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DISCUSSION PAPER NO. 326

Identifying and Measuring the Impact of Government Ownership and Regulation on Airline Performance

by

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RÉSUMÉ

A. Questions étudiées

Dans cette étude, nous tentons de distinguer les effets de la propriété publique et de la réglementation sur la structure de l'industrie canadienne du transport aérien et sur le rendement des transporteurs transcontinentaux et régionaux existants en 1981. L'étude a été conçue en vue de distinguer l'inefficacité découlant de la réglementation gouvernementale de celle qui pourrait être attribuée à l'existence de sociétés d'État dans l'industrie aérienne. L'étude vise également à expliquer la relation symbiotique entre la réglementation et la propriété publique puisque l'existence d'un transporteur appartenant à l'État peut avoir et a effectivement un effet déterminant sur l'étendue de la réglementation et des pratiques de réglementation, de même que sur la structure de l'industrie. La recherche, de nature rétrospective, se fonde sur une base de données chronologiques pour mesurer et évaluer les différents effets de la propriété et de la réglementation. Elle ne renferme pas d'analyse prospective des différentes orientations possibles de la politique de réglementation, ni des diverses formes que peut prendre la propriété.

Dans cette étude, le rendement est mesuré en fonction de l'efficience économique de la distribution des ressources. Bien qu'au Canada, l'opinion la plus répandue est que l'équité et l'efficience sont des dimensions d'importance égale ou complémentaires, nous démontrons que l'efficience est celle qui doit prédominer dans une évaluation de l'industrie canadienne du transport aérien.

Un examen des ouvrages reconnus a révélé que la réglementation et la propriété publique ont des conséquences prévisibles similaires : coûts plus élevés, productivité plus faible, rapport capital-main-d'oeuvre non efficient et utilisation excessive de capital. Toutefois, la réglementation économique s'étend à l'ensemble de l'industrie, tandis que la propriété publique ou une forme particulière de propriété n'a d'effet que sur quelques entreprises. Il existe au Canada, même dans les entreprises publiques, une variation suffisante du degré réel de contrôle ainsi qu'une alternance, pour un même transporteur, de la propriété publique et de la propriété privée (société privée fermée ou ouverte). Nous soutenons donc qu'il est possible de distinguer les effets de la réglementation de ceux de la propriété publique, même sur les mêmes variables.

La méthode retenue consiste à utiliser les écarts entre les fonctions estimées de productivité et de coût pour dégager les

effets distincts de la réglementation et de la propriété publique sur les coûts et sur la productivité. En établissant les paramètres des effets d'autres variables sur les coûts et sur la productivité, nous pouvons réduire les risques d'obtenir de faux résultats de la comparaison des écarts plutôt que des valeurs absolues des coûts et de la productivité.

L'étude vise à répondre à quatre questions. 1° Quels effets ont la propriété publique et la réglementation sur le rendement des transporteurs aériens? 2° Quels sont les effets de la propriété publique et de la réglementation sur les marchés du transport aérien? 3° Quel est l'effet de la propriété publique (en particulier de l'existence d'Air Canada) sur la politique et les méthodes de réglementation? 4° Par rapport à d'autres mécanismes, comment la propriété publique contribue-t-elle à la réalisation des objectifs du Canada en matière de transport aérien?

B. Méthode

La méthode appliquée ici pour répondre aux questions précédentes consiste à extraire une série de données analytiques de modèles des coûts et de la productivité et à définir un ensemble de caractéristiques des entreprises. La matrice de renseignements sur les entreprises comprenant les caractéristiques de l'industrie et de la réglementation présente de façon détaillée les phénomènes importants qui sont propres à l'industrie et aux transporteurs particuliers ou qui influent sur eux. Nous établissons une corrélation statistique et empirique entre la série de données tirées des modèles analytiques et la matrice de renseignements sur les entreprises pour tenter d'attribuer les écarts de rendement soit à la réglementation, soit à la nature de la propriété.

