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DISCUSSION PAPERS

AIRLINE COSTS AND AUSTRALIA'S DOMESTIC AIR TRANSPORT POLICY: TWO PAPERS

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Paper 2: Michael G. Kirby & Robert P. Albon

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DISCUSSION PAPER NO. 112

TWO PAPERS:

AIRLINE ECONOMIES OF "SCALE" AND AUSTRALIAN DOMESTIC AIR TRANSPORT POLICY

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PROPERTY RIGHTS, REGULATION AND EFFICIENCY:
A FURTHER COMMENT ON AUSTRALIA'S
TWO-AIRLINE POLICY

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TABLE OF CONTENTS

DISCUSSION PAPER NO. 112

	Page
Summary (Papers 1 and 2)	i
PAPER 1: AIRLINE ECONOMIES OF "SCALE" AND AUSTRALIAN DOMESTIC AIR TRANPORT POLICY	
1. Introduction	1
2. The Concept of "Scale" In Airlines	1
3. A Model of Airline Costs	4
3.1 Specification	4
3.2 Data	5
3.3 Empirical Results	6
4. Simulation of Some Australian Policy Alternatives	10
4.1 US System Cost Incentives	10
4.2 Privatise TAA	12
4.3 One-Airline Policy	12
4.4 Three Airline Policy	14
4.5 "Creamskimmer Airlines (CSA)"	15
4.6 Abolition of Parallel Schedules	15
4.7 Concluding Remarks	16
5. Conclusion	17
Tables	18
Footnotes	21
References	24
PAPER 2: PROPERTY RIGHTS, REGULATION AND EFFICIENCY: A FURTHER COMMENT ON AUSTRALIA'S TWO-AIRLINE POLICY	27
1. Introduction	29
2. A Model of Firm Behaviour under the Two-Airline Policy	29
3. An Econometric Test of Relative Cost Efficiency	32
4. Conclusions	34
Footnotes	37
References	38

SUMMARY

Two papers are presented here relating to costs in the airline industry and domestic air transport policy in Australia.

In Paper 1 a model of airline total operating costs is developed and estimated. The estimates reveal substantial economies of operation with respect to load factors, aircraft size and stage length, but diseconomies associated with serving more ports and increased departures from a given port. The model is also utilised to simulate various policy alternatives for Australia and to assess their cost implications. The simulation results indicate the existence of substantial potential cost savings in the Australian domestic airline industry. Notable results include: costs in Australia for a particular airline operation appear over 50 per cent higher than the equivalent operation in the USA; there is a small but statistically significant difference in cost efficiency between TAA and Ansett; and parllel scheduling imposes a large burden on industry operating costs.

Paper 2 contributes to the long standing debate on the relative efficiency of public and private firms. It presents an explicit model on firm behaviour under the Two-Airline Policy, which suggests that the government-owned firm will tend to be less cost efficient than its private counterpart. Econometric evidence, based on the cost model reported in Paper 1, indicates that TAA's operating costs are around 5 per cent higher than its private counterpart. However, this difference, while statistically significant, is small compared to the inefficiencies of both operators caused by current policies of economic regulation.

PAPER 1:

AIRLINE ECONOMIES OF "SCALE" AND AUSTRALIAN DOMESTIC AIR TRANSPORT POLICY

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* This paper is a revised version of a paper presented at the Research Workshop in Industrial Organisation, Australian Graduate School of Management, University of New South Wales, 26 May 1982. Most of the research reported in this paper was undertaken while the author was employed at the Australian National University. The opinions expressed in this paper do not necessarily reflect those of the author's current employer.

1. INTRODUCTION

The question of economies of scale in the airline industry has been an important issue over many years and has featured prominently in debates on regulation of the industry. In Australia, for instance, fear of monopoly development appears to be a popular rationale for its Two-Airline Policy.[1] These debates have revealed sharp differences of opinion on the existence or otherwise of scale economies in the airline industry. Economists have generally tended to reject the claims of many industry representatives that such economies exist.[2]

However, this paper suggests that the issue is clouded by the use of imprecise terminology by both sides of the debate and that much of the apparent conflict is due to differences in interpretation of airline "scale", with the result that the discussion is often at cross purposes. Thus a more systematic approach to the concept of airline scale or output is needed. This paper presents a conceptual framework for analysing an airline's scale of operations, estimates an airline cost function based on this framework, and uses the empirical results to simulate some alternative airline industry policies for Australia and to estimate their cost implications.

2. THE CONCEPT OF "SCALE" IN AIRLINES

Ton-miles performed (TMP) is the traditional measure of airline output or scale.[3] However, TMP is a highly aggregated measure of output and its use ignores the multiproduct nature of an airline company's output. For example, an airline transports different cargoes (e.g. freight and passenger services, perhaps of varying qualities) over different routes (e.g. over different distances with varying numbers of stops) in different aircraft. Thus the same aggregate output, as measured by TMP, can be produced in many ways with, perhaps, quite different cost implications.

Several previous empirical studies of airline costs attempt to allow for this difficulty by including in their estimated cost functions, in addition to TMP, other variables which are thought to be important influences, e.g. average stage length (ASL), average aircraft size (AAS) and average load factor (ALF).[4] Such variables are often described as environmental factors or output modifiers. Studies adopting this approach often find that, while network structure and technology are statistically significant determinants of unit operating costs, there is little effect through the level of output itself, TMP. Crude observations of a link between scale and unit operating costs are then explained in terms of the collinearity between size of output and the various network and technology variables, e.g. large airlines tend to fly over long stage lengths with large aircraft, rather than a direct causal relationship.

