	Ex post surveillance	Approval by both countries	No formal charter traffic	0.60
Tokyo	Milan	Single carrier	Ex post surveillance	Approval by both countries	No formal charter traffic	0.61
Milan	Frankfurt	Free entry	Free capacity	Free fares	Charter rights	0.40
Frankfurt	Milan	Free entry	Free capacity	Free fares	Charter rights	0.40
Milan	Paris	Free entry	Free capacity	Free fares	Charter rights	1.00
Paris	Milan	Free entry	Free capacity	Free fares	Charter rights	1.00
Milan	London	Free entry	Free capacity	Free fares	Charter rights	0.46
London	Milan	Free entry	Free capacity	Free fares	Charter rights	0.46
Dublin	New York	Several carriers	Free capacity	Free fares	No formal charter traffic	0.93
New York	Dublin	Several carriers	Free capacity	Free fares	No formal charter traffic	0.96
Dublin	Frankfurt	Free entry	Free capacity	Free fares	Charter rights	0.51
Frankfurt	Dublin	Free entry	Free capacity	Free fares	Charter rights	0.51
Dublin	Paris	Free entry	Free capacity	Free fares	Charter rights	1.00
Paris	Dublin	Free entry	Free capacity	Free fares	Charter rights	1.00
Dublin	London	Free entry	Free capacity	Free fares	Charter rights	0.59
London	Dublin	Free entry	Free capacity	Free fares	Charter rights	0.60

1. 1995 and beyond for air service agreement provisions, 1996 for route-market shares.

Table A.3 **National market structures, 1997**

	Number of ICAO-registered airlines	Number of airlines carrying more than 500000 passengers a year	Domestic market share of the largest airline (incl. subsidiaries)	International market share of the largest airline (incl. subsidiaries)	Share of 100 international routes with more than 3 carriers	Herfindahl concentration index in domestic market	Herfindahl concentration index in international market
Austria	3	3	0.98	0.63	11	0.97	0.50
Australia (1995)	3	2	0.51	0.94	10	0.50	0.88
Belgium	1	1	..	1.00	10	1.00	1.00
Canada	2	2	0.60	0.59	13	0.52	0.52
Czech Republic	1	1	1.00	1.00	0	1.00	1.00
Denmark	1	1	1.00	1.00	6	1.00	1.00
Finland (1995)	3	3	0.75	1.00	0	0.60	1.00
France	7	6	0.70	0.96	25	0.55	0.92
Germany	3	3	0.83	0.98	49	0.70	0.96
Greece	1	1	1.00	1.00	10	1.00	1.00
Hungary			0.00	0.00	0	1.00	1.00
Iceland	1	1	1.00	1.00	..	1.00	1.00
Ireland	1	1	..	..	1	0.44	0.97
Italy (1995)	5	3	0.89	0.99	10	0.35	0.59
Japan	6	6	0.49	0.74	35	0.59	0.63
Korea (1996)	2	2	0.72	0.75	22	0.39	0.48
Mexico	5	3	0.50	0.40	9	0.72	0.72
Netherlands (1996)	3	3	0.00	0.83	19	1.00	1.00
New Zealand (1994)	2	1	1.00	1.00	..	0.44	0.85
Norway	5	3	0.45	0.92	5	1.00	1.00
Portugal	2	1	1.00	1.00	14	1.00	1.00
Poland	1	1	1.00	1.00	2	0.29	0.84
Spain	10	7	0.45	0.91	15	0.56	0.99
Sweden	3	3	0.72	1.00	5	1.00	1.00
Switzerland	3	2	1.00	1.00	9	1.00	1.00
Turkey	1	1	1.00	1.00	4	0.26	0.68
United Kingdom	20	13	0.46	0.81	39	0.12	0.19
United States	50	31	0.18	0.14	34	0.12	0.19

