CONFEREN CE PAPER

Market structure, regulation and performance in the airline industry

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1 Introduction

This paper reviews recent economic literature and presents key findings relating to the impact of market structure, regulation and various operating characteristics on airline performance. It also reviews key studies of the effects of airline alliances and applies an OECD model to assess the likely impact of the proposed Qantas and Air New Zealand Alliance.

The paper does not attempt a comprehensive review of the evolution of airline competition but rather highlights key findings useful to an assessment of the impact of the proposed Qantas–Air New Zealand alliance.

The paper is structured as follows. Section 2 provides background information on significant developments in the air passenger transportation market, particularly market liberalisation. Section 3 presents the results of studies investigating the existence of economies of scale and density in air passenger transportation markets. Section 4 explores how airline deregulation, market structure and various airline operating characteristics have impacted on airline performance. Section 5 considers available evidence of the impact of airline alliances on airline efficiency. Section 6 summarises the results of an OECD study of the impact of changes in regulation and market structure on airline performance. It applies the model used in that study to assess the likely impacts of the proposed Qantas–Air New Zealand alliance. Concluding remarks are made in Section 7.
2 Airline market liberalisation and other industry trends

Prior to recent liberalisation, the global airline industry was heavily regulated\(^1\). Prices, entry and routes were all regulated. The regulation of inter-country air transportation was governed by a maze of bilateral and multilateral agreements between governments and air carriers. Air services agreements controlled market access (points served and traffic rights), designation of airlines authorised to operate and in some cases capacity and frequencies. Fares were controlled by the International Air Transport Association (IATA) system for setting tariffs and by inter-airline pooling agreements. Although there has been substantial liberalisation within the US, the European Union and in other countries over the last three decades, there are still restrictions on international market access governed by various bilateral air service agreements.

In the US the transition to a deregulated domestic environment began around 1976 through various administrative measures that relaxed regulatory constraints and in October 1978 the Airline Deregulation Act was passed. After 1977 and particularly in the early 1980s the United States began to renegotiate more open and less restrictive bilateral air services agreements with other countries. In other parts of the world governments allowed new domestic and international airlines to enter and compete with established national carriers.

From about 1992 the US intensified its efforts to renegotiate a series of more open bilateral air service agreements. The new bilateral agreements also allowed code sharing and other co-operative arrangements in relation to blocked space or leasing which would otherwise have been precluded by anti-trust provisions. However ownership restrictions remained. Airlines designated by each state had to be substantially owned and effectively controlled by nationals of that state.

In Europe liberalisation occurred in three packages. In the first package, announced in December 1987, there was some limited liberalisation of fares, capacity and entry. The second package in June 1990 further liberalised fares, capacity and entry. The third package of measures came into force in January 1993. It ensured open and unrestricted market access to any routes within the European Union for airlines from any member State and removed all capacity controls and virtually all price controls. Ownership constraints were relaxed such that airlines with unlimited access rights could be owned by nationals or companies from any of the member States. In parallel with the third package of measures, the European Commission has taken measures to ensure that the “competition rules” that

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apply to other industries also apply to airlines. Restrictions have also been introduced in
relation to state aid for airlines.

As a result of liberalisation there is much less control of capacity, price and frequency on
many routes and several new international airlines have emerged. The real value of airline
yields has declined reflecting lower fares and the growth of the discount airline and falling
unit costs.

An important regulatory constraint that still exists (except for within the European Union)²
is that the various bilateral air services agreements, including the newer ‘open skies’
agreements require the airlines designated by each of the two states, that are parties to the
bilateral agreement, to be ‘substantially owned’ and ‘effectively controlled’ by nationals of
the designating state.

It is also the case that the ‘seventh freedom’ (the right of an airline to operate flights
between two other states without the flight originating or terminating in its own state) is
rare outside the European Union. The fifth freedom (the right of an airline to carry traffic
between two other states provided the flight originates or terminates in its own state) is
also often restricted. In addition cabotage restrictions (the right of an airline of one state to
carry traffic between two points in another state) are still widespread.

In the mid-1980s privatisation of state owned airlines also became an important new
development. However as of early 2000 over 70 international airlines were still majority
government owned.³

In the wake of deregulation in the US, the airline industry became increasingly
concentrated. Similar developments have occurred in Europe. However new low cost
Value-Based Airlines have also emerged alongside the trend to consolidation of Full
Service Airlines.

Other key trends include: the development of hub and spoke networks, improvements in
technology, the growth of frequent flyer schemes, the role of computer reservation systems
and the proliferation of alliances.

The emergence of alliances between airlines reflects inter alia the incentives to achieve
economies of scope in marketing a more extensive network, and to achieve other
economies of traffic density together with incentives to overcome the restrictions on

² Note that although the third package effectively created a totally ‘open skies’ agreement within
the European Union, services to points outside the European Union are still governed by
bilateral air service agreements.

³ Doganis, op. cit. p. 186.
ownership that affect market access. However alliances can also entail a reduction in competition, especially on specific routes where there is no third carrier.

\[ \text{Note that deregulation has facilitated the growth of alliances but the ownership restrictions are likely to have restricted the form of alliances and in particular international mergers.} \]
3 Economies of scale and density

In assessing the extent to which market concentration and alliances may have adverse impacts on airline performance an important issue is the existence of economies of scale and economies of density. Economies of scale refer to the variation in unit costs with respect to proportional changes in both network size (points served) and level of output in the form of air transportation services. Economies of density refer to the variation in unit costs caused by increasing transportation services within a network of a given size.

Prior to deregulation the conventional wisdom was that there were approximately constant returns to scale for airline systems that have reached the size of US trunk carriers. It was accepted that there were probably some scale economies for smaller airlines to exploit. However early studies were relatively simple and did not isolate the importance of economies of density for which there has subsequently been considerable empirical support.

Following Caves, Christensen and Tretheway,⁵ economies of density can be formally defined as the proportional increase in output made possible by a proportional increase in inputs holding constant: number of airports served; average stage length; average load factor; and input price. Economies of overall scale refer to the proportional increase in output and points served made possible by a proportional increase in inputs holding constant: average stage length; average load factor; and input prices.

Returns to density can be defined as the inverse of the elasticity of cost with respect to output and returns to scale as the inverse of the sum of the elasticities of total cost with respect to output and points served as follows:

\[ RTD = \frac{1}{\varepsilon_y} \]
\[ RTS = \frac{1}{\varepsilon_y + \varepsilon_p} \]

where \( \varepsilon_y \) is the elasticity of total cost with respect to output and \( \varepsilon_p \) is the elasticity of total cost with respect to points served.