Studies adopting this approach can be criticised for their somewhat ad hoc selection of explanatory variables and for their failure to appreciate that the output modifiers are not merely correlated with TMP but rather are linked directly to it via the following identity relationship:[5]

$$TMP = PORTS \times ASL \times ALF \times AAS \times ADPP \qquad (1)$$

where PORTS is the number of airports served and ADPP is the average number of departures per port.

Previous empirical cost studies do not take the information contained in this identity to its logical conclusion by failing to include all of the variables which influence the total level of output. Their findings on the impact of TMP can probably be better interpreted then as the effect of the omitted variables or output dimensions. For example, such empirical studies often find that TMP has little impact on average costs when stage length, market density and aircraft size are held constant. This appears then to be a special interpretation of economies of "scale", referring to the geographic duplication of existing networks and operations. On the other hand, the economies of "scale" discussed by many industry representatives probably often refer to the quite different case where the routes operated remain the same but entry or exit from the industry leads to changes in a firm's market density and perhaps choice of aircraft.

In order to account for the multiproduct characteristics of airline services, an output index, Q, is utilised where the output dimensions, QD_i, which are included in its construction are selected through a systematic breakdown of the aggregate output measure. Thus

$$Q = Q(QD_i) \qquad i = 1,\ldots 7 \qquad (2)$$

where, in addition to the five output dimensions obtained from the right-hand side of equation (1), the index also allows for the proportion of total output that is passenger traffic (PASS) and that is operated with scheduled services (SCH).[6]

The highly general and flexible translog functional form is specified for the output index. Thus

$$\ln Q = \sum_{i=1}^{7} a_i \ln QD_i + \sum_{i=1}^{7} \sum_{j=1}^{7} a_{ij} \ln QD_i \ln QD_j \tag{3}$$

3. A MODEL OF AIRLINE COSTS

3.1 Specification

This paper estimates an airline total cost function which, based on the usual economic theory of the firm, is a relationship between total costs and output and factor prices. Especially in the context of estimating economies of "scale" it is desirable to have a general and flexible functional form. Again the translog specification is used.[7] Thus

$$\ln TOC = b_0 + b_Q \ln Q + b_{QQ} (\ln Q)^2 + \sum_k b_k \ln FP_k + \sum_k \sum_l b_{kl} \ln FP_k \ln FP_l + \sum_k b_{Qk} \ln Q \ln FP_k \tag{4}$$

where TOC is the total operating cost of the airline and FP are prices of factors of production.

Substitution of the output index given by equation (3) into this specification and, for simplicity, deletion of terms of higher order than two, yields the following estimating equation after relabelling of parameters:

$$\ln TOC = a_0 + \sum_i a_i \ln QD_i + \sum_i \sum_j a_{ij} \ln QD_i \ln QD_j + \sum_k a_k \ln FP_k$$

$$+ \sum_k \sum_l a_{kl} \ln FP_k \ln FP_l + \sum_i \sum_k a_{ik} \ln QD_i \ln FP_k \qquad (5)$$

3.2 Data

There are 145 annual observations of Australia's two major carriers[8] and of eight local service[9] and ten trunk[10] airlines (domestic operations only) from the USA over the eight year period 1971 to 1978. The US data were obtained from various issues of the US Civil Aeronautics Board Handbook of Airline Statistics, Airline Operating Cost and Performance Report, and Annual Report. The Australian data were obtained from Department of Transport Domestic Air Transport Statistics, Airline Aircraft Utilisation Statistics, and Annual Report; TAA Annual Report and personal communication; ATI Annual Report, and Annual Financial Report on Airline Activities; and IATA World Air Transport Statistics.

Several points can be noted regarding the assembly of this data base. The Australian financial data, which is available only on a financial year basis (1 July to 30 June), was converted to a calendar year basis by taking a two-period moving average. All cost and factor price data have been converted to US 1976 prices . Due to data unavailability, the fuel price for ATI was assumed to be equal to the fuel price for TAA. Australian data prior to 1976 have been adjusted to convert them to a great circle distance basis. The data for ADPP were obtained for all airlines by residual from equation (1). Finally, strike-affected observations have been deleted from the sample.

In addition, it is interesting to give an impression of the data comparison between the Australian and US carriers. For most variables used in this study the data for the Australian carriers tend to rank between the US trunks and local service operators. In contrast, however, the price of fuel and average load factors are much higher in Australia than in the USA. As well, ATI serves a relatively large number of airports compared with most US carriers. The data also indicate that the price of labour is relatively low for Australian carriers compared with in the USA.

