Estimating the Net Welfare Gains from Australian Domestic Aviation Reforms

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Abstract:

The Australian aviation industry is undergoing dramatic changes as a result of the Government's micro-economic reforms. The impact of these reforms on air fares is readily apparent, but what is the total picture? What have been the net changes to economic welfare as a result of the reforms? To answer this question we go beyond the readily observable phenomena and build a simulation model which adopts a consistent accounting framework and compares actual events with what would have happened if there had been no reform. Using this counterfactual approach we estimate the welfare gains and losses from air fare reductions, industry productivity improvements, and changes in the time dependent aspects of service quality.

The views expressed in this paper are those of the authors, and do not necessarily represent those of the Bureau of Transport and Communications Economics.

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Introduction

This study is undertaken against the background of an Australian aviation industry undergoing immense change as a result of micro-economic reform. Some of the more significant of the reform milestones are outlined below.

In 1988 the Federal Airports Corporation (FAC) was established to own and operate the major and secondary city airports on a commercial basis. Also in 1988 the Civil Aviation Authority (CAA) became operational with responsibility, inter-alia, for setting safety standards, day-to-day operational regulation of the industry and the operation of air traffic control. Since 1988 aeronautical charges by the FAC have increased at a rate less than the Consumer Price Index (CPI), and in April 1992 the CAA announced forthcoming cuts in regulatory charges to the airline industry roughly equal in magnitude to 1.5 per cent of the industry's total costs.

On 30 October 1990, economic deregulation of Australian interstate aviation took place involving Commonwealth withdrawal from the key regulated areas of fare setting, aircraft imports, capacity controls and route entry.

In February 1992, the Prime Minister issued the "One Nation" statement which among other things established a framework and timetable for removing the barriers between Australia's domestic and international aviation sectors, and for developing a single aviation market with New Zealand. The statement also foreshadowed the recent establishment of the International Air Services Commission. In June 1992, the Government announced a full merger of Australian Airlines with Qantas Airways, coupled with a 100 percent sale of the new entity.

Much has been written on the progress of aviation reform over the past two years, including recent works such as BTCE (1991d) which evaluates the impact of deregulation on industry structure, airline competition, fares, other transport modes, and quantifies service quality changes in the first seven months of deregulation. However, little work has yet been done on estimating the changes in economic welfare resulting from aviation reforms. It is readily apparent that the actual air fares paid for travel have decreased since deregulation, translating into a sizeable gain to consumers. However, other gains, or even losses, such as in the quality of services delivered by operators are not so easily discernible nor are the relative magnitudes of changes in these areas. In this paper we estimate the net economic welfare changes resulting from recent aviation reforms.

Background to welfare analysis of aviation reforms

In order to determine the net changes in economic welfare we go beyond the readily observable phenomena and build a simulation model which adopts a consistent accounting framework and compares actual events with what would have happened if there had been no reform (a counterfactual base).

This is similar to the approach taken by Morrison and Winston (1986) in their evaluation of welfare changes resulting from deregulation of the United States airline industry. However, the approach taken by Morrison and Winston and that adopted in our paper differ in two main ways. Firstly, whereas our estimation of welfare gains results from comparing post-deregulation observations with simulated data for this

same period under a continuation of regulation, Morrison and Winston compare actual pre-deregulation observations with data simulating deregulation for this period. Secondly, Morrison and Winston use a disaggregate logit model of mode choice for intercity pleasure and business travellers as the basis for calculating travellers' compensating variations, ie., how much money travellers would have to be given after a price or service quality change to be as well off as they were before the change. We adopt a somewhat less complex approach by disaggregating the sum of welfare changes and determining values of welfare change in discrete areas such as fare reductions and increased access to direct flights. Morrison and Winston (1986, page 51) estimated that deregulation of American domestic aviation led to a yearly welfare gain to travellers and carriers of roughly US$8 billion (1977) dollars.

In broad terms, the net changes in economic welfare resulting from aviation reforms are made up of changes to consumers' surplus, changes to producers' surplus, and any net changes to aviation industry externalities. Changes to consumers' surplus result from changes in: air fares; the time between preferred and available departure times; and the availability of direct services. We estimate quarterly changes in all these three categories. Changes to producers' surplus include loss of profits due to lower air fares, and any gains resulting from improved labour and operational efficiencies. We derive quarterly estimates of the profit loss to producers, and subject to data availability, make some tentative estimates of producer gains from cost reductions. Externalities associated with the aviation industry include: noise pollution; air pollution; congestion in airways, runways, terminals and terminal access routes; and the cost of accidents. In this paper we do not estimate the effect of changes in externalities.

Our study is restricted to a partial equilibrium analysis. While we recognise that changes in the aviation market will have more general equilibrium implications, the constraints of time and data availability have necessitated that we limit the scope of this analysis. Precluded from the analysis are, for example, the losses incurred by operators of passenger rail and bus services who lost customers due to post-deregulation modal transfer. Also not estimated here are welfare changes to rail and bus passengers who may have experienced inconvenience due to discontinuation of under-patronised services. Subject to data availability, these areas could be investigated in future studies.

The welfare analysis framework

In this section we discuss the concepts behind the welfare analysis framework which allows us to estimate the magnitudes of welfare changes in each of the areas of change.

Full price. In Figure 1 the airfare which was paid before reform is represented by P and the corresponding level of demand for airline travel by Q. The line DD represents the demand relationship between the airfare and the number of airline passengers.