Notre méthode s'applique en deux étapes. Premièrement, nous utilisons la série de données chronologiques correspondant à la période de 1964 à 1981 et se rapportant à un échantillon constant d'entreprises composé des deux transporteurs nationaux et de cinq transporteurs régionaux du Canada, pour mesurer et comparer le rendement économique des sociétés aériennes privées ou publiques. Les modèles utilisés tiennent compte explicitement des divergences entre les entreprises sur le plan des prix, de l'étendue des opérations, du réseau, de la répartition des extrants et d'autres caractéristiques du milieu d'exploitation. Après avoir attribué les divergences de rendement aux caractéristiques de l'exploitation susceptibles de les expliquer, il reste des écarts ou des différences de productivité "non expliquées". Une analyse statistique de ces écarts nous permet ensuite de déterminer avec une certaine précision les effets du type de propriété et de la politique de réglementation sur le rendement.

Deuxièmement, l'analyse purement statistique est étoffée à l'aide de données qualitatives tirées de la matrice de renseignements sur les entreprises qui fournit un relevé détaillé de phénomènes tels que les changements de propriétaires, les achats et les retraits d'appareils, les grèves, les changements importants au niveau de la direction, les changements de routes, et les modifications apportées à la politique et à la réglementation. Ces données sont comparées aux écarts dégagés de l'analyse statistique afin de mieux comprendre la nature et l'importance des effets des phénomènes sur le rendement des transporteurs.

La première étape de l'évaluation du rendement de l'industrie canadienne du transport aérien consiste à mesurer la productivité globale des facteurs (PGF) qui désigne le rapport entre la production globale et une unité de l'agrégat des facteurs de production ou intrants. Cette mesure diffère des mesures plus simples de la productivité, telles que la production par heure-personne, parce qu'elle tient compte non seulement de la possibilité, mais de l'existence de plus d'un type d'extrant, et aussi du fait que des intrants autres que la main-d'oeuvre contribuent à fournir des services de transport aérien. La PGF permet de tenir compte des divers intrants et de la qualité différente de chacun d'eux, en leur attribuant un coefficient approprié de pondération; elle permet aussi de corriger le problème d'hétérogénéité de la production en attribuant un coefficient plus élevé aux extrants de qualité supérieure dans la détermination d'une mesure globale de la production. La productivité est le reflet de l'efficience en termes de coûts et l'analyse de la productivité est une étape utile et relativement peu coûteuse qui prépare l'analyse plus chère et complexe au moyen de fonctions de coût. Les fonctions de coût servent ensuite à examiner des aspects tels que les économies de concentration de trafic, d'échelle et de diversification, de même que l'effet de divers genres de réglementation ou types de propriété sur le rendement des transporteurs et de l'industrie.

Les sociétés aériennes ont une production hétérogène et elles utilisent des intrants de qualité variée. La production est fonction de l'importance et de la longueur des routes et de marchés de densité variable. La productivité des facteurs a changé avec le temps au rythme de l'adoption de la technologie nouvelle. Il est raisonnable de supposer que la représentation réaliste de la structure des coûts d'une industrie doit incorporer non seulement les nombreux extrants et intrants, mais aussi les caractéristiques particulières des réseaux et les variations de la productivité des facteurs. La fonction de coûts retenue et estimée nous a permis effectivement de mesurer tous les rapports dont nous avons fait état.

Pour tenir compte de toutes les dimensions découlant de la multiplicité des extrants et des intrants, de même que de la variabilité des caractéristiques des routes et des marchés, nous utilisons dans notre analyse une fonction de coût translog incorporant trois extrants, des intrants multiples et des fonctions d'ajustement hédonistiques pour les extrants. La fonction de coût des transporteurs est estimée à l'aide d'une série de données se rapportant à un échantillon constant de transporteurs aériens, observées sur plusieurs périodes. La fonction de coût incorpore également un facteur de progrès technologique associé au prix de chaque intrant, de même qu'une variable exprimant la tendance chronologique générale. À l'aide de la fonction de coût, nous pouvons mesurer les économies d'échelle, les économies de concentration du trafic et les rapports entre les coûts des différents extrants. Les économies de concentration de trafic traduisent la variation en pourcentage des coûts résultant d'une hausse en pourcentage des extrants, en supposant que l'importance des réseaux (nombre de destinations offertes), les caractéristiques des extrants et les prix des intrants restent constants. Les économies d'échelle reflètent l'augmentation en pourcentage des extrants et des destinations offertes qu'entraîne un accroissement en pourcentage de tous les intrants, lorsque les caractéristiques des extrants et les prix des intrants sont maintenus constants. L'examen des rapports entre les prix des différents extrants suppose l'évaluation, pour chaque paire d'extrants, de la fluctuation des coûts attribuable à la production d'un extrant donné lorsque varie la quantité d'un autre extrant.