Table A.4 **Route market structures, 1996**

Departure city	Arrival city	Number of major carriers	Number of challenger carriers	Number of third-country carriers	Number of airline alliances	Capacity share of largest carrier	Capacity share of challengers	Capacity share of third-country carriers	Capacity share of alliances	Herfindahl index of route capacity concentration
Frankfurt	New-York	5	0	1	1	40	0	11.9	0.52	0.25
New-York	Frankfurt	5	0	1	1	40	0	11.9	0.52	0.25
Frankfurt	Tokyo	3	0	0	1	46	0	0	0.61	0.38
Tokyo	Frankfurt	3	0	0	1	46	0	0	0.61	0.38
Frankfurt	Paris	2	0	0	0	51	0	0	0.00	0.46
Paris	Frankfurt	2	0	0	0	48	0	0	0.00	0.42
Frankfurt	London	4	1	0	0	40	11.5	0	0.00	0.34
London	Frankfurt	4	1	0	0	40	11.5	0	0.00	0.34
Paris	New York	6	0	0	1	48	0	0	0.58	0.29
New York	Paris	6	0	0	1	48	0	0	0.62	0.29
Paris	Tokyo	3	0	0	0	48	0	0	0.00	0.38
Tokyo	Paris	3	0	0	0	50	0	0	0.00	0.39
Paris	London	4	2	0	0	48	19.5	0	0.00	0.35
London	Paris	4	2	0	0	48	19.6	0	0.00	0.35
London	New York	6	1	1	1	38	17.0	6.5	0.57	0.23
New York	London	6	1	1	1	38	17.0	6.5	0.57	0.23
London	Tokyo	4	1	0	1	43	12.6	0	0.68	0.30
Tokyo	London	4	1	0	1	43	12.6	0	0.68	0.30
Tokyo	New York	4	0	0	1	27	0	0	0.51	0.25
New York	Tokyo	4	0	0	1	27	0	0	0.52	0.25
Tokyo	Los Angeles	9	0	4	1	19	0	34.9	0.42	0.13
Los Angeles	Tokyo	9	0	4	1	19	0	34.8	0.42	0.13
Rome	New York	4	0	0	1	35	0	0	0.52	0.29
New York	Rome	4	0	0	1	35	0	0	0.52	0.29
Rome	Tokyo	1	0	0	0	100	0	0	0.00	1.00
Tokyo	Rome	1	0	0	0	100	0	0	0.00	1.00
Rome	Frankfurt	3	0	1	0	36	0	5.5	0.00	0.44
Frankfurt	Rome	3	0	1	0	38	0	3.4	0.00	0.49
Rome	Paris	3	0	1	0	36	0	6.8	0.00	0.46
Paris	Rome	4	0	2	0	36	0	9.4	0.00	0.43
Rome	London	2	0	0	0	43	0	0	0.00	0.50
London	Rome	2	0	0	0	43	0	0	0.00	0.50
Toronto	New York	4	0	0	1	52	0	0	0.38	0.35
New York	Toronto	4	0	0	1	53	0	0	0.37	0.35

Table A.4 **Route market structures, 1996** (continued)

Departure city	Arrival city	Number of major carriers	Number of challenger carriers	Number of third-country carriers	Number of airline alliances	Capacity share of largest carrier	Capacity share of challengers	Capacity share of third-country carriers	Capacity share of alliances	Herfindahl index of route capacity concentration
Toronto	Tokyo	1	0	0	0	100	0	0	0.00	1.00
Tokyo	Toronto	1	0	0	0	100	0	0	0.00	1.00
Toronto	Frankfurt	3	0	0	1	47	0	0	0.90	0.42
Frankfurt	Toronto	3	0	0	1	47	0	0	0.90	0.42
Toronto	Paris	3	0	0	0	43	0	0	0.00	0.35
Paris	Toronto	3	0	0	0	43	0	0	0.00	0.35
Toronto	London	3	0	0	0	46	0	0	0.00	0.36
London	Toronto	3	0	0	0	46	0	0	0.00	0.36
Amsterdam	New York	5	1	2	1	39	1.3	27.4	0.51	0.23
New York	Amsterdam	5	1	2	1	39	1.4	26.0	0.52	0.24
Amsterdam	Tokyo	2	0	0	0	52	0	0	0.00	0.50
Tokyo	Amsterdam	2	0	0	0	52	0	0	0.00	0.50
Amsterdam	Frankfurt	4	0	2	0	52	0	16.6	0.00	0.38
Frankfurt	Amsterdam	4	0	2	0	53	0	16.6	0.00	0.39
Amsterdam	Paris	3	0	1	0	51	0	5.0	0.00	0.43
Paris	Amsterdam	3	0	1	0	52	0	5.0	0.00	0.43
Amsterdam	London	6	1	1	0	30	5.3	3.9	0.00	0.22
London	Amsterdam	6	1	1	0	30	5.2	3.9	0.00	0.21
Madrid	New York	4	1	0	0	32	15.6	0	0.00	0.27
New York	Madrid	4	1	0	0	33	15.7	0	0.00	0.27
Madrid	Frankfurt	3	0	1	1	46	0	14.8	0.54	0.39
Frankfurt	Madrid	3	0	1	1	46	0	14.8	0.54	0.39
Madrid	Paris	3	1	1	0	53	0	5.4	0.00	0.45
Paris	Madrid	3	1	1	0	53	0	5.4	0.00	0.45
Madrid	London	4	5	0	1	50	30.4	0	0.87	0.39
London	Madrid	4	5	0	1	50	30.6	0	0.87	0.39
Seoul	New York	2	0	0	0	67	0	0	0.00	0.56
New York	Seoul	2	0	0	0	67	0	0	0.00	0.55
Seoul	Los Angeles	4	1	2	0	51	7.0	22.7	0.00	0.36
Los Angeles	Seoul	4	1	2	0	51	7.0	22.6	0.00	0.36
Seoul	Tokyo	6	0	2	1	45	0	28.0	0.18	0.27
Tokyo	Seoul	5	0	2	1	45	0	27.9	0.18	0.27
Seoul	Frankfurt	2	0	0	0	59	0	0	0.00	0.52
Frankfurt	Seoul	2	0	0	0	59	0	0	0.00	0.52