A service quality improvement, such as a reduction in travel time, can be represented by a shift in the demand schedule from DD to D^*D^* and, through the demand relationship, a corresponding increase in either demand to Q^* or price to P^* (reflecting an increased willingness to pay at any given level of demand).

A reduction in airfares is depicted by a reduction from P (the base level of airfares) to P^{**}. Assuming that demand at price P has increased from Q to Q^* due to the shift in the demand schedule from DD to D^*D^*, a reduction in airfares from P to P^{**} will further increase demand from Q^* to Q^{**}.

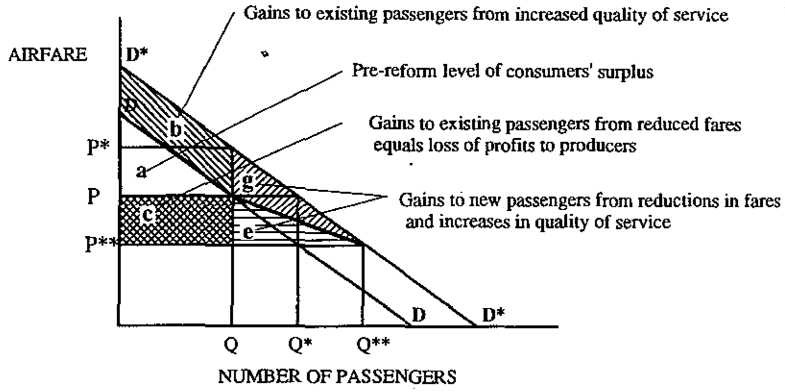

Figure 1 Welfare analysis framework for aviation reforms

Consumers' surplus. The base (pre-reform) level of consumers' surplus is depicted in Figure 2.1 as area **a**, representing the sum of the differences between willingness to pay and what it would have cost to travel if there had been no reform. In the event of reform occurring, these passengers who would have travelled in any event, derive additional surpluses from improvements in the quality of service, depicted by area **b**, and from reductions in airfares, depicted by area **c**.

Area **e** represents net consumers' surplus benefits to airline travellers who have been induced to fly on account of reductions in airfares.

Area **g** represents net consumers' surplus benefits to airline travellers who have been induced to fly on account of improvements in service quality.

Economic rents. The reduction in airfares payable by the set of passengers who would have travelled even without reform is a loss to the airlines which exactly matches the gain to the passengers. So the loss to airlines offsets the gains to consumers in area **c** and represents a transfer between these two groups.

Part of area **c** however, is recovered by the airlines through increased productivity stemming from more efficient utilisation of resources under the new competitive pressures from aviation reform. This part is a net gain to the economy. The other part is a loss of airline profits and factor rents (eg lower wages to employees and tougher working conditions).

Because demand also expands (from Q to Q^{**}), airlines also incur costs in increasing output to match demand. We make the assumption that this increased output is achieved at constant long run marginal and average costs which are equal to the airfares P^{**}. We believe this is a plausible assumption as, with the exception of Compass which had costs lower than that of the incumbent airlines (TPC, 1992), the increased output was largely achieved through the more efficient use of existing fleets,

personnel and infrastructure. Kirby (1981) found that the minimum efficient scale of an airline is about 5 aircraft and beyond this point airline costs as a function of numbers of aircraft is quite flat.

Quality of service

Quality of service in aviation encompasses many aspects such as network coverage, safety and security, service continuity, on-board service. etc. However, we believe that the main service quality changes have been in the time-dependant aspects of service quality. In the aviation industry these aspects are primarily: on-time performance; schedule delay; and travel time.

Analysis undertaken in BTCE (Unpublished) using CAA data indicates that there has been no significant change in the on-time performance of domestic airline operations since deregulation. Our analysis of service quality welfare changes will therefore concentrate on changes in schedule delay and changes in travel time.

Schedule delay. An important measure of service quality in the aviation industry is the length of time between when a traveller would ideally wish to depart from the airport and the departure time of the closest scheduled flight on which he can obtain a seat.

By way of example consider an Adelaide businesswoman wishing to attend a 11.30 am meeting in Sydney. If the total travel time between offices is estimated to be 2 hours - made up of 30 minutes to Adelaide airport, 60 minutes in the air, and 30 minutes to the Sydney office - then her ideal flight departure time will be close to 10.00. However, if the only available flights on that day leave at 8.00, 9.30, and 11.00, she will have to take the 9.30 flight incurring a thirty minute inconvenience. If the 9.30 flight is full she will have to take the 8.00 flight incurring a two hour inconvenience.

If we sum these inconveniences experienced by individual travellers on a particular route and divide by the number of passengers, we obtain an average measure of expected delay, or convenience, for the route. This average measure of expected delay, arising from the structure of airline schedules is termed 'schedule delay' by researchers Douglas and Miller (1974).

In simple terms schedule delay is a function of flight frequency and load factor. As flight frequency increases, ceteris paribus, frequency delay decreases. As load factor increases, ceteris paribus, stochastic delay increases. However, whereas the rate of change in schedule delay resulting from flight frequency increase is logarithmic, schedule delay increases exponentially as load factor rises.

Using a combination of simulation modelling and Markov analysis, Douglas and Miller (1974) developed a model to estimate schedule delay within any specified market (city pair combination). The model calculates schedule delay as the sum of delay incurred as a result of the number of flights available (frequency delay) plus delay incurred by stochastic demand variation resulting in full flights (stochastic delay).