C. Conclusions générales

(1) Résultats de l'analyse de la productivité globale des facteurs

L'analyse de la productivité globale des facteurs a d'abord fourni deux séries de résultats intéressants. Premièrement, les mesures brutes de la PGF laissaient d'abord croire que les transporteurs aériens régionaux étaient moins productifs que les deux transporteurs nationaux, Air Canada et CP Air; mais après avoir pris en considération le niveau de production et l'importance du réseau (mais non pas la capacité), il s'est avéré que les transporteurs régionaux étaient plus productifs. Deuxièmement, si l'on tient compte en plus du stock de capital, la productivité globale résiduelle des facteurs est relativement égale pour tous les transporteurs. Ce résultat donne à entendre que le stock de capital d'Air Canada et (dans une moindre mesure) de CP Air a été inférieur à l'optimum au cours de la période étudiée, soit de 1964 à 1981. L'efficience économique relativement plus grande des transporteurs régionaux par rapport à Air Canada ou à CP Air laisse croire que les coûts des transporteurs régionaux sont moins élevés. En outre, l'analyse comparative d'Air Canada et de CP Air a révélé que la PGF résiduelle de CP Air dépassait, en moyenne, d'environ 23 % celle d'Air Canada. L'écart entre la PGF résiduelle de ces deux transporteurs nationaux disparaît lorsque l'on tient compte du stock de capital, ce qui mène à conclure que le manque d'efficience découle d'une trop forte expansion par Air Canada. Compte tenu des données disponibles, il est difficile de déterminer avec précision la source et l'importance de la trop forte expansion de la capacité d'Air Canada; nous soupçonnons qu'elle se rapporte tant au nombre d'appareils qu'à l'achat d'appareils plus gros que ne l'exigeait réellement le marché.

L'analyse de la productivité a aussi permis de dégager l'apport à la productivité des facteurs de chacune des variables correspondant aux extrants et aux réseaux. De façon générale, les résultats montrent qu'en moyenne, l'accroissement de l'échelle de production, de la part des opérations d'affrètement et de la longueur des étapes a tendance à favoriser l'augmentation de la productivité globale des facteurs et, par conséquent, la diminution des coûts. L'augmentation du nombre de points desservis et du stock de capital produit exactement l'effet contraire, soit une baisse de la productivité et une hausse des coûts. Enfin, l'analyse de la PGF laisse supposer que la technologie utilisée par les transporteurs entraîne des économies de concentration positives, des rendements d'échelle constants et d'importantes économies rattachées à la longueur des étapes.

Les modèles de PGF ont été un moyen initial efficace d'évaluer la productivité et le rendement des transporteurs aériens au Canada. À l'aide de ces modèles, nous avons ensuite analysé la structure des coûts au moyen d'un modèle de coûts à extrants et intrants multiples dans lequel nous pouvions tenir compte des différentes caractéristiques des réseaux et des marchés.

(2) Résultats de l'estimation et de l'analyse de la fonction de coût

L'analyse des coûts a fourni un certain nombre de résultats importants et intéressants. Premièrement, les rendements d'échelle sont constants pour tous les transporteurs aériens, sauf Nordair et Air Canada. Les résultats statistiques indiquent, de façon non concluante, des rendements croissants dans le cas de Nordair et décroissants dans le cas d'Air Canada. De façon générale, toutefois, les résultats montrent des rendements d'échelle constants, des économies de concentration appréciables pour tous les transporteurs sauf Air Canada, et la complémentarité positive des services réguliers et affrétés pour voyageurs, sur le plan des coûts, uniquement si les services d'affrètement représentent moins de 5 % de la production globale. Enfin, parmi les caractéristiques d'extrants que nous avons examinées, la longueur des étapes semble avoir l'effet le plus déterminant sur les coûts. La taille de l'entreprise pour laquelle les coûts sont les plus faibles diminue rapidement à mesure qu'augmente la longueur des étapes.