3.3 Empirical Results

Equation (5) was estimated with ordinary least squares using the Shazam econometric program package (White (1978)). Irrelevant variables were then deleted using appropriate F-test procedures. At this stage most of the higher order and cross-product terms, together with time dummy variables which were introduced to allow for the possibility of technological change over the sample period, were deleted. The following preferred equation was obtained:

$$\begin{aligned} \ln TOC = {} & \underset{(4.30)}{2.905} + \underset{(10.56)}{0.444}\,AUST + \underset{(1.75)}{0.051}\,TAA - \underset{(-2.39)}{0.035}\,US77 \\ & - \underset{(-3.58)}{0.060}\,US78 + \underset{(76.11)}{1.041}\,\ln PORTS + \underset{(42.15)}{0.077}\,(\ln ASL)^2 \\ & + \underset{(4.94)}{0.314}\,\ln ALF + \underset{(12.15)}{0.495}\,\ln AAS + \underset{(65.04)}{1.084}\,\ln ADPP \\ & + \underset{(4.72)}{0.517}\,\ln PASS + \underset{(2.68)}{0.286}\,\ln SCH + \underset{(3.90)}{0.242}\,\ln FPL \\ & + \underset{(6.56)}{0.133}\,\ln FPF \qquad R^2 = 0.998 \qquad SER = 0.048 \qquad (6) \end{aligned}$$

where, in addition to previously defined variables, AUST is a dummy variable for the two Australian airlines; TAA is a dummy variable for TAA; US77 and US78 are dummy variables to capture the effects of airline deregulation in the USA during 1977 and 1978, respectively; FPL is the factor price of labour; FPF is the factor price of fuel; SER is the standard error of residuals of the estimated equation; and t-ratios are in brackets.

This equation performs well from an econometric viewpoint. All the variables are of correct signs and plausible magnitudes, and statistically very significant. The equation explains a large proportion of the total sample variation of the dependent variable. In addition, asymtotic LM tests performed by the econometric program suggest that the assumptions of normality and homoscedasticity of the residuals cannot be rejected. The standard error of residuals gives an indication of the model's predictive ability by suggesting a two-standard error range for an airline's actual total operating costs of plus or minus 10 per cent around the estimated value. This paper is particularly interested in the Australian carriers. All their estimates, except TAA (1973 and 1974), are within five per cent of their actual sample observations.

A more demanding test of the model is its ability to forecast outside the sample observations. Equation (5) was reestimated over the period 1971 to 1976 and used to forecast total operating costs for the Australian carriers for the next three years. The results of this test are shown in Table 1. The 1971 observation on the US local service operator Allegheny (AL) was deleted from the estimation sample because of data deficiency which was subsequently corrected. The model performs well at forecasting outside the sample observations in this test.

Table 2 contains the estimates of cost elasticities with respect to various output dimensions. All these elasticities are significantly different from unity. The elasticity of ASL has been evaluated at 370 miles, which is around the length prevalent in Australia. As expected, the model suggests substantial economies of operation with respect to load factors, aircraft size and stage length. Clearly, once a flight is being undertaken, the marginal cost of additional passengers is very small. Economies of aircraft size result from aerodynamic advantages and lower proportionate drag, as well as a higher ratio of payload to total weight (Strazheim (1969)). Economies of stage length arise as the relatively fixed costs of takeoff, climbing to cruise and landing are spread over longer flight distances. However, this effect occurs only up to the design range of the aircraft in operation. After a certain distance payload must decrease (Douglas and Miller (1974)). This effect is captured by equation (6), in which the estimated cost elasticity with respect to ASL increases as ASL increases.

In contrast, the estimated model suggests that there are diseconomies associated with serving more ports and operating more flights from a given port. This last finding is quite strong and exerts a significant influence on the simulation results of the following section. This diseconomy most likely arises from increased airside congestion at busier airports, i.e. the extra time spent taxiing and awaiting landing. Thus while ADPP is a component of market density (which can be defined as the product of the last three variables on the right-hand side of equation (1)), it seems clear that the cost advantages of dense markets result from the scope they provide to operate large aircraft at relatively high load factors, rather than merely the opportunity to make more flights.

Of interest to many is the question of the impact on costs of changing the composition of an airline's output, while keeping total output constant and operating over the same network structure. For example, a firm could produce the same output by operating fewer flights at a higher average load factor. Clearly, an infinite number of possibilities exist. However, three cases are shown for illustration in Table 3. Thus, if ALF were to rise and its rise offset by a fall in ADPP so that total output remained unchanged, then total operating costs would fall by 77.0 per cent of the initial percentage change in ALF. The model clearly suggests that operating costs are lowered by flying large aircraft, relatively full and relatively infrequently. In addition, Table 3 reveals that passenger traffic and scheduled services are more expensive to provide than their alternatives.

4. SIMULATION OF SOME AUSTRALIAN POLICY ALTERNATIVES

The appropriate policy for Australia's airline industry has been the subject of considerable debate in recent years. This section uses the framework and estimated model from above to simulate some of these policy alternatives and to assess their cost implications.

4.1 US System Cost Incentives

The Australian system of setting air fares in which prices are adjusted so that changes in revenue offset any changes in costs, i.e. regulation of the level of profit, appears to provide strong incentives and ample scope for cost inefficiency (see Albon and Kirby (1983)). Such opportunities are not as readily available in the US industry. Prior to deregulation fares were determined by rate of return regulation, where costs for regulatory purposes were taken to be an industry-wide average. The US regulatory framework at that time provided much greater scope for non-price competition, e.g. through frequency of service and aircraft type, which lessens the ability to engage in cost-padding practices. The larger number of carriers and the greater diversity of networks also rendered more difficult the collusion (tacit or otherwise) necessary to extract potential monopoly rents through cost-padding. In addition, taking averages of industry costs provided each individual airline with greater incentive to perform better than average and so reap extra profits.