Frequency delay is "the expected differential, in minutes per passenger, between the most desired departure time and that of the closest scheduled departure". In the example of the Adelaide businesswoman this would be 30 minutes being the difference between the 10.00 am preferred departure time and the 9.30 am closest scheduled flight.

Stochastic delay is "the expected length of delay a potential passenger faces because of the chance that his most preferred scheduled departure will be booked up and he will have to select another and possibly even a third or a fourth and so on". In our example the businesswoman finding the 9.30 am flight fully booked has to take the 8.00 am flight, thus incurring an additional 90 minute (stochastic) delay.

The full form of Douglas and Miller's schedule delay model is the following:

(1) Schedule delay = Frequency delay + Stochastic delay

Where: Frequency delay = $92*(F^{-0.456})$
Stochastic delay = $0.455*(Y^{-0.645})*(X^{-1.79})*(I)$

F = daily flight frequency
which equals total flights per qtr / days in qtr
Y = ratio of flight demand mean to its standard deviation
which equals mean passengers per flight /
(4.12 * sqr root of mean passengers per flight)
X = relative capacity
which equals (mean aircraft capacity - mean passengers per flight) /
(4.12 * sqr root of mean passengers per flight)
I = average interval between flights
which equals total available scheduled time per qtr / total flights per qtr
(in deriving the average interval between flights from quarterly data we make the assumption that for the top 10 routes, flights are offered on average over a 12 hour day. For all other routes we assume an average 8 hour day)

Valuation of travel time savings. Travel time savings have an intrinsic value made up of both an opportunity cost and a marginal disutility cost (Hensher, 1989, p.224). The opportunity cost of travel results from the reduction or loss of employee productivity during travel whereas the disutility cost results from the traveller's preference for spending the time taken to travel in other pursuits.

We obtain our values of business and leisure travel time from work undertaken in this area by Hensher. Hensher (1977) undertook an exhaustive empirical analysis of the factors which individually contribute to the value of business travel time. This research was further developed by Hensher (1989) to derive a set of average travel time values by means of travel for both work and non-work purposes and a range of values of travel time savings for both business and leisure travellers.

We use the mid-points of Hensher's travel time ranges for the monetary value of schedule delay and travel time savings. These values are presented in Table 1.

Our analysis involves a number of steps where data is averaged between time of day, day of week, and purpose of travel. Accordingly, the estimate we obtain for the schedule delay time saved in minutes is an average per passenger and must be treated as an average saving rather than a marginal saving.

As we have values of time for both business and leisure travellers, we must determine the relative numbers of these for each route analysed. We use business/leisure ratios estimated in BTCE (1991a).

Table 1 Values of air travel time savings by purpose of travel ($ 1991Q4)

	Value of time by purpose of travel ($ 1991Q4)	
	Business	Leisure
Schedule delay time	24	12
Travel time	24	8

Source Hensher (1989), p. 228.

Counterfactual simulations of demand for domestic aviation passenger services

Another part of our analysis is the evaluation of increases in consumers' surplus arising from reductions in airfares which were brought about by the reforms to aviation policy. In order to do this it is necessary to simulate the level of demand which would have prevailed but for the reforms. We use the model developed by Gargett et al in BTCE (1991b) to simulate this level of demand, which we then use as a benchmark for estimating how much demand has increased on account of the reforms.

We assume that, if there had been no deregulation, prices would have continued the same in real terms, that is, that nominal average air fares would have increased in line with general increases in prices as indicated by the CPI. This assumption accords closely with experience under the two airlines policy (see BTCE 1991c, page 16 and 1991d, page 40).

Because the demand simulation is subject to error which may have some systematic bias, the demand growth due to reform is estimated as the difference between two simulations - one the counterfactual simulation of what might have happened but for the reforms and the other the simulation of what actually did occur.

Overall however, we believe that adopting this model is likely to provide a conservative estimate of the demand response to deregulation discounting on account of most of any potential bias in the model appearing to be towards underestimating price responsiveness.

Estimation of welfare changes from aviation reforms

Estimation period. Despite deregulation of the industry occurring on 30 October 1990 we use 31 December 1990 as our cut-off point for comparison of pre and post reform industry performance. The reason for this is twofold. Firstly, and most importantly the majority of our model's data requirements can only be provided as aggregated quarterly figures. Secondly, there was minimal movement for the December 1990 quarter in the key variables which affect economic welfare.

Welfare change resulting from changes in schedule delay

We estimate the net welfare change to consumers resulting from changes in schedule delay on specific routes following aviation reforms through the following summation:

$$(2) \quad \sum_i \sum_j \sum_k \sum_l \Delta \text{ Schedule delay}_{ijk} * \text{Existing passengers}_{ijkl} * \text{Value of time}_l$$
$$+ 1/2 \sum_i \sum_j \sum_k \sum_l \Delta \text{ Schedule delay}_{ijk} * \text{New passengers}_{ijkl} * \text{Value of time}_l$$

Where: i = Post-deregulation quarter in which welfare change is achieved
j = Domestic city pair.
k = Direction of travel (City 1 to 2/City 2 to 1)
l = Purpose of travel (Business/Leisure).

The 'existing passengers' section of the equation models part of area **b** in figure 1. The 'new passengers' section models part of area **g**.