Table A.4 **Route market structures, 1996** (continued)

Departure city	Arrival city	Number of major carriers	Number of challenger carriers	Number of third-country carriers	Number of airline alliances	Capacity share of largest carrier	Capacity share of challengers	Capacity share of third-country carriers	Capacity share of alliances	Herfindahl index of route capacity concentration
Seoul	Paris	2	0	0	0	67	0	0	0.00	0.56
Paris	Seoul	2	0	0	0	68	0	0	0.00	0.56
Seoul	London	2	0	0	0	57	0	0	0.00	0.51
London	Seoul	2	0	0	0	57	0	0	0.00	0.51
Sydney	Los Angeles	2	1	0	1	64	0	0	0.00	0.54
Los Angeles	Sydney	2	1	0	1	64	0	0	0.00	0.54
Sydney	Tokyo	3	0	0	1	37	0	0	0.72	0.34
Tokyo	Sydney	3	0	0	1	43	0	0	0.83	0.37
Sydney	Auckland	3	0	1	0	46	0	7.9	0.00	0.43
Auckland[1]	Sydney	3	0	1	0	45	0	8.0	0.00	0.42
Auckland	Los Angeles	3	0	1	1	39	0	22.3	0.78	0.35
Los Angeles	Auckland	3	0	1	1	39	0	22.6	0.77	0.35
Auckland	Tokyo	2	0	0	0	50	0	0	0.00	0.50
Tokyo	Auckland	2	0	0	0	50	0	0	0.00	0.50
Auckland	Singapore	2	0	0	0	50	0	0	0.00	0.50
Singapore	Auckland	2	0	0	0	50	0	0	0.00	0.50
Milan	New York	4	0	0	1	41	0	0	0.41	0.34
New York	Milan	4	0	0	1	41	0	0	0.41	0.34
Milan	Tokyo	2	0	0	0	40	0	0	0.00	0.52
Tokyo	Milan	2	0	0	0	39	0	0	0.00	0.52
Milan	Frankfurt	2	0	0	0	59	0	0	0.00	0.51
Frankfurt	Milan	2	0	0	0	60	0	0	0.00	0.52
Milan	Paris	2	0	0	0	50	0	0	0.00	0.50
Paris	Milan	2	0	0	0	50	0	0	0.00	0.50
Milan	London	3	4	0	0	46	20.1	0	0.00	0.43
London	Milan	3	2	0	0	43	19.2	0	0.00	0.41
Dublin[1]	New York	2	2	0	0	93	9.1	0	0.00	0.88
New York	Dublin	2	2	0	0	96	9.8	0	0.00	0.93
Dublin	Frankfurt	2	0	0	0	49	0	0	0.00	0.50
Frankfurt	Dublin	2	0	0	0	49	0	0	0.00	0.50
Dublin	Paris	1	0	0	0	100	0	0	0.00	1.00
Paris	Dublin	1	0	0	0	100	0	0	0.00	1.00
Dublin	London	4	4	0	0	59	6.4	0	0.00	0.44
London	Dublin	4	3	0	0	60	6.4	0	0.00	0.44