This discussion suggests then that the Australian system of airline regulation is likely to result in a greater degree of cost inefficiency than its US counterpart. The estimated parameter of the dummy variable for Australian carriers implies that costs in Australia for a particular airline operation are 55.9 per cent higher than the equivalent operation in the USA.[11] Part of this observed difference might be explained by omitted variables or differences in measurment of included variables. For example, some relevant output dimensions may not be included in the output index, e.g. safety and other operating standards or in-flight service, and the cost of capital has been omitted from the estimated model (for data availability reasons). In addition, another often quoted explanation for the existence of some difference is the distance in location of the Australian carriers from the manufacturers of their aircraft, necessitating the holding of larger inventories of spare parts. However, it is felt unlikely that these considerations would substantially reduce the order of magnitude of the estimated cost differences between the Australian and US airlines.

Equation (6) also sheds some light on the impact of deregulation in the US airline industry.[12] The US-specific time dummy variables indicate that total operating costs of existing carriers were 3.4 per cent and 5.8 per cent lower in 1977 and 1978 respectively, the first two years of deregulation, than in previous years. This structural break was not detected with respect to the Australian airlines and indicates the likelihood of even further improvement in cost efficiency from more open market conditions.[13]

4.2 Privatise TAA

It can be argued on theoretical grounds that government-owned enterprises are likely to be less efficient than their privately-owned counterparts. The Australian Two-Airline Policy is a well known case study (see Davies (1971) and Kirby and Albon (1984)). Hence calls are sometimes made to return TAA to the private sector.

An estimate of the impact of government ownership on airline costs was obtained by the inclusion of a dummy variable for TAA. The estimated coefficient of the TAA dummy variable is 0.051 which implies that TAA's costs are 5.2 per cent higher than those of its private counterpart, ATI. Furthermore, the t-ratio is 1.75 which is significant in a one-tailed test at a 95 per cent level of confidence, so that there is only 5 per cent level of confidence that the actual cost difference is zero. This estimate, while providing some further empirical support for Davies' hypothesis, also supports the view that the difference in cost efficiency between TAA and ATI is relatively small in magnitude compared with the cost inefficiencies of both operators induced by the Australian regulatory policies.

4.3 One-Airline Policy

Some commentators argue that a monopoly airline would more fully capture economies of scale and hence lower the total cost to the community of the provision of airline services. A "crude" interpretation of the One-Airline Policy is to merge the operations of ATI and TAA. This policy would result in all of Australia's domestic airline operations, except those of the independent regional carrier East-West Airlines, being undertaken by a single company. It is assumed that this company will operate the same aircraft and services over the current networks. For the simulation exercise its total output is taken to be the sum of the outputs of the separate ATI and TAA operations. All output dimensions, except ADPP, and factor prices of the simulated operation are taken as the total output weighted averages of their ATI and TAA counterparts. ADPP for the simulated operation is calculated as a residual from the identity given by equation (1).

Over the three year period 1974-1976 the total costs of this policy are estimated to be $1834m (Item 7, Table 4), compared with the model's estimate of $1804m under the existing Two-Airline Policy (Item 6), i.e. costs would be 1.7 per cent or $10m per annum higher under this interpretation of the One-Airline Policy.[14]

The Two-Airline Policy relates more directly to Ansett Airlines of Australia (AAA) than to the total operations of ATI, which also includes the activities of its regional carriers. Using data for AAA's operations its total operating costs can be estimated (Item 8) and hence the total industry costs as the sum of those of AAA and TAA (Item 10).

An "exact" interpretation of a One-Airline Policy then involves the merging of AAA's and TAA's activities, again assuming the same networks, aircraft and services. Item 11 shows that the three year total cost of such a policy would be $1647m, which is 2.2 per cent or $12m per annum higher than costs under the current policy (Item 10).

Particular concern is often shown for the major trunk routes over which both AAA and TAA operate and where the Two Airline Policy has its most obvious effects. By adjusting the data for the regional or "non competitive" activities of AAA and TAA, the model can estimate their cost of operations on the "competitive" route network (Items 13 and 14), and hence the total industry cost of airline services on these trunk routes (Item 15).

Then an even "more exact" interpretation of the One Airline Policy would involve the merging of the competitive route activities of AAA and TAA. The estimate of total costs of such a policy over 1974 1976 is $1670m (Item 16), i.e. 3.2 per cent or $17m per annum higher than the current policy (Item 15).

4.4 Three Airline Policy

A Three Airline Policy is sometimes advocated as a means of increasing competition within the Australian airline industry. This policy can be interpreted as the introduction of a third airline over the trunk network of AAA and TAA. Assume that there is an equal division of the total industry output and that the output dimensions of the new entrant are output weighted averages of the existing two, i.e. in particular, it will operate similar sized aircraft. Total industry costs under this policy are estimated to be $1523m over the three years to 1976 (Item 17), which is 5.9 per cent or $32m per annum lower than[15] corresponding costs under the Two Airline Policy (Item 15).

4.5 "Creamskimmer Airlines (CSA)"

Consider the impact of the introduction of a creamskimming airline operation on the networks of AAA and TAA. Assume that the new entrant operates on the following major routes: Melbourne to Adelaide, Sydney and Brisbane, and Sydney to Adelaide and Brisbane. Assume that after its introduction current traffic is shared equally by the three airlines on these major routes and that the output dimensions and factor prices of CSA are output weighted averages of those of AAA and TAA on these routes. Then over the three years 1974 1976 the total cost of serving the AAA and TAA networks is $1601m (Item 12), i.e. 0.7 per cent or $4m per annum lower than under the current policy (Item 10).