Some aspects of economies of density have been interpreted as a form of economies of scope. They can be reflected in economies of marketing as traffic density increases and also in various savings associated with higher traffic through the use of hub and spoke

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networks. Economies of density can arise by allowing airlines to add more flights, larger planes and denser seat configurations. Hub and spoke networks have had the effect of increasing traffic on each sector flown thereby leading to economies of density. Hubbing facilitates the consolidation of traffic from many different origin-destination markets onto a smaller number of links in the network. Hubbing makes it easier to carry on a single spoke passengers with the same origin but different destinations or passengers with different origins but the same destination.\(^6\)

The empirical literature also supports an inverse relationship between unit cost and average stage length and between unit cost and average load factor. The greater use of hub and spoke networks would have most likely led to increased average load but may have reduced average stage length.

### 3.1 Empirical evidence of economies of scale and density

Because the early studies of scale effects were undertaken prior to deregulation it is possible that they did not capture the economies of density that were subsequently realised as routes were deregulated. Also, as noted by Caves et al,\(^7\) casual comparison of smaller airlines might lead one to conclude that there is scope to exploit scale economies. However their study showed that for local airlines increased scale would not lead to lower costs, but increased traffic density and stage length would significantly reduce costs.

Caves et al\(^8\) investigated economies of density and economies of scale based on a panel data set for the years 1970 through 1981 comprising all trunk and local service airlines in the United States. There were 15 airlines in the sample for the full period and six additional airlines for shorter periods.

They estimated a translog cost function, controlled for average stage length and average load factor and used the number of points (airports) served as an indicator of the size of the airline network.

Key results were as follows:

- Returns to density were statistically significant and economically large. Returns to density are 1.24 at the sample mean in a total cost function and 1.18 in a variable cost function (that treats capital as fixed input).
- Approximately constant overall returns to scale were confirmed.

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\(^7\) Caves, Christensen and Tretheway, op. cit. p. 483.

\(^8\) Caves, Christensen and Tretheway, op. cit.
Baltagi, Griffin and Rich\textsuperscript{9} analysed cost changes in the US airline industry for the domestic operations of 24 trunk and local airlines for the period 1971–1986. They estimated a translog variable cost function that included stage length and number of points served as route characteristics. They also tested for improvements in fuel efficiency in aircraft airframe and engine design.

They estimated a general measure of technical change from the restrictions imposed in their cost function and then isolated the impact of factors likely to affect the measure of technical change. These factors included fuel efficiency, load factors, a measure of hubbing defined as departures from the airline’s three most active airports divided by the airline’s total departures, and a merger variable defined as the proportion of industry output subject to mergers in that year.

Key results were as follows:

- There was evidence of returns to density, particularly in the post deregulation period, but not returns to scale.
- The measure of pure technical change declined from 4.6 for 1971–78 to 3.4\% for 1987–86.
- Aircraft quality changes as reflected in the fuel efficiency measure were critical to explaining the long term trend growth in technical change, accounting for 1.37\% of the 3.95\% increase in pure technical change, and to explaining the reduced rate of technical change in the post-deregulation period.
- Secular improvements in load factor accounted for 0.97\% of the improvement in pure technical change of 3.95\% but load factor declines also contributed to the slow down in productivity growth in the post-deregulation era.
- Hubbing played a minor role in the pre-deregulation era but a major one in the post deregulation era, accounting for 2.03\% of the 3.37\% increase in technical change over the 1978–86 period. Note that the hubbing measure captured the direct effect on the estimate of technical change apart from (i.e. additional to) the separate estimate of economies of density from the cost function.
- Mergers captured short term inefficiency effects but were not important for explaining secular trends in technical change.
- Trunk airlines experienced 9.7\% lower costs due to deregulation. Increased hubbing was the most important factor.
- Non-trunk airlines experienced 19.9\% lower costs due to deregulation. Hubbing was again the most important factor in reducing costs.

Kumbjakar\textsuperscript{10} also investigated returns to scale, returns to density and technical change in US airlines for a panel of 31 trunk and local service airlines for the period 1970–84. He estimated a system of input demand functions consistent with a form of a Symmetric Generalised McFadden cost function to overcome violations of concavity assumptions in earlier studies. He incorporated average stage length, average load factor and points served into the cost function.

Key results were as follows:

• Returns to density were statistically significant and declined from 1.37 prior to deregulation to 1.20 after deregulation.
• Returns to scale were also statistically significant and declined from 1.23 prior to deregulation to 1.09 after deregulation.
• Neither the trunk nor the local airlines had fully exhausted returns to density or returns to scale and the local carriers had similar economies of density and lower economies of scale than the trunks for the sample period as a whole.

Using more recent data for a panel of 12 European and 7 US airlines for the period 1982 to 1995 Ng and Seabright\textsuperscript{11} estimated a translog cost function that incorporated the key operating characteristics of stage length, load factor and network size (number of city pair routes served) and also the potential influence of market power and state ownership.

Key results for returns scale and density were as follows:

• Returns to density were estimated to be 1.19 and returns to scale (after allowing for network size effects) are estimated to be 1.08. Second order terms indicate that returns to scale were exhausted at higher levels of output.

### 3.2 Implications for airline performance

There is a body of empirical evidence that supports the view that there are significant economies of density in air passenger transport markets. There has been less agreement across the studies reviewed for this paper on the existence of economies of scale.

Ceteris Paribus, these studies suggest that airline carriers are able to reduce unit production costs and improve measured performance by increasing network density and possibly by increasing scale.


4 Deregulation, competition and privatisation

This section briefly reviews a number of prominent studies that attempt to quantify the impact on airline performance of liberalisation of airline regulations, measures of competition, and government ownership while taking account of different operating and environmental characteristics.

4.1 Studies making broad inferences about the impact of deregulation on airline performance

Oum and Yu\textsuperscript{12} investigated the cost competitiveness of 22 major international airlines in North America, Europe and Asia for the period 1986 to 1993. The study measured overall productivity using total factor productivity indexes and stochastic production functions and calculated efficiency measures after adjusting for key factors beyond an airline’s control (specifically stage length and output mix). The study also estimated a translog variable cost function and decomposed costs into various sources including size, output mix, input prices, operating characteristics, time effects and residual efficiency. The study also reviewed general trends, changes in regulatory arrangements and yields, and financial performance.

Oum and Yu draw inferences about the impact of deregulation simply by comparing productivity growth differences between regions and informally associating differences to some liberalisation of regulatory arrangements.