1. On routes involving Auckland and Dublin one carrier's capacity has been estimated.

Table A.5 **Airport situations**[1]

Departure City	Arrival City	Congestion in departure airport	Concentration of slots at departure[2]	Congestion in arrival airport	Concentration of slots at arrival[2]
Frankfurt	New-York	Yes	0.53	Yes	0.17
New-York	Frankfurt	Yes	0.17	Yes	0.53
Frankfurt	Tokyo	Yes	0.53	Yes	0.25
Tokyo	Frankfurt	Yes	0.25	Yes	0.53
Frankfurt	Paris	Yes	0.53	Yes	0.44
Paris	Frankfurt	Yes	0.44	Yes	0.53
Frankfurt	London	Yes	0.53	Yes	0.38
London	Frankfurt	Yes	0.38	Yes	0.53
Paris	New York	Yes	0.44	Yes	0.17
New York	Paris	Yes	0.17	Yes	0.44
Paris	Tokyo	Yes	0.44	Yes	0.25
Tokyo	Paris	Yes	0.25	Yes	0.44
Paris	London	Yes	0.44	Yes	0.38
London	Paris	Yes	0.38	Yes	0.44
London	New York	Yes	0.38	Yes	0.17
New York	London	Yes	0.17	Yes	0.38
London	Tokyo	Yes	0.38	Yes	0.25
Tokyo	London	Yes	0.25	Yes	0.38
Tokyo	New York	Yes	0.25	Yes	0.17
New York	Tokyo	Yes	0.17	Yes	0.25
Tokyo	Los Angeles	Yes	0.25	No	0.10
Los Angeles	Tokyo	No	0.10	Yes	0.25
Rome	New York	Yes	0.69	Yes	0.17
New York	Rome	Yes	0.17	Yes	0.69
Rome	Tokyo	Yes	0.69	Yes	0.25
Tokyo	Rome	Yes	0.25	Yes	0.69
Rome	Frankfurt	Yes	0.69	Yes	0.53
Frankfurt	Rome	Yes	0.53	Yes	0.69
Rome	Paris	Yes	0.69	Yes	0.44
Paris	Rome	Yes	0.44	Yes	0.69
Rome	London	Yes	0.69	Yes	0.38
London	Rome	Yes	0.38	Yes	0.69
Toronto	New York	Yes	0.55	Yes	0.17
New York	Toronto	Yes	0.17	Yes	0.55

1. Congestion: 1999, slot concentration: 1997-1998.
2. Concentration of slots is measured by the share of the incumbent airline in the total number of departures from the airport. Heterogeneity of data sources and measurement difficulties, including double-counting for code-share flights, makes this indicator not fully comparable across airports.

Table A.5 **Airport situations**[1] (continued)

Departure City	Arrival City	Congestion in departure airport	Concentration of slots at departure[2]	Congestion in arrival airport	Concentration of slots at arrival[2]
Toronto	Tokyo	Yes	0.55	Yes	0.25
Tokyo	Toronto	Yes	0.25	Yes	0.55
Toronto	Frankfurt	Yes	0.55	Yes	0.53
Frankfurt	Toronto	Yes	0.53	Yes	0.55
Toronto	Paris	Yes	0.55	Yes	0.44
Paris	Toronto	Yes	0.44	Yes	0.55
Toronto	London	Yes	0.55	Yes	0.38
London	Toronto	Yes	0.38	No	0.55
Amsterdam	New York	No	0.60	Yes	0.17
New York	Amsterdam	Yes	0.17	No	0.60
Amsterdam	Tokyo	No	0.60	Yes	0.25
Tokyo	Amsterdam	Yes	0.25	No	0.60
Amsterdam	Frankfurt	No	0.60	Yes	0.53
Frankfurt	Amsterdam	Yes	0.53	No	0.60
Amsterdam	Paris	No	0.60	Yes	0.44
Paris	Amsterdam	Yes	0.44	No	0.60
Amsterdam	London	No	0.60	Yes	0.38
London	Amsterdam	Yes	0.38	No	0.60
Madrid	New York	No	0.45	Yes	0.17
New York	Madrid	Yes	0.17	No	0.45
Madrid	Frankfurt	No	0.45	Yes	0.53
Frankfurt	Madrid	Yes	0.53	No	0.45
Madrid	Paris	No	0.45	Yes	0.44
Paris	Madrid	Yes	0.44	No	0.45
Madrid	London	No	0.45	Yes	0.38
London	Madrid	Yes	0.38	No	0.45
Seoul	New York	No	0.53	Yes	0.17
New York	Seoul	Yes	0.17	No	0.53
Seoul	Los Angeles	No	0.53	No	0.10
Los Angeles	Seoul	No	0.10	No	0.53
Seoul	Tokyo	No	0.53	Yes	0.25
Tokyo	Seoul	Yes	0.25	No	0.53
Seoul	Frankfurt	No	0.53	Yes	0.53
Frankfurt	Seoul	Yes	0.53	No	0.53