4.6 Abolition of Parallel Schedules

Parallel departures of flights by AAA and TAA are a cost of the Two Airline Policy. We can use the model to estimate the cost savings which might occur when these services are deparallelled. Assume that each operator can, for currently parallel flights, halve the number of departures and double the size of the aircraft. Then, given data on the proportion of flights in parallel,[16] we can adjust the data to obtain simulated airlines with less ADPP and larger AAS (Items 18 and 19). It is estimated that the total cost of serving the competitive network in this manner is $1293m (Item 20), which is 20.1 per cent or $108m per annum lower than the cost of doing so under the Two Airline Policy (Item 15).[17]

The coordination necessary to achieve these significant cost savings has not been forthcoming under Two-Airline Policy. However, it could presumably become possible if the two operators were merged. So consider the merging of AAA's and TAA's competitive services where the new company deparallels existing parallel flights by doubling aircraft size and halving the number of departures. This probably represents many industry representatives' interpretation of the One-Airline Policy. In this case the total costs of operation are estimated to be $1336m (Item 21) over the three year period, i.e. 17.4 per cent or $94m per annum lower than currently (Item 15) .

4.7 Concluding Remarks

All the policy simulations assume that total industry output remains unchanged, that cost changes arise merely because of changes in output dimensions of the simulated system, and that cost efficiency incentives are unaltered. Thus the findings should be used with caution as a guide to policy recommendations.

For example, a more relaxed approach to market entry which permits the establishment of a "Creamskimmer Airlines" may decrease the scope for cost inefficiency, so that some of the difference between US and Australian carriers may be regained. Thus the cost savings from such a policy may be much greater than those suggested by the present simulation results alone. On the other hand, other policies which indicate relatively large reductions in costs, e.g. deparallelling schedules within a One-Airline Policy, appear to offer little added incentive to cost efficiency and may even diminish such incentives. The apparent existence of such large potential cost savings can be taken as evidence of substantial regulatory failure at the present and perhaps argues against further regulatory intervention and for the greater adoption of market-oriented policies.

5. CONCLUSION

This paper presents a further econometric study of airline costs. However, it contains several advances over many previous studies. Firstly, it utilises all the available information regarding the multiproduct nature of an airline's aggregate output, as given by the identity relationship of equation (1). Secondly, it takes account of this information by the construction of an output index. Thirdly, the use of this index within the framework of the highly general and flexible translog cost function specification ensures a well specified and less ad hoc estimating equation. Finally, a large and high quality data base is available for estimation.

The empirical results are satisfactory from an econometric viewpoint. The estimated model has high explanatory power, together with statistically significant and plausible coefficient estimates. These estimates reveal substantial economies of operation with respect to load factors, aircraft size and stage length, but diseconomies associated with serving more ports and increased departures from a given port.

The model can also be used for simulation purposes to examine the cost implications of various policy alternatives. The simulation results, while they must be used with caution, indicate the existence of substantial potential cost savings in the Australian domestic airline industry.

TABLE 1

Forecasting ability of estimated cost model

Observation	Actual (A)	Forecast (F)	F/A
AL (1971)	239.37	247.39	1.03
ATI (1977)	311.10	321.68	1.03
TAA (1977)	253.03	263.19	1.04
ATI (1978)	339.95	357.21	1.05
TAA (1978)	282.62	289.05	1.02
ATI (1979)	347.46	371.61	1.07
TAA (1979)	294.46	305.60	1.04

TABLE 2

Cost elasticity with respect to selected output dimensions

Output dimensions	Elasticity
PORTS	1.041
ASL(a)	0.911
ALF	0.314
AAS	0.495
ADPP	1.084

(a) Evaluated at 370 miles.

TABLE 3

Cost elasticity with respect to changed composition of output

Output dimension		Elasticity
Initial	Offsetting	
ALF	ADPP	-0.770
ALF	AAS	-0.181
AAS	ADPP	-0.589
PASS	n.a.	0.517
SCH	n.a.	0.286

TABLE 4

Simulation of various Australian policy alternatives

Observation/Policy	1974	1975	1976	Period Total
1. ATI(A)	333.96	328.05	323.55	985.56
2. ATI(E)	327.08	343.61	311.28	981.97
3. TAA(A)	280.17	273.18	265.05	818.40
4. TAA(E)	274.76	287.75	259.07	821.58
5. ATI(A) + TAA(A)	614.13	601.23	588.60	1803.96
6. ATI(E) + TAA(E)	601.84	631.36	570.35	1803.55
7. One-Airline Policy: Crude(S)	610.99	642.76	579.79	1833.54
8. AAA(S)	264.10	276.12	249.91	790.13
9. AAA(S) + TAA(A)	544.27	549.30	514.96	1608.53
10. AAA(S) + TAA(E)	538.86	563.87	508.98	1611.71
11. One-Airline Policy: Exact(S)	554.76	574.32	517.51	1646.59
12. "Creamskimmer Airlines"(S)	534.84	560.40	505.57	1600.81
13. AAA: Trunk Routes(S)	263.71	276.35	250.41	790.47
14. TAA: Trunk Routes(S)	278.73	291.11	257.61	827.45
15. AAA: TR(S) + TAA: TR(S) (13 + 14)	542.44	567.46	508.02	1617.92
16. One-Airline Policy: More Exact(S)	559.66	584.58	525.64	1669.88
17. Three-Airline Policy(S)	510.24	533.14	479.39	1522.77
18. AAA: TR,Deparallelled(S)	215.49	229.08	186.24	630.81
19. TAA: TR,Deparallelled(S)	228.53	240.94	192.24	661.71
20. AAA: TR,Dep.(S) + TAA: TR, Dep.(S)	444.02	470.02	378.48	1292.52
21. One-Airline Policy: More Exact,Dep.(S)	458.61	485.74	391.66	1336.01

(A): Actual, (E): Estimate, (S): Simulation.