Oum and Yu showed that US carriers were more efficient than European carriers and Asian carriers and that both European carriers and Asian carriers closed the efficiency gap with the US in the sample period. But the study had nothing to say about the intensity of competition in the US in the sample period and it did not isolate the impact of specific regulatory and competition variables in any of the regions.

It should also be recognised that Oum and Yu did not specifically correct residual Total Factor Productivity (TFP) or their cost competitiveness measure for hubbing, load factor, points served and aircraft airframe and engine fuel efficiency improvements. As suggested by the general findings in the literature, such corrections could narrow the advantage of US airlines relative to non-US airlines, particularly for hubbing.

Oum and Yu also found that majority government ownership had a significant negative impact on the productive efficiency of an airline.\textsuperscript{13} However no attempt was made to isolate developments in relation to government ownership from regulatory developments.

Distexhe and Perelman\textsuperscript{14} analysed a panel of 33 airlines from Asia and Oceania, Europe and the US over the period 1977 to 1988. They used Data Envelopment Analysis to construct a Malmquist index of productivity. A Malmquist index of productivity can be used to disaggregate changes in productivity due either to technological progress generally or efficiency change for a particular firm or to the influence of output and input attribute variables. The output variable was transportation capacity in tons-kilometre. The inputs were labour and aircraft. They also investigated two variables representative of output and input attributes. These were average weight load factor as a measure of market performance and the average number of aircraft departures per 100,000 km (the inverse of average stage length which they interpret as a measure of route network density) as an input variable.

Key results were as follows:

• Regardless of the approach used, the average levels of technical efficiency reached in the eighties were higher than those obtained in the late seventies. The authors suggest this can be associated with a more competitive environment.

• The convergence towards efficiency was the most significant among the Far East/Pacific airlines. The authors suggest that this phenomenon must be interpreted as a catching up effect similar to what has occurred in other industrial activities.

• European carriers were on average technically less efficient than other carriers but some major carriers reached high levels of efficiency. The authors suggested this may be related to the slow evolution of airline deregulation in Europe.

• Among the US carriers no clear cut results emerged in relation to exploiting the attributes except for the high positive scores attained by Continental, Pan Am and TWA in the 1983–85 period which the authors attributed most probably to the result of mergers.

• With minor exceptions, only the airlines operating on a worldwide scale were able to take maximum advantage of technological progress. Such airlines were also successful in removing inefficiencies as were some smaller airlines.

\textsuperscript{13} Ibid, p. 114.

4.2 Studies isolating the impact of market structure and government ownership on airline performance

Ng and Seabright\(^{15}\) have noted that it has been hard to find convincing empirical answers to the question of whether competition has significant effects on productive as well as allocative efficiency.

Does competition have significant effects on productive as well as allocative efficiency? Convincing empirical answers to this question have been hard to find for two reasons. First, data of the quality required for robust estimation of productive efficiency are rarely available. Secondly there is frequently no convincing standard against which the efficiency of an industry or firm may be compared, since when the degree of competition varies many other things (such as technology, network structures and firm sizes) typically vary as well. These problems do not automatically make comparison impossible but they compound the need for high quality data.

However they suggested that the relatively high quality of data available in the airline industry and the deregulation that occurred in the United States in 1978 facilitate assessment of the effects of deregulation.

Their study estimated an airline translog cost function that takes account of the key operating characteristics of stage length, load factor and network size (number of city pair routes served) and also incorporates the potential influence of market power and state ownership. Their study also investigated the impact of market power and operating characteristics on labour rent and the subsequent effect on costs. Labour rent was treated as endogenous but competitive, market based wages were treated as exogenous. Their study was based on a panel of 12 European and 7 US airlines for the period 1982 to 1995.

Two measures of market power were calculated. One was the weighted average market share of each carrier in the international routes in which it operates. The second was the proportion of such routes in which there are at most two carriers.

Key results were as follows:

- Stage length, load factor and network size all had the expected signs and are significant.
- Returns to density were estimated to be 1.19 and returns to scale (after allowing for network size effects) were estimated to be 1.08. Second order terms indicated that returns to scale were exhausted at higher levels of output.
- The market structure variables were significant but had the opposite sign. A 1 percentage point increase in market share of a carrier implied about a 3% reduction in

total costs while a 1 percentage point increase in the proportion of the carrier’s routes served by at most two carriers (holding market share of the carrier constant) implied an increase in total costs of about 2 percentage points.

- The market structure results were not robust to alternative specifications. For example, with the introduction of a lagged dependent variable, the coefficients on both the market structure variables fell to about a quarter of their previous levels and ceased to be statistically significant.
- The public ownership variable was statistically significant and economically important and robust to alternative specifications. In the static model an increase in the share of public ownership by 10 percentage points implied a 10% increase in rents and a 6.5% increase in total costs.
- A dummy variable representing the impact on each airline of the first European Union liberalisation package in 1987 showed no significant effect across the sample.
- When differences in output and network sizes, operating characteristics, ownership and competitive structure were all controlled for, European carriers costs were on average 35% above what they might be under US conditions in 1990 falling to 16% in 1995.

Ng and Seabright concluded as follows\(^\text{16}\):

What have we learned from these data? First, the basic cost function is reassuringly well estimated, with the coefficients on output, factor prices and route characteristics in line with those predicted by theory and prior studies. Secondly state ownership has a large upward impact on costs. The effect of competition is harder to disentangle, though openness of routes to competition from third airlines appears to have an overall downward impact on rents and costs, while merely losing market share to existing competitors has the opposite effect.

Baltagi, Griffin and Rich\(^\text{17}\) examined the same data set as in their earlier study (described above in Section 3) to contrast the estimates from a multilateral TFP approach with a measure of technical change estimated from a cost function and to explore the impacts of fuel efficiency, operating characteristics, route structure, competition and unionisation of workers. The measure of competition was the inverse of a Herfindahl Index for each of the largest 230 domestic city pair markets weighted by the relative importance of each market to each firm.

Key results (after controlling for output effects)\(^\text{18}\) were as follows:

\(^{16}\) Ibid, p. 615.


\(^{18}\) Including economies of density and stage length.
• Technical improvements in fuel efficiency and variations in load factor were found to be highly significant in explaining both TFP and the technical cost efficiency index (TCI).

• Hubbing was marginally significant in explaining TCI but not significant in explaining TFP.

• The merger variable (which reflects temporary inefficiency effects) was insignificant in explaining both measures.