Change in schedule delay. To quantify any change in average schedule delay per person for a particular city pair as a result of aviation reform we subtract the schedule delay found in the post-reform quarter from the schedule delay for the like quarter prior to reform. We compare June, September and December 1991 with June, September and December 1990 respectively. We compare March 1991 with March 1989. We do not use March 1990 as during this period the industry was still recovering from the 1989 pilots dispute and traffic levels were significantly lower than long term average figures.

Accounting for yield management systems. The schedule delay associated with a particular route is composed of both stochastic delay and frequency delay. However, in reality we propose that the schedule delay facing a full fare paying passenger will not be the same as the delay facing a leisure passenger. This is because the airlines employ sophisticated yield management systems to attain optimal ratios of full and discount fares per trip. It therefore seems reasonable to assume that full fare travellers will be subject to less stochastic delay than discount fare passengers as blocks of full fare seats are likely to be held aside until the last minute before departure.

To account for this we derive two estimates of the welfare changes resulting from changes to schedule delay. On one hand we assume all passengers on a particular route face the same schedule delay, ie., the same stochastic delay. On the other hand we assume that all business passengers - our proxy for full fare paying passengers - face no stochastic delay. Clearly, both these approaches are simplifications of the real situation. Not all business passengers pay full fare, and not all flights will have blocks of full fare seats reserved right up until departure time. Therefore, we believe the real answer lies somewhere between these two estimates.

Passengers benefiting (losing) from the change in schedule delay. In order to calculate the value of schedule delay changes, the model requires us to determine the relative numbers of passengers in the post reform quarters that; a) would have travelled anyway, irrespective of reform, and b) were induced to travel as a result of fare reductions and quality of service changes.

Our demand model indicates that there was no growth in demand over the post-reform period attributable to factors other than the price cuts and service quality improvements due to deregulation. Therefore, to estimate passenger numbers we adopt

a straightforward approach based on a counterfactual zero growth assumption, attributing all growth in passenger numbers to reform-induced changes.

On routes which have experienced post-reform growth in passenger traffic we use the number of pre-reform passengers as a proxy for post-reform traffic that would have occurred irrespective of the reform-induced changes. In the model above these are termed "Existing Passengers". The balance of post-reform traffic we deem to have been generated by the reform-induced changes. In the model these are termed "New Passengers".

On routes which have experienced post-reform declines in passenger traffic we deem that reform stimulated no additional traffic, and accordingly, that all post-reform traffic would have occurred irrespective of reform-induced changes. All post-reform traffic are therefore "Existing Passengers".

Results. Table 2 presents a post-reform quarterly summary of the welfare changes resulting from changes in schedule delay.

Table 2 Welfare changes resulting from changes to schedule delay

	Welfare change ($ 1991Q4 millions)	
	All passengers subject to stochastic delay variation	Business passengers not subject to stochastic delay variation
1991Q1	+ 26	+ 11
1991Q2	+ 11	+ 6
1991Q3	- 12	- 1
1991Q4	- 13	- 1

Source BTCE estimates.

Interpretation of results. It is apparent from this analysis that consumers gained in the first two post-reform quarters and lost in the second two. How can this be? In conventional wisdom improvements in schedule convenience are positively correlated with increases in flight frequency.

In fact, over the post reform period the number of flights offered on many routes did increase. However, in addition to flight frequency increases, the other key determinant of schedule delay, load factor, also increased on many of the domestic routes.

While Table 2 provides a general indication of what has happened in the post-reform market, it is important to note that these quarterly results are an aggregate for all domestic routes. Within these totals are hidden the increases and decreases in flight frequency, load factor and resultant schedule delay on the individual routes.

In the latter part of the post reform period, in particular the September and December quarters of 1991, there was a substantial increase in the number of flights offered on many of the more popular domestic routes. However, at the same time on many of these routes the rate of increase in demand has exceeded the rate of increase in the supply. So, despite the advantage of a wider range of choice of scheduled services, the probability of obtaining a seat on the preferred flight has diminished, leading to an increase in the average schedule delay (or a decrease in economic welfare) on these routes.

One such example is the Brisbane-Melbourne route. A breakdown by post-reform quarter for Brisbane-Melbourne traffic provides an indication of why the relative magnitudes of the aggregate quarterly welfare changes are as they are. These results are presented in Table 3.

Table 3 Post-reform schedule delay and welfare changes on the Brisbane-Melbourne route

	Mar Qtr (89) to 91	Jun Qtr (90) to 91	Sep Qtr (90) to 91	Dec Qtr (90) to 91
Flights (No.)	(631) 766	(676) 884	(808) 1010	(843) 1050
Load factor (%)	(78.3) 76.8	(72.0) 73.2	(79.3) 86.2	(78.7) 84.4
Frequency delay (Min)	(37.9) 34.7	(36.9) 32.6	(34.2) 30.9	(33.5) 30.3
Stochastic delay (Min)	(59.9) 41.1	(29.4) 27.0	(49.7) 82.9	(45.3) 58.9
Schedule delay (Min)	(97.8) 75.8	(66.3) 59.6	(83.9) 113.8	(78.8) 89.2
Welfare change ($)				
All passengers subject to stochastic delay	+ 479 000	+ 160 000	- 948 000	- 350 000
Business passengers not subject to stochastic delay	+ 145 000	+ 113 000	- 89 000	- 23 000

Source BTCE estimates.