FOOTNOTES

* This paper is a revised version of a paper presented at the Research Workshop in Industrial Organisation, Australian Graduate School of Management, University of New South Wales, 26 May 1982. Most of the research reported in this paper was undertaken while the author was employed at the Australian National University. The opinions expressed in this paper do not necessarily reflect those of the author's current employer.

1. See Kirby (1979) for a discussion of this policy and Kirby (1981, Ch.2) on the monopoly issue.
2. From a survey of several studies, White(1979, p. 564) concludes that "economies of scale are negligible or non-existent at the overall firm level".
3. There is some discussion in the literature as to whether this measure or ton-miles available (TMA) is to be preferred. It is sometimes argued that the bulk of the costs of airline operations are more directly related to the provision of capacity rather than the amount of traffic carried, and that the use of TMP confounds a carrier's ability to sell with its ability to produce. However, choice of the latter involves a somewhat forced or artificial split of an airline firm's activities, with all the associated problems of allocating joint and common costs, and is especially not to be preferred when trying to analyse total operating costs (TOC), as in this paper. Furthermore, the approach adopted in this paper explicitly takes account of an airline's load factor.

4. For example, Murphy (1969), Strazheim (1969), Douglas and Miller (1974) and Mackay (1979).

5. This is a modified form of an identity presented in Sarndal and Statton (1975).

6. Spady and Friedlaender (1978) construct a similar index. However, they do not take advantage of the identity relationship between total output and its various components and hence their choice of output dimensions remains ad hoc.

7. See Christensen and Greene (1976) for a useful summary of the economic theory of the firm relating to the use of the translog cost function and an empirical application.

8. Trans-Australia Airlines (TAA), a government-owned carrier, and Ansett Transport Industries (ATI), consisting of the major trunk operator Ansett Airlines of Australia (AAA) and several regional operators.

9. Allegheny, Frontier, Hughes Airwest, North Central, Ozark, Piedmont, Southern and Texas International.

10. American, Braniff, Continental, Delta, Eastern, National, Northwest, Transworld, United and Western.

11. The actual difference is likely to be less than 41.2 per cent with only one per cent confidence.

12. See Kirby (1984) for an overview of the US airline deregulation experience.

13. These data understate the impact on operating costs in the industry since they take factor prices, notably that of labour, as given. A feature of the deregulated US industry has been the emergence of new operators with a much lower labour cost structure. Further cost savings can be expected over time as carriers continue to rationalise their route networks.

14. For the simulation exercises here and below, where the purpose is to assess the impact on costs of regulatory policies which affect output dimensions within the industry, it is preferable to compare the simulation results with the model's estimates of costs under the current policy, not with the actual observed costs under the current policy. A comparison with the latter data would seem to confound policy effects with the model's prediction error.

15. Mackay (1979) notes that his results imply that costs under a One Airline Policy would fall by 4 per cent and increase by 2.5 per cent under a Three Airline Policy. However, it is difficult to interpret and hence reconcile these results as his specification fails to fully account for all the relevant output dimensions and data limitations necessitate the use of proxy variables.

16. Gannon (1979) finds that the proportion of flights on selected competitive routes that were considered to be in parallel for December of 1974, 1975 and 1976 was 57.7 per cent, 54.8 per cent and 78.7 per cent respectively.

17. Forsyth (1981) estimates a cost penalty of 5 to 10 per cent from parallel scheduling. However, his specification and simulation method differ from this paper.

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PAPER 2:

PROPERTY RIGHTS, REGULATION AND EFFICIENCY: A FURTHER COMMENT ON AUSTRALIA'S TWO-AIRLINE POLICY

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PROPERTY RIGHTS, REGULATION AND EFFICIENCY: A FURTHER COMMENT ON AUSTRALIA'S TWO-AIRLINE POLICY

1. Introduction

The relative efficiency of public and private firms has been a long-standing issue in the property rights literature and Australia's Two-Airline Policy is one of the few applied case studies on the topic.[1] Davies (1971, 1977) uses labour productivity measures to argue that TAA is less efficient than its private counterpart, thus supporting his general thesis regarding the effects of property rights on economic performance. However, his analysis has not gone unchallenged. The recently published exchange between Forsyth and Hocking (1980) and Davies (1980) is typical of the debate. In fact, the criticisms have been such that accepted opinion, as represented in a recent survey on public and private enterprise, is that 'the major conclusion that can be drawn from the case of Australian airlines is ... that ... there is no signficant evidence that productivity is lower in public firms than private firms' (Millward and Parker, 1982, p. 239).[2]

However, it is our contention that the debate on the relative efficiency of public and private firms within Australia's Two-Airline Policy presently suffers two serious deficiencies. Firstly, no explicit model of firm behaviour under the Two-Airline Policy has been developed. Thus it is difficult to assess the claim, put forward by both Forsyth and Hocking (1980) and Jordan (1981), that the regulatory environment constrains the two operators to a similar economic performance. Secondly, inadequate empirical techniques have been used to address the question of relative efficiency. This note corrects these two deficiencies and, in doing so, provides evidence to challenge the apparent conventional wisdom regarding the case of Australia's domestic airlines.