• The measure of competition was not statistically significant in explaining TFP and marginally significant in explaining TCI. Although the significance varied across airlines such that at the extreme competition could account for up to a 5% differential in airline efficiency.

• Unionisation was found to be significant in explaining TFP but not significant in explaining TCI but to have a positive influence in both cases (which could be consistent with a higher labour quality interpretation or a rent seeking explanation of unions targeting high efficiency airlines).

Windle19 analysed efficiency differences for 27 non-US and 14 US airlines in 1983. He used the cost function results from an earlier study by Caves et al (1987)20 to decompose costs into effects associated with input prices, output, capital stock, stage length, load factor, points served, government ownership, time and firm-specific effects.

Key results were as follows:

• Unit cost differentials between US and non-US airlines were largely accounted for by two factors: labour price and traffic density. The US mean firm had 51.9% higher unit costs because of higher labour prices but 49.7% lower costs as a result of higher traffic density. Overall unit costs for the US were 4% higher than for non-US firms.

• The East Asian mean firm had a 22.4% cost advantage over the US mean firm reflecting a substantially lower factor price advantage and a relatively low traffic density disadvantage relative to the US mean firm.

• The next most important factor was government ownership, leading to US firms having an 8.8% cost advantage over non-US firms and a 10.5% cost advantage over European firms.


Windle summed up the implications of his findings as follows:

The above analysis indicates that movements towards greater competition in the form of liberal bilaterals and privatisation can lead to some improvements in productivity, but the greatest improvements in productivity will come from deregulation that enables air carriers to increase their traffic density. Many policies that will improve traffic density are not likely to be popular, particularly merger and failure of firms. It is therefore unlikely that the present deregulatory movement will entirely close the productivity gap. However any deregulation that allows pricing and route freedom will be likely to increase traffic density and productivity.  

Liu investigated the effect of state ownership on efficiency of firms by estimating a shadow cost function and associated input demand functions that allow for the separation of technical and allocative efficiency in a dynamic setting. He used data on 23 international airlines, with varying state ownership, for the period 1973–83 and allowed for the influence of average stage length, number of airports served and load factor. Dummy variables were used to test for the effects of deregulation.

The key findings were as follows:

- Allocative inefficiency was present in all firms and worsened with state ownership. But the effect of State ownership on allocative inefficiency was only a level effect raising the level of costs relative to private firms for fully state owned airlines by 5.4%.
- State ownership reduced the rate of cost decline associated with technical efficiency for fully state owned airlines by as much as 1.1%.
- Deregulation had no impact on technical and allocative efficiency.

In contrast to the general findings in the literature, in a study focussing on the performance of 17 European airlines over the period 1991–95, Fethi, Jackson and Weyman-Jones found that government ownership was not associated with lower efficiency. They estimated a measure of technical efficiency using data envelopment analysis and then estimated the relationship between efficiency and various environmental and operating characteristics using a Tobit model. The key findings were as follows:

- A dummy variable that related to when alliances were in operation indicated an adverse effect on efficiency.
- State ownership was not associated with lower efficiency.

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21 Ibid, p. 47.
• Subsidies to airlines implied lower efficiency.
• A dummy for the third airline liberalisation package in Europe indicated positive effects.
• In terms of marginal effects load factor was the most important variable.

One issue with this study is that scale effects were not explicitly allowed for and that density effects were only recognised in the load factor variable. In a subsequent study using the same data set Fethi et al.\textsuperscript{24} used the technique of stochastic data envelopment analysis and were unable to find a strong relation between ownership and technical efficiency. However they did find a relationship between inefficiency and smallness of fleet size and suggested further work on scale effects was required.

\textsuperscript{24} Fethi, M. D., P. M. Jackson and T. G. Weyman-Jones 2001, ‘European Airlines: a Stochastic DEA study of efficiency with market liberalisation’, Management Centre University of Leicester and Department of Economics, Loughborough University
5 The impact of airline alliances on airline efficiency

As evidenced in the discussion below, the economic literature generally finds that airline alliances generate substantial costs savings through the exploitation of economies of density and route rationalisation, and sharing of a wide range of production inputs. Importantly, these cost savings have generally been sufficiently large to offset any impact of increased market power on prices.

The subsections below provide an overview of the literature on the effects of alliances, a summary of theoretical alliance models and their implications for airline efficiency, and evidence from empirical studies of the effects of airline alliances on airline efficiency.

5.1 Overview of the literature on the impact of airline alliances on airline efficiency

As explained by Oum, Park and Zhang\(^\text{25}\) the literature on airline alliances has identified two broad categories of advantages to firms from alliances:

(a) Improved operational efficiency or productivity; and
(b) Enhanced competitive position through strategic behaviour and market power.

Both of these can improve profitability but from a public welfare perspective the issue is the extent to which enhanced market power is sufficiently detrimental to lead to a net public detriment.

A good starting point in assessing alliances is the economic reasons as to why airlines are motivated to form alliances. It should be recognised that in a completely open international aviation market one would expect that many alliances would be replaced by mergers and acquisitions. However this continues to be effectively precluded by a host of bilateral air service agreements and associated foreign ownership rules that effectively hinder cross-border mergers and acquisitions.

The same underlying economic forces are likely to be relevant for both alliances and mergers of airlines. The main reasons for forming alliances have been identified as follows\(^\text{26}\):


(1) The realisation of economies of traffic density reflected in securing more traffic per unit of capital. This can be reflected in better utilisation of aircraft and other assets and the use of larger aircraft. An important channel for increasing traffic density is increased traffic feed as each partner feeds traffic to the other.

(2) A range of opportunities to share the costs of airline facilities and staff leading to better utilisation of all factors of production; for example through route co-ordination and rationalisation; joint purchases of inputs and joint development of systems; or the greater use of the lower cost inputs of one partner e.g. lower labour costs of one partner relative to the other.

(3) Marketing benefits that are related to the sharing of costs (largely in the form of economies of scope that relate to a more extensive network) but also to the greater attraction of frequent flyer programs that become more valuable to passengers when they have more choice.

(4) Alliances entail multiple and priority listing of code shared flights in computer reservation systems enhancing the likelihood of bookings relative to competitors who are not part of an alliance. Code sharing effectively enables an airline to offer an additional airline service taking advantage of economies of scope. Note however, that concerns have been raised about the possible anti-competitive crowding out effect of computer reservation systems.

(5) Scope to improve quality through greater flight frequency, more seamless travel, more convenient connections and lower waiting times; all of which increase traffic and contribute to better realisation of economies of density as well.