Limitations of the model. When interpreting the results in Table 2 it is important to be aware of certain limitations with the model. The main problem concerns those domestic routes on which regional carriers offer parallel services. We do not have data concerning regional operations, and therefore, when evaluating schedule delay gains associated with all air travel options we may be in fact be mis-specifying the available number of flights and accordingly the schedule delays experienced by travellers.

Welfare change resulting from changes in direct flight availability

We estimate the net welfare change to consumers resulting from reductions or increases in the time taken to travel between ports of origin and destination (O-D) through the following summation:

$$(3) \quad \sum_i \sum_j \sum_k \Delta \text{ Travel time}_{ij} * \text{Passengers}_{ijk} * \text{Value of time}_k$$

Where: i = Post-reform quarter in which welfare change is achieved
j = Top 30 O-D city pairs.
k = Purpose of travel (Business/Leisure).

This equation models part of area **b** in figure 1.

Quantifying a change in travel time. When a passenger is forced, either through lack of available services or lack of seats on a desired flight, to take an indirect service between his ports of origin and destination the inconvenience experienced is directly measured as the difference between the direct and indirect trip duration.

We estimate the net changes in this measure of service quality by estimating the number of passengers that gained (lost) access to direct services as a result of schedule changes that occurred between the pre and post-reform periods. We then multiply this number of passengers by the time difference involved. The methodology is explained in more detail below.

Time constraints associated with this study dictated that we limit the depth of our analysis. We restricted our analysis to the top 30 O-D routes for each post-reform quarter. This simplification may result in some bias. While we capture the majority of O-D passengers in analysing the top 30 routes there may be some major changes in direct flight availability that we have missed. Based on the March quarter 1991, 85 per cent of all O-D passengers are included in the top 30 routes.

Passengers affected by the change in travel time. We estimate the number of passengers subjected to a change in flight duration (direct vs indirect service) by comparing the availability of direct flights between ports of origin and destination before and after aviation reforms. For any one route the range of service possibilities facing passengers can be expressed as a simple matrix as illustrated below.

		Post-reform	
		No direct service	*Direct service*
Pre-reform	*No direct service*	A	B
	Direct service	C	D

In category A, O-D passengers were unable to obtain a direct service in either the pre or post-reform period. Therefore, there are no net gains or losses to these passengers. In category B, some or all of the post-reform O-D passengers were able to obtain a direct service. In category C, some or all of the post-reform passengers lost access to a direct service that they would have had in the pre-reform period.

Estimating the number of passengers affected by changes in access to direct services on category D routes is more complicated. For the top 30 city pairs we have two pieces of information: 1) the number of passengers that were actually carried on direct services between the two ports, these are termed traffic-on-board-by-stage (TOBS) passengers; and 2) the number of passengers with a ticketed port of origin and destination corresponding to the city pair. We assume that if TOBS is greater than O-D for any route, then all O-D travellers on this route obtained a direct flight. The possible range of TOBS:O-D ratios for these routes is illustrated by the following matrix:

	Base O-D < Post-reform TOBS	*Base O-D > Post-reform TOBS*
Base O-D < Pre-reform TOBS	D1	D2
Base O-D > Pre-reform TOBS	D3	D4

The method by which we establish the number of O-D passengers that were able to gain access to a direct service is explained in the following paragraphs.

Firstly we establish a base O-D number representing the number of passengers that would have travelled in the post-reform period irrespective of any reform-induced changes. This is the lesser of the pre and post-reform O-D numbers.

On category D1 routes all O-D travellers theoretically obtained a direct flight both pre and post-reform. Therefore, there are no net gains or losses to travellers on these routes.

On category D2 routes some of the 'base' post-reform O-D travellers lost access to a direct service and were forced onto an indirect service. The number of O-D passengers who lost the direct service is counted as the number of 'base' O-D passengers minus the number of post-reform TOBS passengers (post-reform available capacity).

On category D3 routes all the 'base' O-D passengers who were unable to obtain a direct service in the pre-reform period are now able to do so in the post-reform period. The number of O-D passengers who now obtain a direct service and realise the associated time saving is counted as the number of 'base' O-D passengers minus the number of pre-reform TOBS passengers (pre-reform capacity gap).

On category D4 routes there is a demand-capacity gap both pre and post-reform. For those routes where available capacity increased post-reform, the number of O-D passengers that gain a direct service is the difference between the pre and post-reform TOBS. For those routes where available capacity decreased post-reform the number of O-D passengers that lose a direct service is the difference between the pre and post-reform TOBS.

Results. Table 4 presents a post-reform quarterly summary of the welfare changes resulting from changes in access to direct services. At this point in time available data has only permitted analysis of the March and June 1991 quarters.

Table 4 Consumer gains (losses) from changes in access to direct services

	Welfare change ($ 1991Q4 millions)
1991Q1	+ 1.3
1991Q2	+ 1.5

Source BTCE estimates.

Interpretation of results. What these limited results available so far tell us is that net changes to consumers' surplus as a result of the changes in the number of direct services available to travellers is fairly small.

The reason for the small changes is largely due to the fact that the bulk of the O-D demand in these periods was adequately satisfied by direct services. In both the pre and post-reform March quarters direct services were offered on all of the top 20 O-D city pairs. In both quarters, on 14 of the top 20 routes, the number of passengers utilising direct services - our proxy for available capacity - exceeded the O-D demand, ie., demand was fully satisfied. The top 20 routes for the post reform March quarter

accounted for 80 percent of all O-D demand. Therefore the number of passengers achieving (or losing) access to a direct service and incurring the time differential is relatively small.