1. Congestion: 1999, sot concentration: 1997-1998.
2. Concentration of slots is measured by the share of the incumbent airline in the total number of departures from the airport. Heterogeneity of data sources and measurement difficulties, including double-counting for code-share flights, makes this indicator not fully comparable across airports.

Table A.5 **Airport situations**[1] (continued)

Departure City	Arrival City	Congestion in departure airport	Concentration of slots at departure[2]	Congestion in arrival airport	Concentration of slots at arrival[2]
Seoul	Paris	No	0.53	Yes	0.44
Paris	Seoul	Yes	0.44	No	0.53
Seoul	London	No	0.53	Yes	0.38
London	Seoul	Yes	0.38	No	0.53
Sydney	Los Angeles	No	0.36	No	0.10
Los Angeles	Sydney	No	0.10	No	0.36
Sydney	Tokyo	No	0.36	Yes	0.25
Tokyo	Sydney	Yes	0.25	No	0.36
Sydney	Auckland	No	0.36	Yes	0.56
Auckland	Sydney	Yes	0.56	No	0.36
Auckland	Los Angeles	Yes	0.56	No	0.10
Los Angeles	Auckland	No	0.10	Yes	0.56
Auckland	Tokyo	Yes	0.56	Yes	0.25
Tokyo	Auckland	Yes	0.25	Yes	0.56
Milan	New York	Yes	0.50	Yes	0.17
New York	Milan	Yes	0.17	Yes	0.20
Milan	Tokyo	Yes	0.50	Yes	0.25
Tokyo	Milan	Yes	0.25	Yes	0.50
Milan	Frankfurt	Yes	0.50	Yes	0.53
Frankfurt	Milan	Yes	0.53	Yes	0.50
Milan	Paris	Yes	0.50	Yes	0.44
Paris	Milan	Yes	0.44	Yes	0.50
Milan	London	Yes	0.50	Yes	0.38
London	Milan	Yes	0.38	Yes	0.50
Dublin	New York	No	0.43	Yes	0.17
New York	Dublin	Yes	0.17	No	0.43
Dublin	Frankfurt	No	0.43	Yes	0.53
Frankfurt	Dublin	Yes	0.53	No	0.43
Dublin	Paris	No	0.43	Yes	0.44
Paris	Dublin	Yes	0.44	No	0.43
Dublin	London	No	0.43	Yes	0.38
London	Dublin	Yes	0.38	No	0.43

1. Congestion: 1999, sot concentration: 1997-1998.
2. Concentration of slots is measured by the share of the incumbent airline in the total number of departures from the airport. Heterogeneity of data sources and measurement difficulties, including double-counting for code-share flights, makes this indicator not fully comparable across airports.

Table A.6 **National performances, 1997**

	Total productivity indicators			Capital productivity indicators		
	Efficiency ranking (DEA method)	Efficiency gap from best performer (%)	Efficiency gap from best performer - stage-length adjusted (%)	Average unoccupancy rate	Domestic unoccupancy rate[1]	International unoccupancy rate
Austria	23	36	43	43	53	33
Australia	6	6	13	28	28	28
Belgium	21	28	36	34	34	34
Canada	14	22	26	28	28	28
Czech Republic	24	46	53	34	32	35
Denmark	19	24	31	38	41	34
Finland	11	13	24	37	44	31
France	12	22	25	33	37	30
Germany	5	5	11	33	41	26
Greece	13	19	26	29	24	33
Hungary	26	59	64	..	..	..
Iceland	10	12	22	33	39	27
Ireland	4	1	10	32	38	26
Italy	17	22	28	31	33	29
Japan	1	0	0	32*	37*	28*
Korea	8	10	16	31	30	32
Mexico	15	19	27	36	39	34
Netherlands	2	0	0	26	26	26
New Zealand	3	0	7	30	30	30
Norway	7	10	15	38	41	35
Portugal	18	22	31	34	34	33
Poland	25	48	54	36	36	36
Spain	9	13	21	29	32	25
Sweden	16	21	28	37	41	34
Switzerland	22	30	37	38	46	30
Turkey	20	25	33	30	24	35
United Kingdom	1	0	0	32	36	27
United States	1	18	0	29	31	26