2. A Model of Firm Behaviour under the Two-Airline Policy

Albon and Kirby (1983) examine the case of a private firm operating in an industry where entry is effectively prohibited by the State, giving rise to potential monopoly profits, $\bar{\pi}_m$. That model assumes that the regulatory authorities set prices so that the regulated firm earns a chosen level of profits, π_r ; that the firm's costs are merely verified, not justified, by the regulators; and that the firm's utility function, $U(\pi, CI)$, depends on profits and cost inefficiency such that $U_\pi > U_{CI} > 0$. In this regulatory environment the firm has an incentive to capture the remaining potential monopoly profits, $\pi_m - \pi_r$, through padding its costs of production. The result of this behaviour can be seen in Figure 1, which shows the firm's regulatory profit constraint, its possible trade-off between profits and cost inefficiency and its preferences between these. The utility maximising firm chooses to operate at point B where its costs are padded by D dollars. At B the firm (and society) is worse off by AE than it is at the unconstrained monopoly optimum, point A.

With the aid of a simple characterisation of a government-owned firm this analysis can be readily extended to the case of a regulated public monopoly and then to that of the Two-Airline Policy framework. Assume that the public firm has an identical utility function to its private counterpart. Assume further that the managers of the public firm are unable to directly share in the profits earned by it and that there is no effective direct control on management. Under these assumptions the public firm, like the private firm, has an incentive to maximise potential profits by operating at the usual monopoly outcome. However, unlike the private firm, it has an incentive to extract all of the potential monopoly profits, π_m, as cost-padding, with an associated deadweight loss of AF. If the regulatory authorities set prices so as to achieve a target level of profits, π_r, this public firm is constrained to point B, where management suffers a loss of FG compared with its unconstrained behaviour (point C). However, government revenue increases by π_r, so that deadweight costs to society are reduced by $(\pi_r - FG)$. These efficiency gains are simply due to less profits being dissipated as cost-padding.

It can be noted that profit regulation of both the privately-owned and government-owned monopoly firm leads each to the same point B on Figure 1 with identical costs (assuming an effective cost verification procedure). However, at that position, they each face opposite incentives with respect to cost inefficiency.

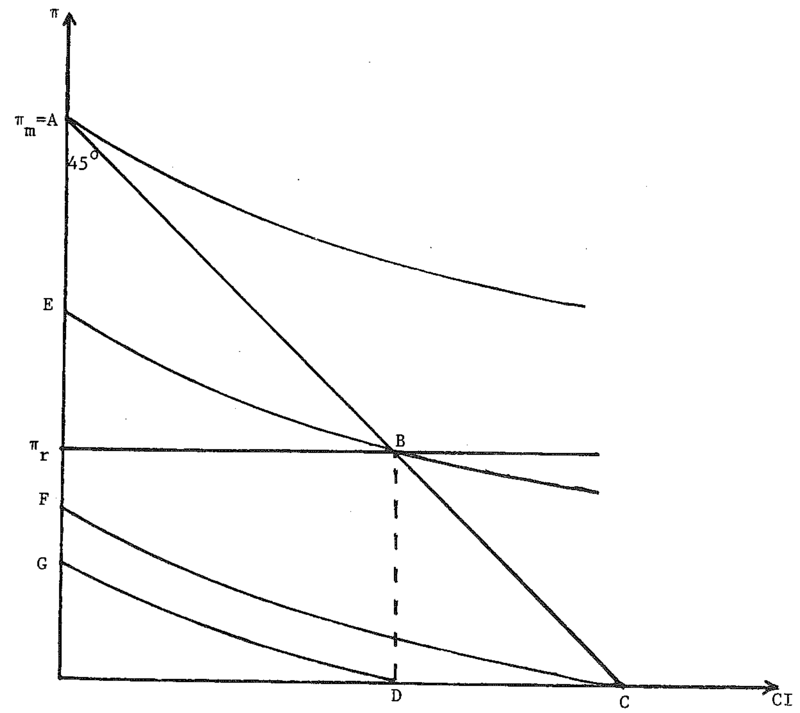

FIGURE 1

However, this divergence of incentives, combined with the requirement that both firms charge the same prices, complicates profit regulation in an industry where both types of firm operate together, such as under the Two-Airline Policy. If prices are set on the basis of the private firm's costs, the profit constraint binds it to point B on Figure 1.[3] The government-owned firm, in the absence of further constraints (e.g. the threat of a change in management if it performs noticeably worse than its private competitor), would then choose to operate at point C with the maximum possible degree of cost-padding. The efficiency costs of this strategy include AE plus the costs of government ownership, AF (in addition to the usual deadweight loss associated with the monopoly price/quantity outcome). On the other hand, if the costs of the government firm are used as the benchmark for setting prices, the profit constraint binds it to B. In contrast, the private firm, in the absence of further constraints (e.g. the threat of abolition of entry restrictions if it performs significantly better than its competitor), would have an incentive to minimise cost-padding and operate at point A, where it takes out its share of the monopoly profits directly. The efficiency costs of this strategy, compared to the unconstrained monopoly position, include AG less π_r, which is (AE + π_r - FG) less than under the previous pricing strategy. This analysis then suggests the perhaps somewhat counter-intuitive result that the deadweight losses to the community from attempting to regulate profits in entry-restricted industries can be lessened if the high-cost firm is used as the standard for costs.[4]

However, for our present purpose, it can be noted that, in our model, regardless of which firm is used as the cost benchmark for pricing purposes, the government-owned firm will tend to be less cost efficient than its private counterpart. The extent to which this tendency is realised is an empirical question and the subject of the following section.