It is possible we may see larger welfare gains in the September and December quarters of 1991 due to the substantial expansion in the number of services on some routes caused by the demand response to greater fare reductions.

Limitations of the analysis. We were unable to obtain O-D data prior to 1 July 1990. Therefore, we do not have a sound pre-reform base against which to compare the March and June post-reform quarters. The way we got around this problem was to use the September 1990 quarter as our base for both these quarters. Choosing this base will possibly introduce some distortion into the results, due to the seasonal nature of airline patronage. However, we believe these errors will be relatively insignificant.

Welfare change resulting from reductions in average air fares

We estimate the net welfare gains to consumers resulting from the reductions in air fares following aviation reform through the following summation:

(4) $$\sum_i \Delta \text{ Air fare}_i * \text{Existing passengers}_i + 1/2 \sum_i \Delta \text{ Air fare}_i * \text{New passengers}_i$$

Where: i = Post-reform quarter in which welfare change is achieved

The 'existing passengers' section of the equation models all of area **c** in figure 1. The 'new passengers' section models all of area **e**.

Changes in air fares. The magnitude of the gain in aggregate consumers' surplus due to fare discounting is the sum of individual gains and losses realised by all travellers on the post-reform network.

We use estimates provided by the Prices Surveillance Authority for the quarterly average fare that was actually paid for post-reform travel. This is the best estimate currently available and, as it is based on fares sold on the top 18 principal interstate routes, which carry around 80 precent of all traffic, we believe it is a good estimate of the network average fare.

We estimate the quarterly non-reform counterfactual air fares using the CPI with a base value of the average full economy fare paid for travel in the September quarter 1990. We use the CPI as empirical evidence shows that growth in the average full economy fare over the last decade has been very closely linked to growth in the CPI. The correlation coefficient (R^2) between these two variables over this period is 0.986.

Table 5 summarises the results of our estimation of the reductions in average actual fare due to reforms.

Passengers benefiting from the reduction in air fares. We use a different method to estimate the number of 'existing' and 'new' passengers who realise gains from the post-reform reductions in air fares. We substitute into the passenger demand forecasting model, estimates of what we believe would have been the average fare paid if reforms

Table 5 Change in average fare paid for post-reform travel

	Counterfactual non-reform average fare ($)	Actual average fare ($)	Difference in average fare ($)
1991Q1	207	176	-31
1991Q2	207	178	-29
1991Q3	209	139	-70
1991Q4	211	135	-76

Source PSA, BTCE estimates.

had not occurred and accordingly derive quarterly post-reform estimates of demand for travel that would have occurred without price cuts. We also run the demand forecasting model with the average actual fare paid for post-reform travel and accordingly derive estimates of actual post-reform demand.

The difference between these sets of results yield quarterly estimates of the number of passengers stimulated to travel as a result of price cuts. In equation (4) these are termed "new passengers".

We then subtract these "new passengers" from the actual values of demand in the post reform period to arrive at estimates of the number of passengers who would have travelled irrespective of price cuts. In equation (4) these are termed "existing passengers". The quarterly post-reform estimates for 'new' and 'existing' passengers are presented in Table 6.

Table 6 Post-reform existing and new passengers - aggregate for domestic network

	Existing passengers (millions)	New passengers (millions)	Total passengers (millions)
1991Q1	3.3	0.26	3.6
1991Q2	3.5	0.25	3.7
1991Q3	4.1	0.78	4.9
1991Q4	4.3	0.77	5.1

Source DOTC, BTCE estimates.

This method of estimating 'existing' and 'new' demand is significantly different to the method used to estimate demand for the schedule delay and direct service parts of the model. However, the different methods yield results which are acceptably similar. For example, the passenger demand forecasting method yields the values of 260 000 new passengers and 3 350 000 existing passengers for the March 1991 quarter, whereas the method used in the schedule delay section yields values of 540 000 new passengers and 3 070 000 existing passengers.

Results. Gains to existing passengers from the reduced fares come at an equivalent loss to producers, and are a direct transfer of welfare. As such, these figures while certainly representing substantial gains in consumers' surplus are netted out of the welfare gain.

However, the gains to passengers who chose to fly in response to the price cuts are net economic welfare gains within the aviation market. Bearing in mind that this is a partial equilibrium analysis, there may be consumers' surplus changes to the existing passengers of rail and bus modes, resulting from service frequency reductions and/or load factor changes and fare variations caused by a drain of passengers to air transport. Consumers' surplus changes in these modes will effect the net economic gains to the community. However, we do not currently have the data to quantify any such changes.

Table 7 presents a quarterly post-reform summary of the consumers' surplus gains to both 'new' and 'existing' aviation passengers. We expect the magnitude of these quarterly gains may decline in the first half of 1992 as the industry re-adjusts prices in response to the exit of Compass. However, the period following this may see the entry of new operators such as Compass MkII perhaps generating a new round of price competition leading to further fare reductions and new travel demand.

Table 7 Gains in consumers' surplus from lower air fares

	Fare reduction ($)	Gains to existing passengers ($ millions)	Gains to new passengers ($ millions)	Total Gains ($ millions)
1991Q1	31	102	4	106
1991Q2	29	102	4	106
1991Q3	71	288	28	316
1991Q4	76	328	29	357

Source BTCE estimates.

Welfare change resulting from increased competition between producers

With this part of the model we make rough estimates of the net losses and gains incurred by air transport operators as a result of the changes to profit levels and cost structures brought about by reform-induced competition.