1. Total unoccupancy rates have been used as a proxy for domestic unoccupancy rates for certain carriers.
*1996

Table A.7 **Route performances**

Departure city	Arrival city	Price performances, 1999			Capital productivity, 1996	
		Percentage deviation of business fares from value predicted by stage-length	Percentage deviation of economy-class fares from value predicted by stage-length	Percentage deviation of discount fares from value predicted by stage-length	Average load factor (occupancy rate)	Load factor of the best carrier on the route
Frankfurt	New-York	-13	5	-37	0.76	0.80
New-York	Frankfurt	63	50	-33	0.74	0.79
Frankfurt	Tokyo	17	47	43	0.70	0.76
Tokyo	Frankfurt	38	56	18	0.75	0.78
Frankfurt	Paris	-20	-3	9	0.56	0.58
Paris	Frankfurt	-19	-5	62	0.59	0.61
Frankfurt	London	-20	0	10	0.64	0.66
London	Frankfurt	-16	1	12	0.65	0.69
Paris	New York	23	-2	-48	0.81	0.85
New York	Paris	72	-15	-40	0.77	0.82
Paris	Tokyo	12	39	40	0.66	0.73
Tokyo	Paris	33	24	28	0.70	0.74
Paris	London	-28	-29	-40	0.66	0.73
London	Paris	-13	-30	-32	0.62	0.67
London	New York	70	9	-49	0.74	0.80
New York	London	74	18	-39	0.73	0.81
London	Tokyo	43	58	23	0.73	0.79
Tokyo	London	35	52	30	0.72	0.79
Tokyo	New York	-9	-7	-28	0.76	0.79
New York	Tokyo	6	-27	-9	0.74	0.80
Tokyo	Los Angeles	-19	-3	-14	0.77	0.89
Los Angeles	Tokyo	2	-36	-22	0.76	0.88
Rome	New York	-15	-28	-48	0.78	0.81
New York	Rome	31	-25	-33	0.75	0.78
Rome	Tokyo	-4	8	28	0.57	0.57
Tokyo	Rome	31	22	26	0.70	0.70
Rome	Frankfurt	-4	28	76	0.57	0.62
Frankfurt	Rome	1	28	53	0.63	0.66
Rome	Paris	3	17	40	0.69	0.69
Paris	Rome	3	24	16	0.64	0.62
Rome	London	-19	4	20	0.69	0.70
London	Rome	-32	-13	-11	0.71	0.71
Toronto	New York	-10	2	-2	0.55	0.59
New York	Toronto	-2	-5	36	0.56	0.62

Table A.7 **Route performances** (continued)