Nous avons constaté que les transporteurs régionaux affichent une plus grande efficience économique qu'Air Canada ou CP Air. Le rendement médiocre apparent d'Air Canada découle de la trop grande expansion de la capacité en vue de fournir des services; mais ces investissements lui ont peut-être été imposés du fait qu'elle est une société d'État. Une fois que ces investissements excessifs sont pris en considération, le niveau de productivité est sensiblement le même pour tous les transporteurs. Nous avons aussi constaté qu'Air Canada avait le plus important excédent de stock de capital, suivie des transporteurs régionaux. Ce dernier résultat semble être la conséquence directe du mode d'application de la politique touchant les transporteurs aériens régionaux adopté en 1967.

De façon générale, le transport aérien au Canada semble fournir des rendements d'échelle constants, ce qui laisse croire que l'ajout de destinations au réseau ne fera pas diminuer les coûts unitaires. Cela laisse également croire que les coûts d'Air Canada, en dépit de sa taille, ne sont peut-être pas inférieurs à ceux des autres transporteurs canadiens. Par contre, nous avons observé d'importantes économies de concentration de trafic (sauf peut-être pour Air Canada). Les transporteurs peuvent réduire les coûts unitaires en augmentant le trafic sur les marchés existants, par la modification des prix et une meilleure affectation des sièges. Parallèlement, il est possible de réduire les coûts moyens du réseau en y ajoutant une nouvelle destination à forte concentration de trafic. Ces résultats semblent mettre en évidence l'importance d'un réseau ayant un bon volume de trafic. L'importance du volume peut faire croître la concentration du trafic pour un transporteur donné. Un système rayonnant convenablement conçu qui contribue effectivement à accroître la concentration sur un tronçon donné du réseau peut être souhaitable du point de vue des coûts.

Sur le plan des coûts de production, les services réguliers et affrétés pour voyageurs sont complémentaires uniquement lorsque l'affrètement représente une part relativement faible de l'ensemble des services. Nous n'avons trouvé aucune complémentarité dans le cas des transporteurs régionaux pour qui l'affrètement représente souvent la moitié des extrants. En fait, ces transporteurs ont enregistré des coûts plus élevés pour leurs services réguliers parce que l'affrètement constituait une part importante de leur production. Une explication intuitive de cette constatation est la suivante. Le transporteur offrant un service régulier peut absorber une part des frais généraux en offrant, à l'occasion, des vols nolisés en périodes creuses, durant les fins de semaine, par exemple, ou les mois moins occupés de l'année. Les vols nolisés servent à payer une partie du coût des appareils achetés pour les vols réguliers. Les transporteurs régionaux, par contre, ne pouvaient compter beaucoup sur le temps mort des appareils achetés ou loués pour assurer les vols réguliers, pour deux raisons. Premièrement, les transporteurs régionaux ont besoin de gros porteurs long-courriers pour les vols nolisés ou des appareils court-courriers pour les vols réguliers. Deuxièmement, puisque les services d'affrètement constituaient une part très élevée de leur production totale, les transporteurs régionaux n'ont pu compter sur le temps mort des appareils servant aux vols réguliers. En conséquence, ils ont dû acheter des appareils pour les vols nolisés à tarifs réduits, ce qui ne contribuait pas à réduire le coût des vols réguliers.

(3) Effets de la politique visant les transporteurs régionaux

Les résultats de l'analyse des coûts et de la productivité nous ont mené à conclure que la politique visant les transporteurs régionaux avait été très coûteuse pour le Canada. Elle a restreint les activités de ces transporteurs à des régions géographiques bien définies et les a ainsi empêchés d'accroître les services réguliers et la longueur des étapes. Les transporteurs régionaux étaient clairement incités à assurer leur croissance par l'exploitation accrue des marchés d'affrètement, ce qu'ils ont fait. En conséquence, les coûts de l'industrie canadienne du transport aérien ont été plus élevés que nécessaire. Nous estimons donc que l'annulation de la politique visant les transporteurs régionaux par une politique adoptée le 10 mai 1984 est une première mesure dans la bonne direction. La nouvelle politique du transport aérien permettrait aux transporteurs de modifier leur réseau en vue de déterminer la longueur d'étape optimale, de fixer les routes d'embranchement de manière à accroître la concentration du trafic et de redistribuer les services offerts entre les vols réguliers et les vols nolisés.