(6) Greater prospect of improving competitiveness and securing traffic in wider international markets as the advantages of lower per unit cost, brand recognition and greater reach can be more effectively leveraged.

(7) Increased market power on particular routes. This can lead to higher prices and lower quality but depends on the productive efficiencies that are secured, entry barriers and broader competitive influences.

Alliance benefits are expected to rise as the depth of co-operation increases across the functions and assets of the alliance partners.

5.2 Theoretical alliance models and their implications for airline efficiency

Alliances can be classified into two types: complementary and parallel alliances. Complementary alliances refer to alliances where firms link up their networks so as to feed traffic to each other. Parallel alliances refer to alliances where firms have overlapping competing routes prior to the alliance. Most alliances will have aspects of both but can be characterised as predominantly complementary or predominantly parallel.

Where there are network complementarities an increase in traffic of one partner in the alliance increases the connection opportunities and marginal profit of the other partner. If an alliance entails joint profit maximisation this network complementarity externality is internalised. This effect tends to increase the output and profits of a complementary alliance relative to a competitor.27 A complementary alliance improves the quality of connection and this can increase the demand for the services of the alliance by both taking market share from rival airlines and increasing the overall size of the market which in turn leads to overall welfare improvements.

In contrast for parallel alliances, economic models tend to show a reduction in output of the alliance in overlapping markets but can entail an increase in output of the alliance in connecting markets (reflecting network complementarities). For a parallel alliance overall output is generally expected to be lower. There are however qualifications to these results, especially when market size and economies of density are taken into account. In particular Park’s model suggests that parallel alliances may make society better off if the size of the market is sufficiently small but economies of traffic density are sufficiently high.28

Another channel through which airline alliances can lead to both welfare benefits and carrier benefits is through coordination of pricing29. In particular the co-ordination of pricing can eliminate the ‘double marginalisation’ problem, where each airline ignores the impact of its fares on the other airlines fares for interline products. The co-ordination of pricing can in turn lead to lower fares and increased traffic and when combined with the presence of economies of density can lead to further downward pressure on fares.

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A final theoretical result is that if economies of scale and imperfect competition are important, then horizontal merger of domestic firms enables them to earn greater profits in international markets.\(^\text{30}\) This result is similar to that in the trade literature where trade policy may be welfare enhancing when used as a form of export promotion if there are economies of scale and imperfect competition.

### 5.3 Empirical studies of the effects of airline alliances on airline efficiency

Oum, Park and Zhang\(^\text{31}\) have undertaken a comprehensive study of the effects of airline alliances. They studied a number of aspects of airline alliances, including: the impact on productivity, pricing and profitability distinguishing between the effects of major (co-operation at network levels) and minor alliances (co-operation at route levels), the impact on quality as reflected in flight frequency and delays, and the effect of alliances that tended to be of a more complementary or more parallel form.

Their key findings for a panel of 22 airlines over the 1986–95 period were as follows:

- A major strategic alliance was estimated to improve Total Factor Productivity (TFP) of the partner airlines by 4.9% and the effect was highly statistically significant. A minor strategic alliance was estimated to improve TFP by 0.9 but the effect was not statistically significant.

- A major strategic alliance was estimated to reduce average revenue yields by 5.5% and improve profitability by 1.3%, with both effects being statistically significant. The effects for minor strategic alliances were not statistically significant.

An important aspect of airline performance is the quality of service. There are various dimensions of quality including on time arrival, frequency of service, check in and in-flight service, safety and comfort. Oum, Park and Zhang noted the importance of scheduled delay time and the positive association with flight frequency in the airline literature. They examined three major alliances in North Atlantic markets:

- Northwest/KLM — a complementary alliance.
- United/Lufthansa — a mixture of a complementary and no shut down parallel alliance where frequencies were maintained on competing routes and networks were linked to feed traffic.
- Delta/Sabena/Swissair — a shut down parallel alliance where the partners were competitors before the alliance and only one partner continued to operate non-stop flights after the alliance.


They examined 13 alliance routes for these alliances for the period 1990–96. They found for both the complementary alliance and mixed alliance that the partner airlines linked their networks and either maintained or increased their flights on the alliance routes following the alliances, and this allowed reductions in the scheduled delay time. In contrast for the shut down parallel alliance the partners rationalised their operations on code-sharing routes and, although flight frequencies increased, scheduled delay time increased.

Oum, Park and Zhang also examine these alliances and an additional alliance, British Airways–US Air, such that their sample was 17 alliance routes for the period 1990–94. The key findings were:

- For a complementary alliance total traffic increased by an average of 11–17% following the alliance but for a parallel alliance decreased by an average of 11–15% following the alliance.
- For the complementary Northwest/KLM alliance and for the parallel Delta/Sabena/Swissair airfares declined by 22% and 19% respectively.
- In both the complementary and parallel alliances market power appeared to increase in gateway markets, following the alliances but the reduction in costs (through joint operations and traffic density effects) dominated, resulting in lower fares.

The benefits of alliances in terms of the co-ordination of pricing were examined by Brueckner who tested the proposition that the lowest interline fares will tend to be set by alliance partners with antitrust immunity while higher fares will be charged by carriers who lack antitrust immunity (in coordinating prices). Brueckner examined a sample of 54,687 observations in international city pair markets for the third quarter of 1999, where at least one route segment is flown on a US carrier and regressed fares on distance, market size, a competition variable, regional effects, fare category, airline-specific effects and cooperation measures. He found that presence of codesharing on an international airline itinerary reduces the fare from 8–17% and the presence of anti-trust immunity reduces the fare by 13–21% with the combined effect ranging from 17 to 30%, suggesting substantial benefits for interline airline passengers.

Bamberger, Carlton and Neumann reviewed the code share, price co-ordination and other benefits of alliances as well as potential anti-competitive effects and examined the effects on fares and traffic of the Continental/America West alliance and the Northwest/Alaska alliance. They investigated the competitive effects of these alliances.

using a series of “before-and-after” regression studies applied to city pairs. Their key findings were as follows:

- Both alliances provided substantial benefits to consumers with average fares falling for the respective alliances by 8.4% and 3.9% and found to be highly statistically significant. Traffic increases were statistically significant in one case but only marginally statistically significant in the other.

- The size of the fare effect depended on the pre-alliance level of competition on a city pair with the fare decline being larger on those city pairs where the level of competition was relatively low.

Bamberger, Carlton and Neumann drew the following conclusion: 34

Our empirical findings provide strong support for the view that domestic airline alliances benefit consumers and that anti-competitive concerns with such alliances are misplaced.