Departure city	Arrival city	Price performances, 1999			Capital productivity, 1996	
		Percentage deviation of business fares from value predicted by stage-length	Percentage deviation of economy-class fares from value predicted by stage-length	Percentage deviation of discount fares from value predicted by stage-length	Average load factor (occupancy rate)	Load factor of the best carrier on the route
Toronto	Tokyo	-22	-30	-14	0.74	0.74
Tokyo	Toronto	-7	23	6	0.68	0.68
Toronto	Frankfurt	-8	12	8	0.77	0.82
Frankfurt	Toronto	-12	-6	-30	0.78	0.84
Toronto	Paris	-1	19	-5	0.72	0.76
Paris	Toronto	12	33	-2	0.79	0.87
Toronto	London	-8	-22	-6	0.75	0.81
London	Toronto	52	53	27	0.77	0.84
Amsterdam	New York	3	6	-62	0.78	0.87
New York	Amsterdam	41	15	-38	0.75	0.80
Amsterdam	Tokyo	28	56	40	0.74	0.78
Tokyo	Amsterdam	38	29	33	0.76	0.79
Amsterdam	Frankfurt	-35	-28	3	0.60	0.73
Frankfurt	Amsterdam	-31	-15	5	0.59	0.65
Amsterdam	Paris	-29	-17	-5	0.61	0.65
Paris	Amsterdam	-34	-5	25	0.64	0.70
Amsterdam	London	-54	-48	-43	0.68	0.78
London	Amsterdam	-41	-32	-26	0.73	0.79
Madrid	New York	-10	-28	-9	0.75	0.77
New York	Madrid	11	-22	-18	0.69	0.78
Madrid	Frankfurt	4	22	24	0.62	0.67
Frankfurt	Madrid	0	25	-4	0.63	0.70
Madrid	Paris	-4	19	7	0.63	0.69
Paris	Madrid	-3	10	13	0.64	0.72
Madrid	London	-22	0	1	0.68	0.72
London	Madrid	-34	-15	21	0.65	0.71
Seoul	New York	-41	-32	-5	0.65	0.71
New York	Seoul	-40	-36	-18	0.64	0.69
Seoul	Los Angeles	-51	-50	-14	0.72	0.79
Los Angeles	Seoul	-51	-48	-39	0.72	0.76
Seoul	Tokyo	-51	-51	72	0.79	0.89
Tokyo	Seoul	-27	-18	93	0.77	0.84
Seoul	Frankfurt	-15	-21	28	0.66	0.72
Frankfurt	Seoul	26	59	56	0.66	0.69

Table A.7 **Route performances** (continued)

Departure city	Arrival city	Price performances, 1999			Capital productivity, 1996	
		Percentage deviation of business fares from value predicted by stage-length	Percentage deviation of economy-class fares from value predicted by stage-length	Percentage deviation of discount fares from value predicted by stage-length	Average load factor (occupancy rate)	Load factor of the best carrier on the route
Seoul	Paris	-18	-24	23	0.74	0.76
Paris	Seoul	-2	21	-10	0.79	0.80
Seoul	London	-18	-24	24	0.69	0.74
London	Seoul	54	69	97	0.68	0.76
Sydney	Los Angeles	-18	-19	-12	0.69	0.75
Los Angeles	Sydney	-45	-53	-32	0.70	0.73
Sydney	Tokyo	-9	7	13	0.65	0.73
Tokyo	Sydney	3	3	-6	0.59	0.70
Sydney	Auckland	-28	-32	40	0.66	0.88
Auckland	Sydney	-32	-34	-24	0.67	0.67
Auckland	Los Angeles	-17	-13	-14	0.75	0.76
Los Angeles	Auckland	1	-6	-30	0.77	0.77
Auckland	Tokyo	-30	-14	-13	0.47	0.47
Tokyo	Auckland	-14	1	18	0.50	0.50
Auckland	Singapore	-41	-26	-29	0.73	0.73
Singapore	Auckland	-8	13	-29	0.79	0.79
Milan	New York	-30	-24	-36	0.70	0.71
New York	Milan	-2	-16	-29	0.69	0.70
Milan	Tokyo	-9	9	30	0.79	0.79
Tokyo	Milan	33	-23	28	0.83	0.83
Milan	Frankfurt	-12	15	91	0.59	0.59
Frankfurt	Milan	-12	8	68	0.58	0.58
Milan	Paris	-7	10	62	0.55	0.55
Paris	Milan	-6	11	71	0.58	0.58
Milan	London	-20	1	-15	0.62	0.69
London	Milan	-23	-8	-11	0.62	0.69
Dublin	New York	20	-41	-3	0.71	0.71
New York	Dublin	52	-23	-20	0.79	0.79
Dublin	Frankfurt	-6	13	20	..	0.66
Frankfurt	Dublin	-6	19	-11	..	0.69
Dublin	Paris	-3	-3	-32	0.70	0.70
Paris	Dublin	-3	7	-43	0.70	0.70
Dublin	London	-52	-52	-50	0.74	0.77
London	Dublin	-43	-45	-34	0.75	0.75