(4) Effet de la propriété publique - Air Canada

À l'aide des résultats de modèles des coûts globaux et des coûts variables, nous avons tenté de mesurer l'effet de la propriété publique sur le transport aérien. En particulier, nous avons utilisé la fonction des coûts variables totaux pour déterminer les effets du stock de capital excédentaire (attribuables à la propriété publique et à la politique de réglementation) du point de vue de l'efficience, en termes de coûts. Nous avons constaté que la propriété publique d'Air

Canada en avait réduit l'efficience d'environ 18 % des coûts totaux au cours de la période de 18 ans (1964-1981). Ce pourcentage est la moyenne observée durant la période étudiée. La baisse réelle des coûts qu'aurait engendrée la privatisation, même en 1981, aurait été nettement moins élevée parce qu'Air Canada a amélioré l'efficience économique de ses opérations depuis l'adoption de la Loi d'Air Canada en 1977 (projet de loi C-33). En termes des coûts totaux d'Air Canada en 1981, ces 18 % se seraient traduits par une baisse de coûts de 370 millions de dollars. Ce montant correspond par ailleurs à environ 10,5 % des coûts totaux de l'industrie. De cet excédent de coûts de 18 %, environ 15 % sont attribuables à un stock de capital trop important et les autres 3 %, à l'inefficience associée à d'autres intrants variables dont la main-d'oeuvre, le carburant et d'autres achats. Nous avons constaté une baisse importante des coûts trop élevés après l'adoption de la Loi d'Air Canada de 1977. Il est bien connu que la direction d'Air Canada, sous la direction de M. Claude Taylor, a beaucoup amélioré le rendement et l'efficience de ce transporteur aérien après 1977.

Nous avons constaté en outre que la privatisation aurait tendance à réduire les coûts de la main-d'oeuvre à l'échelle de l'industrie. D'après nos calculs, l'industrie aurait économisé environ 50 millions de dollars en 1981. La privatisation et la baisse subséquente des coûts de main-d'oeuvre se seraient traduits par des économies annuelles moyennes correspondant à 12 % des coûts totaux de l'industrie durant la période étudiée (1964-1981). Une perte supplémentaire de 26 millions de dollars aurait été enregistrée si nous avions tenu compte de la perte de poids mort (de bien-être) attribuable à des tarifs dépassant de 12 % ceux que suppose l'efficience économique. Cet écart de 12 % exprime le manque d'efficience en termes de coûts qui résulte de la propriété publique, mais ne tient pas compte des effets de l'adoption de la Loi d'Air Canada de 1977 en conséquence de quoi l'exploitation de la société a été beaucoup plus orientée vers le marché. Il est donc probable que l'inefficience en termes de coûts, attribuable à la propriété publique, en 1981, correspondait à moins de 12 % des coûts totaux de l'industrie. En fait, d'après d'autres modèles de simulation des coûts que nous avons estimés, le gain d'efficience se serait élevé à 6,7 % des coûts totaux de l'industrie si la société d'Air Canada avait été privatisée en 1981, ce pourcentage étant fondé sur des modifications à court terme apportées par Air Canada à son réseau et à sa flotte d'appareils pour les rapprocher de l'optimum. Ainsi, le gain d'efficience de 6,7 % est celui qui pourrait être réalisé à court terme, tandis que le gain à long terme se situerait entre 6,7 et 12 % des coûts totaux de l'industrie.

(5) Effets de la réglementation et de son assouplissement entre 1977 et 1981

Nous avons conclu que la réglementation avait pour effet de gonfler les coûts totaux de l'industrie et des transporteurs individuels. Dans le cas d'Air Canada et de CP Air, cette augmentation des coûts totaux est d'environ 7 %, tandis que pour les transporteurs régionaux, elle est d'environ 17 % et découle en grande partie de la politique visant les transporteurs régionaux. La moyenne pondérée des deux est d'environ 9 % des coûts totaux de l'industrie et résulte principalement du fait que la réglementation amenait les transporteurs à avoir un stock de capital excédentaire.