Finally in terms of the impact on international competitiveness Clougherty 35 examined a panel data set of 21 nations and associated international airline markets over the 1983–1992 period. He confirmed that higher domestic concentration led to improved international performance in terms of international market share, with the estimation taking account of the possibility of a reciprocal relationship.

34 Ibid, p.20.

6 The Gonenc and Nicoletti OECD study

An OECD study by Gonenc and Nicoletti\(^{36}\) examined the relationship between various measures of firm performance and indicators for regulatory arrangements and market structure, while controlling for certain operating and environmental variables.

Gonenc and Nicoletti examined data at both the national level and at the level of specific routes for 27 OECD countries for the period circa 1996–97. They developed 21 regulatory and market structure indicators at the country level and 23 similar indicators for 102 routes connecting 14 major international airports. They combined these individual indicators into summary measures of market structure and regulatory conditions to overcome potential multicollinearity problems, using the statistical technique of factor analysis.

The individual indicators included various measures of market concentration at both the domestic and international level many of which overlap, and various measures of airline liberalisation and government intervention. The individual indicators and summary measures were constructed in such a way that a lower value indicates a less concentrated market structure or more liberal regulatory arrangements.

Factor analysis is a technique for combining many correlated variables into a smaller number of unobserved dimensions or factors. A factor is a linear combination of variables with weights (or factor loadings) for the variables reflecting the extent of association with the factor and constructed in such a way that a factor is uncorrelated with other factors. The weights for each variable represent the proportion of the variance of each variable that is explained by the factor it is associated with. The factors contribute to explaining the overall variance in the data set and can be weighted according to their overall contribution to explaining the variance in the total data set. When they are combined in this way an overall synthetic measure can be constructed of all the variables.

Gonenc and Nicoletti used factor analysis to form two summary measures. One was described as the market environment and the other was described as the regulatory environment. They also combined these two summary measures into an overall summary measure described as the overall regulatory and market environment. These measures were then subsequently used in regression analysis of airline performance.

At the national level the efficiency of air travel was measured by two separate indicators. One was a measure of the efficiency of all factors of production, measured by means of

data envelopment analysis. This was calculated by specifying total passengers transported and total passenger-kilometres as outputs and total personnel, capacity, fleet, fuel and average stage length as inputs. The second measure of efficiency was the average aggregate load factor defined as a weighted average of carriers’ percentage share of seats occupied in total aircraft seat capacity on international routes. The measures of efficiency for the regressions were the distance from the efficiency frontier expressed as a percentage and the inverse of the load factor measure (which is interpreted as the average inoccupancy rate). Fares were not examined at the national level.

At the route level, the performance measures were average inoccupancy rates and business, standard economy and discount fares.

Gonenc and Nicoletti then estimated the relationship between these measures of performance, the summary indicators of market structure and regulatory arrangements and variables such as average aircraft size, average aircraft age and propensity to air travel. The analysis was undertaken at both the national level and at the route-specific level.

Table 1 presents the results of Gonenc and Nicoletti’s regressions at the country level and is a copy of Table 6 in their publication 37. The results in panel A for each regression model refer to regressions when an overall summary measure of the regulatory and market environment is used. The results in panel B for each regression model refer to regressions when separate regulatory and market environment summary measures are used.

The results shown in Table 1 indicate that the average aircraft size and the propensity to travel have a negative and statistically significant effect on the DEA measure of efficiency (distance from the efficient frontier). That is larger aircraft size or higher propensity to travel are both consistent with higher efficiency. This reflects the extent to which these variables are reasonable proxies of economies of density and other scale effects, which the economic literature has confirmed as important in explaining productive efficiency. The results shown in Table 1 also confirm that a less concentrated market structure and more liberal regulatory arrangements have a positive and significant statistical effect on the DEA measure of efficiency. The average aircraft age variable was not statistically significant and did not have the expected sign in the DEA regressions. The results for the inoccupancy regressions were similar but the statistical significance of several variables was marginal.

For the route level regressions Gonenc and Nicoletti found that government control over route carriers has a marginally statistically significant effect in explaining inoccupancy rates, that is, higher government control implies lower inoccupancy (a result which is in contrast to the general findings of the economic literature).

37 Ibid p. 36.
Table 1  Performance of the airline industry at the country level

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Distance of domestic industry from efficiency frontier (DEA measure)</th>
<th>Average inoccupancy rate on international routes served by domestic carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regressions</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Explanatory variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.53</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>3.77</td>
<td>3.71</td>
</tr>
<tr>
<td>Average aircraft size in fleet</td>
<td>-0.51</td>
<td>-0.51</td>
</tr>
<tr>
<td></td>
<td>-5.45</td>
<td>-5.32</td>
</tr>
<tr>
<td>Average aircraft age in fleet</td>
<td>-0.03</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>-0.29</td>
<td>-0.28</td>
</tr>
<tr>
<td>Propensity to air travel</td>
<td>-0.43</td>
<td>-0.43</td>
</tr>
<tr>
<td></td>
<td>-4.65</td>
<td>-4.11</td>
</tr>
<tr>
<td>Overall regulatory and market environment</td>
<td>0.53</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>5.18</td>
<td>2.78</td>
</tr>
<tr>
<td>Regulatory environment</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.08</td>
<td></td>
</tr>
<tr>
<td>Market Environment</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.25</td>
<td></td>
</tr>
</tbody>
</table>

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

Note the constant was not provided in Table 6 of Gonenc and Nicoletti but was derived given the data and the other parameter estimates (constant = actual dependent variable less forecast (excluding constant) averaged over all observations). t statistics are in italics.


NECG used the OECD regressions at the national level to predict the impact of the proposed Qantas-Air New Zealand Alliance in the factual scenario (that is, in the event the proposed Alliance goes ahead) and the counterfactual scenario (that is, in the event that the proposed Alliance does not proceed). The OECD data were obtained and an attempt was made to replicate the results in Table 1. It was possible to replicate the means and standard deviations of all the variables reported in Table 5 of Gonenc and Nicoletti and to also replicate the t statistics and other statistical measures as reported in their Table 6. However, it was not possible to replicate the size of the coefficients in their regressions, indicating that they may have scaled some data when estimating the regressions.

Table 2 contains the results of the re-estimated regressions. As can be seen by comparing with the results in Table 1, all the coefficients have the same sign as in Table 1 but are
generally numerically larger in the DEA regressions and smaller in the inoccupancy regressions.