This includes estimates of the economic rents lost to producers as well as preliminary estimates, based on available data, of the magnitude of cost savings achieved by operators. We do not have comprehensive data on the revenues, costs, and profits of individual firms in the industry and accordingly, cannot fully quantify these cost savings, or the resultant changes in producers' surplus. However, given some data on labour rationalisations we are able to make tentative estimates of the size of savings in this area. Subject to data availability further work on defining the cost structure of the aviation industry will allow these estimates to be refined.

Loss of economic rents. Prior to reform of the aviation market, domestic airline operators by virtue of the existing market structure were able to extract economic rents from the flying public. With the introduction of post-reform competition, average air fares were forced down towards or even below the average cost of service provision.

This difference between actual average fare paid for post-reform travel and the average fare that would have been paid if there had been no reform represents a loss of revenue to the airlines, being this difference in fare times the number of passengers that would have flown irrespective of reforms. We quantify producer losses only within the aviation market. The loss of economic rents to aviation market producers is presented in Table 8.

Table 8 Estimated losses to operators

	Transfer to existing passengers (due to average fare reductions) ($ millions)	Transfer to new passengers (Compass pricing below cost) ($ millions)
1991Q1	- 102	-
1991Q2	- 102	-
1991Q3	- 288	- 3.5
1991Q4	- 328	- 3.3

Source BTCE estimates.

Cost of Compass collapse. No evaluation of net producer losses would be complete without an estimation of the welfare loss resulting from the collapse of Compass Airlines in December 1991. We acknowledge that Compass losses were very large. However, the majority of these losses were transfers between various classes of debtors and creditors.

We include the operating loss incurred by Compass as a result of selling seats below the cost of provision in our net welfare sum. The transfer component to existing passengers resulting from reduced fares has already been netted out and it remains to take out the transfer component to new passengers.

We have used information from the Trade Practices Commission report on Compass' collapse and the BTCE estimates of Compass costs to arrive at a figure of 3.5 cents loss incurred by Compass per passenger kilometre over the last two quarters of 1991 (before then Compass was breaking about even). These transfers are presented in Table 8.

Gains resulting from operational efficiencies. Increased pressure to become more competitive and cut costs to compensate for reduced revenues has forced the incumbent airlines to introduce a range of efficiencies into their operations. We believe that some of the more significant changes have occurred in the areas of staff productivity gains - pilot reductions and general staff rationalisations - and maintenance facility rationalisations.

We attribute any financial gains to producers flowing from resolution of the 1989 pilots dispute to aviation reforms. To determine these gains we estimate the difference in the number of pilots that were employed pre and post-dispute to undertake the same magnitude of transport task, and multiply this difference by the average quarterly cost

of employing a pilot to obtain an upper limit to the saving. To convert this cost saving to a welfare gain we reduce it by the welfare loss to pilots as a result of changed work conditions, using the assumption in BTCE (1991a) that average employee losses from work practice efficiencies are approximately two thirds of the gain to producers. Readers who disagree with this assumption can make the necessary adjustments in Tables 9 and 10.

We make no further adjustments to these figure to account for the personal financial losses incurred by pilots who lost their jobs and were forced to obtain lower paid employment, as we argue that this simply constitutes a devaluation of the labour asset, and while being a loss to the individual is not a loss to society. We also apply this assumption later in the paper when evaluating the gains from general labour productivity improvements.

Haddad (1991) cites estimated losses to the airlines during the period of the pilots' dispute of about $150 million for Australian and $106 million for Ansett. Resulting from the dispute Australian reputedly cut pilot numbers from 547 to about 280, realising cost cuts of $21 million per year. Eastwest reputedly cut pilot numbers from 142 to 72 and Ansett from 974 to about 490.

Based on an extrapolation of Australian's savings, costs savings for Ansett and Eastwest combined could be expected to be in the order of $44 million per year. In summary then we can broadly conclude that cost savings from pilot labour restructuring saves the airline industry about $65 million per year.

To calculate net welfare gains from this productivity improvement we remove two thirds of the productivity saving, this two thirds being loss of welfare to pilots who have to work harder for the same level of pre-dispute remuneration. The resultant net welfare gains are shown in Table 9.

In the lead up and subsequent to deregulation the incumbent operators pursued significant work force rationalisation programs, resulting in reductions to total staff numbers, while at the same time expanding the scale of their operations to meet the post-deregulation growth in demand. Reports in the media around the time of transition to the deregulated environment indicate that total staff cuts across incumbent operators were of the magnitude of 1000 to 2000 personnel.

We assume an annual total employee cost of $50 000 to obtain an upper limit to the aggregate saving of $12 500 per quarter times 1000 to 2000 staff, or $12.5 to 25 million. However, when we reduce this by the number of staff unable to find alternative employment and the cost of redundancy payouts, it is highly likely that these cost savings will not be realised for some time, perhaps up to six months after retrenchment. We therefore assume no net cost saving until September 1991, whereupon we suggest a saving in the order of about one third of the quarterly maximum - roughly $4.2 to $8.3 million. Table 9 summarises the savings to producers resulting from these lower staff costs.

We do not have quantitative information on the savings resulting from rationalisation of maintenance facilities. However, we believe they probably represent significant savings in overhead costs to incumbent operators. Examples of such rationalisations include the closure of the Ansett WA heavy engineering workshops at Perth airport (circa April 1991) and the closure of the Eastwest maintenance facility in Tamworth (circa August 1991).