Table A.8 Route symbols

Route number	Departure city	Arrival city	Abbreviation	Route number	Departure city	Arrival city	Abbreviation	Route number	Departure city	Arrival city	Abbreviation
1	Frankfurt	New-York	FRANY	35	Toronto	Tokyo	TORTOK	69	Seoul	Paris	SEOPAR
2	New-York	Frankfurt	NYFRA	36	Tokyo	Toronto	TOKTOR	70	Paris	Seoul	PARSEO
3	Frankfurt	Tokyo	FRATOK	37	Toronto	Frankfurt	TORFRA	71	Seoul	London	SEOLON
4	Tokyo	Frankfurt	TOKFRA	38	Frankfurt	Toronto	FRATOR	72	London	Seoul	LONSEO
5	Frankfurt	Paris	FRAPAR	39	Toronto	Paris	TORPAR	73	Sydney	Los Angeles	SYDLA
6	Paris	Frankfurt	PARFRA	40	Paris	Toronto	PARTOR	74	Los Angeles	Sydney	LASYD
7	Frankfurt	London	FRALON	41	Toronto	London	TORLON	75	Sydney	Tokyo	SYDTOK
8	London	Frankfurt	LONFRA	42	London	Toronto	LONTOR	76	Tokyo	Sydney	TOKSYD
9	Paris	New York	PRANY	43	Amsterdam	New York	AMSNY	77	Sydney	Auckland	SYDAUK
10	New York	Paris	NYPRA	44	New York	Amsterdam	NYAMS	78	Auckland	Sydney	AUKSYD
11	Paris	Tokyo	PARTOK	45	Amsterdam	Tokyo	AMSTOK	79	Auckland	Los Angeles	AUKLA
12	Tokyo	Paris	TOKPAR	46	Tokyo	Amsterdam	TOKAMS	80	Los Angeles	Auckland	LAAUK
13	Paris	London	PARLON	47	Amsterdam	Frankfurt	AMSFRA	81	Auckland	Tokyo	AUKTOK
14	London	Paris	LONPAR	48	Frankfurt	Amsterdam	FRAAMS	82	Tokyo	Auckland	TOKAUK
15	London	New York	LONNY	49	Amsterdam	Paris	AMSPAR	83	Auckland	Singapore	AUKSIN
16	New York	London	NYLON	50	Paris	Amsterdam	PARAMS	84	Singapore	Auckland	SINAUK
17	London	Tokyo	LONTOK	51	Amsterdam	London	AMSLON	85	Milan	New York	MILNY
18	Tokyo	London	TOKLON	52	London	Amsterdam	LONAMS	86	New York	Milan	NYMIL
19	Tokyo	New York	TOKNY	53	Madrid	New York	MADNY	87	Milan	Tokyo	MILTOK
20	New York	Tokyo	NYTOK	54	New York	Madrid	NYMAD	88	Tokyo	Milan	TOKMIL
21	Tokyo	Los Angeles	TOKLA	55	Madrid	Frankfurt	MADFRA	89	Milan	Frankfurt	MILFRA
22	Los Angeles	Tokyo	LATOK	56	Frankfurt	Madrid	FRAMAD	90	Frankfurt	Milan	FRAMIL
23	Rome	New York	ROMNY	57	Madrid	Paris	MADPAR	91	Milan	Paris	MILPAR
24	New York	Rome	NYROM	58	Paris	Madrid	PARMAD	92	Paris	Milan	PARMIL
25	Rome	Tokyo	ROMTOK	59	Madrid	London	MADLON	93	Milan	London	MILLON
26	Tokyo	Rome	TOKROM	60	London	Madrid	LONMAD	94	London	Milan	LONMIL
27	Rome	Frankfurt	ROMFRA	61	Seoul	New York	SEONY	95	Dublin	New York	DUBNY
28	Frankfurt	Rome	FRAROM	62	New York	Seoul	NYSEO	96	New York	Dublin	NYDUB
29	Rome	Paris	ROMPAR	63	Seoul	Los Angeles	SEOLA	97	Dublin	Frankfurt	DUBFRA
30	Paris	Rome	PARROM	64	Los Angeles	Seoul	LASEO	98	Frankfurt	Dublin	FRADUB
31	Rome	London	ROMLON	65	Seoul	Tokyo	SEOTOK	99	Dublin	Paris	DUBPAR
32	London	Rome	LONROM	66	Tokyo	Seoul	TOKSEO	100	Paris	Dublin	PARDUB
33	Toronto	New York	TORNY	67	Seoul	Frankfurt	SEOFRA	101	Dublin	London	DUBLON
34	New York	Toronto	NYTOR	68	Frankfurt	Seoul	FRASEO	102	London	Dublin	LONDUB

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