### Table 2  NECG replication of regressions reported in Table 6 of Gonenc and Nicoletti

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Distance of domestic industry from efficiency frontier (DEA measure)</th>
<th>Average inoccupancy rate on international routes served by domestic carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regressions</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td><strong>Explanatory variable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.69</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>3.07</td>
<td>2.82</td>
</tr>
<tr>
<td>Average aircraft size in fleet</td>
<td>-0.92</td>
<td>-0.92</td>
</tr>
<tr>
<td></td>
<td>-5.45</td>
<td>-5.32</td>
</tr>
<tr>
<td>Average aircraft age in fleet</td>
<td>-0.05</td>
<td>-0.05</td>
</tr>
<tr>
<td></td>
<td>-0.29</td>
<td>-0.27</td>
</tr>
<tr>
<td>Propensity to air travel</td>
<td>-0.53</td>
<td>-0.53</td>
</tr>
<tr>
<td></td>
<td>-4.65</td>
<td>-4.11</td>
</tr>
<tr>
<td>Overall regulatory and market environment</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>Regulatory environment</td>
<td></td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>2.08</td>
<td></td>
</tr>
<tr>
<td>Market Environment</td>
<td>0.35</td>
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</tr>
<tr>
<td></td>
<td>3.24</td>
<td></td>
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</tbody>
</table>

**Statistics:**

<table>
<thead>
<tr>
<th></th>
<th>Observations</th>
<th>Degrees of freedom</th>
<th>R²</th>
<th>Adj. R²</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27</td>
<td>22</td>
<td>0.83</td>
<td>0.79</td>
<td>26.12</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>21</td>
<td>0.83</td>
<td>0.79</td>
<td>19.95</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>22</td>
<td>0.48</td>
<td>0.38</td>
<td>5.03</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>21</td>
<td>0.48</td>
<td>0.36</td>
<td>3.89</td>
</tr>
</tbody>
</table>

Note: Calculated using Eviews 4.1. *t statistics are in italics.*

Source: NECG estimates based on Gonenc and Nicoletti (2000).

Preferred regressions for forecasting purposes were obtained by progressively removing variables from the equations that were not statistically significant at the 5% level of significance and adjusting for heteroscedasticity where necessary. This entailed the dropping of the aircraft age variable in all the regressions and regulatory environment variable in the inoccupancy regression B. Results for the preferred regressions for forecasting are presented in Table 3. Log likelihood ratio tests indicated that regression B was the preferred regression for both the DEA and inoccupancy regressions.
Table 3: NECG replication of regressions reported in Table 6 of Gonenc and Nicoletti, with correction for heteroscedasticity and omission of insignificant variables

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Distance of domestic industry from efficiency frontier (DEA measure)</th>
<th>Average inoccupancy rate on international routes served by domestic carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regressions</td>
<td>A</td>
<td>B₁</td>
</tr>
<tr>
<td>Explanatory variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.64</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>4.11</td>
<td>3.32</td>
</tr>
<tr>
<td>Average aircraft size in fleet</td>
<td>-0.92</td>
<td>-0.92</td>
</tr>
<tr>
<td></td>
<td>-5.59</td>
<td>-5.19</td>
</tr>
<tr>
<td>Average aircraft age in fleet</td>
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<td>0.0</td>
</tr>
<tr>
<td>Propensity to air travel</td>
<td>-0.52</td>
<td>-0.52</td>
</tr>
<tr>
<td></td>
<td>-4.76</td>
<td>-5.66</td>
</tr>
<tr>
<td>Overall regulatory and market environment</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>5.98</td>
<td></td>
</tr>
<tr>
<td>Regulatory environment</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.15</td>
<td></td>
</tr>
<tr>
<td>Market Environment</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.30</td>
<td></td>
</tr>
</tbody>
</table>

Statistics:
- Observations: 27
- Degrees of freedom: 23
- R²: 0.83
- Adj. R²: 0.80
- F: 36.25

Note: Calculated using Eviews 4.1. t statistics are in italics.
1 Has White’s Heteroskedastic corrected standard errors.
Source: NECG estimates based on Gonenc and Nicoletti (2000).

The regression equations were used to predict the impact of the Alliance on the efficiency measures in the regressions. This required estimation of the independent variables in the equations including the calculation of the summary market and regulatory environment variables. Table 4 presents the summary measures for the factual and the counterfactual scenarios prepared by NECG, using the weights obtained from the factor analysis results reported by the OECD.

Note both the regulatory environment and market environment measures as constructed in accordance with the OECD methodology are both higher in the factual scenario than the counterfactual scenario. This largely reflects the influence of market structure variables on both measures. This is because the regulatory environment measure is a combination of two factors described by Gonenc and Nicoletti as entrenchment of a flag carrier and openness of international regulations and both of these will also contain some element of
all the measures in the data set. The reduction in government ownership implied by the proposed Alliance was captured in one of the regulatory variables but this effect by itself was more than offset by changes in other variables.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Regulatory and market environment measures in the factual and the counterfactual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1997</td>
</tr>
<tr>
<td>Overall regulatory and market environment</td>
<td>0.57</td>
</tr>
<tr>
<td>Regulatory environment</td>
<td>0.42</td>
</tr>
<tr>
<td>Market environment</td>
<td>0.36</td>
</tr>
</tbody>
</table>

Source: NECG estimates based on Gonenc and Nicoletti (2000).

Table 5 contains NECG’s forecasts and confidence intervals based on the OECD coefficients from Table 1. Table 6 contains NECG’s forecasts and confidence intervals based on the preferred regressions in Table 3.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>NECG forecasts and confidence intervals based on OECD regression coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>DEA RegA</td>
<td></td>
</tr>
<tr>
<td>OECD 1997</td>
<td>0.055</td>
</tr>
<tr>
<td>Actual 2002</td>
<td>0.189</td>
</tr>
<tr>
<td>Factual</td>
<td>0.010</td>
</tr>
<tr>
<td>Counter factual</td>
<td>-0.039</td>
</tr>
<tr>
<td>RegB OECD 1997</td>
<td>-0.053</td>
</tr>
<tr>
<td>Actual 2002</td>
<td>0.075</td>
</tr>
<tr>
<td>Factual</td>
<td>-0.103</td>
</tr>
<tr>
<td>Counter factual</td>
<td>-0.143</td>
</tr>
<tr>
<td>Inoccupancy RegA</td>
<td></td>
</tr>
<tr>
<td>OECD 1997</td>
<td>0.625</td>
</tr>
<tr>
<td>Actual 2002</td>
<td>0.691</td>
</tr>
<tr>
<td>Factual</td>
<td>0.580</td>
</tr>
<tr>
<td>Counter factual</td>
<td>0.533</td>
</tr>
<tr>
<td>RegB OECD 1997</td>
<td>0.665</td>
</tr>
<tr>
<td>Actual 2002</td>
<td>0.715</td>
</tr>
<tr>
<td>Factual</td>
<td>0.599</td>
</tr>
<tr>
<td>Counter factual</td>
<td>0.559</td>
</tr>
</tbody>
</table>