Table 9 Estimated welfare gains from reductions in producers' labour costs

	Welfare gains from reductions to airline costs ($ millions)	
	Pilots	General workforce
1991Q1	+5	0
1991Q2	+5	0
1991Q3	+5	+4 to 8
1991Q4	+5	+4 to 8

Source BTCE estimates.

Summary of results

A summary of results is presented in Table 10. This summary table includes the quarterly post-reform welfare gains and losses attributable to changes in schedule delay, changes in the availability of direct services, average air fare reductions, and changes in costs and revenues to producers. Results are presented on a quarterly basis as we feel changes are occurring in the aviation market on a frequency which are best illustrated by a quarterly exposition, a situation that we feel is likely to continue for some time yet.

Table 10 Summary table of quarterly changes in economic welfare

	Net quarterly welfare change ($ millions)			
Cause of welfare change	1991Q1	1991Q2	1991Q3	1991Q4
Schedule delay				
(a) stochastic delay applies to all passengers, or	26	11	-12	-13
(b) no stochastic delay for business passengers	11	6	-1	-1
Access to direct services	1	1	-	-
Reduced air fares	4	4	28	29
Reduced operator costs	5	5	11	11
Compass pricing below cost	0	0	- 4	- 3
Total (a)	36	21	23	24
Total (b)	21	16	34	36

Source BTCE estimates.

Table 11 shows the results of a +/- 10 percent sensitivity analysis of key parameters of the net welfare change model. The analysis provides an indication of the nature of change to be expected if certain key parameters/inputs are altered.

Table 11 Sensitivity analysis of key parameters of the welfare change model

	Net quarterly welfare change ($ millions)			
	1991Q1	1991Q2	1991Q3	1991Q4
Schedule delay (base)	**25.8**	**11.0**	**-11.6**	**-13.3**
+/- 10% F parameter [1]	25.8 / 25.8	11.0 / 11.0	-11.6 / -11.6	-13.3 / -13.4
+/- 10% Y parameter [2]	24.5 / 27.3	10.6 / 11.5	-10.7 / -12.6	-12.3 / -14.5
+/- 10% X parameter [3]	29.5 / 22.5	11.7 / 10.4	-16.9 / -7.2	-18.1 / -9.2
+/- 10% value of time [4]	28.4 / 23.2	12.1 / 9.9	-12.8 / -10.5	-14.6 / -12.0
Reduced air fares (base)	**4.0**	**3.6**	**27.5**	**29.4**
+/- 10% air fare difference [5]	4.4 / 3.6	4.0 / 3.3	30.3 / 24.8	32.3 / 26.4
Direct services (base)	**1.3**	**1.5**		
+/- 10% travel time saving [6]	1.4 / 1.1	1.6 / 1.3		
+/- 10% value of time[6]	1.4 / 1.1	1.6 / 1.3		

Notes
1. See equation (1), F parameter = -0.456
2. See equation (1), Y parameter = -0.645
3. See equation (1), X parameter = -1.79
4. Value of time = $24 (business) and $12 (leisure)
5. See equation 4
6. See equation 3

Source BTCE estimates

Conclusions

In conclusion, we believe that there have been net economic welfare gains to the community resulting from the aviation reforms of the last few years. While we would caution the reader that our estimates of welfare changes show only broad orders of magnitude, we believe they are nevertheless indicative of the gains made to date. It is of interest to note that, on an annual basis for the first year of deregulation, our estimates, while derived using a different methodology, accord quite closely with the benefits from deregulation forecast in BTCE (1991a).

The magnitude of gains and losses from changes in schedule delay are also interesting as they reveal the down-side to stimulating the market through price reductions in that attempting to raise load factors by filling otherwise empty seats with marginally-priced passengers can result in significant increases in schedule delay for all travellers. However, the extent to which the airline operators can employ sophisticated yield management systems to reserve seats for premium passengers while still obtaining full aircraft will reduce the magnitude of the welfare losses associated with these schedule delay increases (see Tables 2 and 10).

Future analysis could reveal the impact of the withdrawal of Compass from the market, and allow us to make some projections as to the impact of the new entrant Southern Cross (Compass MkII). Depending on the strategies adopted by the various players we may see a reversal of the schedule delay increases on key East Coast routes as additional capacity and increased flight frequency is made available to the market.

Additional areas where further analysis of welfare gains could be undertaken include re-estimating the parameters of Douglas and Miller's schedule delay formula, deriving a sliding scale for value of schedule delay time for both business and leisure passengers, and interrogating airline timetables to refine our estimates of the impact of changes to direct flight availability. However, while these areas of further analysis would increase the accuracy of our estimates, we believe any resultant changes to the totals would be marginal.

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Energy Market Failure in the Road Transport Sector: Is There Scope for 'No Regrets' Greenhouse Gas Reduction?

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Abstract:

The Australian Government Policy on reduction of greenhouse gas emissions announced in 1990 includes exploring the scope for immediate, low cost reductions. Such measures can be taken as including 'no regrets' policies: those that, in addition to mitigating climate change, confer economic gains (including other environmental benefits) which exceed their costs.

Some possible 'no regrets' opportunities and policies are identified relevant to energy use by the road transport sector over the period to 2020. The MARKAL–MENSA multi-period linear programming model of the Australian energy sector is used to investigate the cost-effectiveness of these policies.

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