3. An Econometric Test of Relative Cost Efficiency

Davies (1971, 1977) utilises labour productivity ratios to assess the relative efficiency of TAA and its private counterpart, ATI. While this procedure has intuitive appeal and the advantage of simplicity, there are several reasons for caution in its use. Since each partial productivity measure captures only a particular facet of a firm's operations, no single ratio is adequate and one really needs to consider a wide range of such ratios. Any particular ratio also ignores the impact of other production inputs. Thus observed differences or changes in partial productivity may be due to factor substitution, technical progress or higher quality inputs. Finally, firms often operate in quite different environments - e.g. different outputs, qualities, factor prices, climate and geography - which can affect the measurement of productivity ratios.

While Forsyth and Hocking (1980) are well aware of the difficulties with the use of partial productivity ratios, the debate between themselves and Davies (1980) still relies exclusively upon the use of such ratios. It thus faces the danger of becoming little more than a succession of conflicting opinions as to the significance or otherwise of various productivity differences after essentially subjective assessments of the impact of other influencing factors. Clearly, it would be more desirable to utilise a technique which is capable of explicitly allowing for any differences in operating conditions and which provides statistical assessments of the impact of such conditions and of relative efficiency.

Kirby (1984) estimates an econometric model of airline costs. This model explains the total operating costs of the two major Australian airlines and 18 US local service and trunk airlines over the period 1971 to 1978 in terms of their operating environment (e.g. number of ports served, average stage length, load factors, aircraft size) and factor prices. Furthermore, assuming fixed effects, differences in performance by the Australian airlines and TAA can be estimated with the use of dummy variables. The preferred estimated equation is:

$$\begin{aligned}\ln TOC = {} & \underset{(4.30)}{2.905} + \underset{(10.56)}{0.444}\, AUST + \underset{(1.75)}{0.051}\, TAA - \underset{(-2.39)}{0.035}\, US77 \\ & - \underset{(-3.58)}{0.060}\, US78 + \underset{(76.11)}{1.041} \ln PORTS + \underset{(42.15)}{0.077} (\ln ASL)^2 \\ & + \underset{(4.94)}{0.314} \ln ALF + \underset{(12.15)}{0.495} \ln AAS + \underset{(65.04)}{1.084} \ln ADPP\end{aligned}$$

$$+0.517 \ln PASS + 0.286 \ln SCH + 0.242 \ln FPL$$
$$(4.72) \quad (2.68) \quad (3.90)$$

$$+0.133 \ln FPF \quad R^2 = 0.998 \quad SER = 0.048$$
$$(6.56)$$

where TOC is the total operating cost of each airline; AUST is a dummy variable for the two Australian airlines; TAA is a dummy variable for TAA; US77 and US78 are dummy variables to capture the effects of airline deregulation in the US during 1977 and 1978, respectively; PORTS is the number of airports served; ASL is average stage length; ALF is average load factor; AAS is average aircraft size; ADPP is average number of departures per port; PASS and SCH are the proportions of total output that is passenger traffic and is with scheduled services, respectively; FPL is the factor price of labour; and FPF is the factor price of fuel.

The estimated coefficient of the TAA dummy variable implies that TAA's operating costs are 5.2 per cent higher than those of ATI. Furthermore, this estimate is signficantly different from zero in a one-tailed test at a 95 per cent level of confidence. Thus this econometric analysis suggests that there is a signficant difference in cost efficiency between TAA and ATI.[5]

Note also that there is a very much larger difference in the cost efficiency of the Australian operators compared with the US carriers - Australian airline costs appear to be of the order of 55 per cent higher than for equivalent operations in the US.

4. Conclusions

In this note we use a model of profit regulation under the Two-Airline Policy to show that there is a tendency for the government-owned firm to be less cost efficient than the private one. In addition, we present econometric evidence that a significant difference in cost efficiency does exist. Our analysis and evidence is contrary to what currently appears to be a widely accepted view. However, this result, while in our view important, should be kept in perspective. The conclusion of Kirby (1981, p.45) appears to be still valid: 'while there appears to be some theoretical and empirical evidence that the state firm is less efficient than the private one, this difference is likely to be small compared with the inefficiencies of both operators which are due to the current policies of economic regulation'.

FOOTNOTES

1. Other case studies include Canadian railroads (Caves and Christensen, 1980) and US municipal water utilities (Feigenbaum and Teeples, 1983).

2. Jordan (1981) also argues that ownership appears to have had little effect on airline performance in Australia.

3. Assuming identical preferences and equal market shares we can continue to use Figure 1, where A should now be interpreted as $\pi_m/2$, to show the behaviour of both firms.

4. The data in Table 1 of Albon and Kirby (1983) suggest that past air fare adjustments have, in fact, been based on the costs of TAA.

5. An earlier, although relatively less sophisticated, econometric study by Mackay (1979) has implications for the relative efficiency of TAA and ATI. His results, which have been neglected by both Davies and Forsyth and Hocking, also suggest that TAA performed slightly worse than ATI. Further evidence to support the hypothesis that the public firm will be less cost efficient is provided by the data in Table 1 of Albon and Kirby (1983). That data shows that over the period 1974-75 to 1979-80, despite the regulatory controls, ATI was able to increase its profits by $18.6m compared with only $1.8m for TAA.

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