Source: NECG estimates based on Gonenc and Nicoletti (2000).
Table 6  **NECG forecasts and confidence intervals based on replication of OECD regressions, with correction for heteroscedasticity and omission of insignificant variables**

<table>
<thead>
<tr>
<th></th>
<th>Lower</th>
<th>Point estimate</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RegA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OECD 1997</td>
<td>-0.028</td>
<td>0.023</td>
<td>0.074</td>
</tr>
<tr>
<td>Actual 2002</td>
<td>0.190</td>
<td>0.232</td>
<td>0.275</td>
</tr>
<tr>
<td>Factual</td>
<td>-0.092</td>
<td>-0.035</td>
<td>0.022</td>
</tr>
<tr>
<td>Counter factual</td>
<td>-0.165</td>
<td>-0.109</td>
<td>-0.053</td>
</tr>
<tr>
<td><strong>RegB</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OECD 1997</td>
<td>-0.168</td>
<td>-0.116</td>
<td>-0.065</td>
</tr>
<tr>
<td>Actual 2002</td>
<td>0.072</td>
<td>0.121</td>
<td>0.170</td>
</tr>
<tr>
<td>Factual</td>
<td>-0.215</td>
<td>-0.150</td>
<td>-0.086</td>
</tr>
<tr>
<td>Counter factual</td>
<td>-0.258</td>
<td>-0.196</td>
<td>-0.133</td>
</tr>
<tr>
<td><strong>Inoccupancy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RegA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OECD 1997</td>
<td>0.737</td>
<td>0.752</td>
<td>0.767</td>
</tr>
<tr>
<td>Actual 2002</td>
<td>0.783</td>
<td>0.796</td>
<td>0.810</td>
</tr>
<tr>
<td>Factual</td>
<td>0.721</td>
<td>0.738</td>
<td>0.755</td>
</tr>
<tr>
<td>Counter factual</td>
<td>0.700</td>
<td>0.717</td>
<td>0.733</td>
</tr>
<tr>
<td><strong>RegB</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OECD 1997</td>
<td>0.702</td>
<td>0.716</td>
<td>0.731</td>
</tr>
<tr>
<td>Actual 2002</td>
<td>0.731</td>
<td>0.745</td>
<td>0.759</td>
</tr>
<tr>
<td>Factual</td>
<td>0.664</td>
<td>0.681</td>
<td>0.697</td>
</tr>
<tr>
<td>Counter factual</td>
<td>0.651</td>
<td>0.668</td>
<td>0.684</td>
</tr>
</tbody>
</table>

Source: NECG estimates based on Gonenc and Nicoletti (2000).

The confidence interval estimate of the forecast has the interpretation (for the specified level of confidence) that under repeated sampling such intervals will contain the true value of the forecast estimate with a probability consistent with the level of confidence that has been specified. The intervals in Tables 5 and 6 have been constructed at the 95% level of confidence. Thus under repeated sampling on average the estimated intervals will enclose the true population estimate with a 95% probability.

The interval estimates were calculated for the 1997 data in the OECD study, for the actual situation circa 2002, and for the factual and counterfactual scenarios. Given the definition of the dependent variable, a smaller value indicates a higher level of efficiency for both the DEA measure and the inoccupancy rate. Strictly speaking an estimate of 0 for the DEA measure indicates that the estimate is on the DEA efficiency frontier. It is possible to forecast a negative DEA measure as the forecasts are not constrained to be non-zero. A
larger negative DEA estimate has the intuitive interpretation of a higher level of efficiency given changes in explanatory variables.

An important feature of the results is that there is an apparent deterioration in efficiency between 1997 and the actual current situation, implied by the regression forecasts for all equations. However this deterioration is reversed in both the factual and counterfactual scenarios in all regressions. These observations apply to the forecasts using the OECD equations (Table 5) and the revised equations (Table 6).

Generally the results indicate a higher level of efficiency in the counterfactual compared to the factual. However an important finding is that in most cases the confidence intervals overlap substantially for the factual and counterfactual scenarios, implying in such cases that there is likely to be a low level of confidence that the forecast estimates are significantly different in a statistical sense. The overlap is particularly noticeable in regression B for both the DEA and inoccupancy regressions in both Tables 5 and 6.
7 Conclusion

The economic literature finds that economies of density, stage length, load factors, improvements in airframe and engine efficiency and government ownership are all important factors in explaining airline efficiency. Some of these factors have been affected by deregulation, for example the scope to realise economies of density as a result of the restructuring of routes and bilateral agreements.

It is notable that several prominent studies find that the extent of government ownership has a substantial adverse impact on productive efficiency, while greater competition, as reflected in market structure measures, has weak, ambiguous or negative effects on productive efficiency. However the results for these factors are not unequivocal with some studies finding that government ownership is not necessarily adverse for airline efficiency and that a more concentrated market has adverse impacts on airline efficiency.

A general finding of the literature is that the exploitation of economies of density and the realisation of cost savings from route rationalisation and sharing of a wide range of production inputs have been important features of airline alliances.

Some studies find that in predominantly parallel alliances (where prior to the alliance the partner airlines competed) total traffic has declined and in some cases scheduled delay time has increased. However the review of airline alliances also finds that the extent of cost savings and/or productivity improvements depends on whether the alliance entails major co-operation such that the networks of the partner airlines are substantially integrated. This increases the scope for realising complementary network benefits through increased traffic feed, to co-ordinate operations, avoid double marginalisation in pricing and realise various cost savings. Thus the extent of any adverse effects in terms of for example lower flight frequency depends on the extent to which there are complementary-type benefits to the alliance from increasing traffic feed. Finally the extent to which prices are likely to rise or whether they will rise at all depends on the scale of cost efficiencies that can be achieved. Generally the evidence is that prices decline on routes affected by alliances, including parallel alliances, reflecting the cost savings that can be realised.

Collectively it is considered that the economic literature provides persuasive evidence that generally alliances will enhance productivity performance and that the effects will be sufficiently strong to more than offset the influence of increased market power on prices.