Nous n'avons décelé aucune baisse importante du coût de la main-d'oeuvre en conséquence de l'assouplissement de la réglementation entre 1977 et 1981. Toutefois, les phénomènes observés par suite de la déréglementation ou de l'assouplissement des règlements dans d'autres pays nous incitent à penser que le coût d'équilibre à long terme de la main-d'oeuvre pourrait fléchir d'un maximum de 20 %, ce qui correspond à 6 % des coûts totaux de l'industrie.

La combinaison du gain d'efficience en termes de coûts et de la baisse du coût de main-d'oeuvre nous permet de déterminer que la perte d'efficience attribuable à la réglementation correspond à un coût d'environ 15 %, ce pourcentage étant une moyenne pour l'ensemble de la période étudiée (1964-1981). Nous avons constaté que, de 1977 à 1981, tous les transporteurs, sauf Québecair, ont enregistré des gains d'efficience en termes de coûts résultant à la fois de l'assouplissement de la réglementation et de l'apparition de la concurrence sur les marchés. Le gain d'efficience en pourcentage est positivement lié à la taille du transporteur : les résultats par ordre décroissant sont de 7,3 % pour Air Canada, 5,4 % pour CP Air, 4,1 % pour PWA, 2,4 % pour Nordair et -0,5 % pour EPA. Les économies totales de l'industrie, calculées en fonction des coûts en 1981, se situaient entre 222 et 364 millions de dollars. Nous estimons que les économies de 222 millions de dollars correspondraient à l'amélioration la plus faible. Ce montant laisse supposer que, de 1977 à 1981, environ 6,4 % ont été soustraits aux 15 % des coûts totaux de l'inefficience qu'explique la réglementation. Il reste donc, au plus, 8,6 % des coûts correspondants à la perte d'efficience en 1981. (Ce pourcentage se rapproche des économies de coûts de 8,8 % résultant d'une simulation des coûts par Gillen, Oum et Tretheway (1985a)). D'après les coûts totaux de l'industrie en 1981, il s'agit d'économies d'environ 307 millions de dollars. Un gain supplémentaire de bien-être correspondant à 11 millions de dollars pourrait être réalisé si les économies de coûts se traduisaient par une baisse des tarifs. Ces économies totales sont la conséquence d'une baisse du coût de la main-d'oeuvre, de l'élimination des stocks de capital excédentaires, de la modification des réseaux et de la rationalisation de la composition des services. Compte tenu des changements apportés à la réglementation depuis 1981, il est évident que les gains d'efficience en termes de coûts qui découleront d'autres mesures de déréglementation seront probablement inférieurs au pourcentage de 8 à 9 % calculé ici.

(6) Propriété publique et autres mécanismes

Dans notre analyse de l'importance relative de la propriété publique et de la propriété privée, nous avons constaté qu'il n'est pas nécessaire de recourir à la propriété publique pour atteindre des objectifs à caractère non économique. En l'absence de la réglementation, la propriété publique n'est pas suffisante (à moins qu'elle ne soit accompagnée d'importantes subventions) pour garantir la réalisation de ces objectifs. Pour qu'un transporteur, quel que soit le type de propriété, continue d'offrir un service non rentable, il est nécessaire de recourir à la réglementation ou à des subventions. Reste à savoir s'il demeure nécessaire d'utiliser la propriété publique et la réglementation pour atteindre d'autres objectifs. Nous prétendons que la propriété publique n'est ni une nécessité ni un moyen convenable d'atteindre ces autres objectifs. La réglementation suffit, mais il est très coûteux, en termes d'efficience économique, de l'utiliser. Il existe un autre mécanisme possible : les subventions directes. Il a été utilisé avec succès aux États-Unis et dans d'autres pays pour assurer des services locaux réduits et, parallèlement, pour profiter de l'efficience économique que peut engendrer la déréglementation.

Par suite d'un examen des activités des sociétés ferroviaires et des transporteurs aériens au Canada, aux États-Unis et en Australie, nous avons constaté que les sociétés de transport publiques et privées ont réagi de façon remarquablement semblable à l'évolution de la conjoncture et de la concurrence. Cela nous a amené à conclure que l'efficience de l'industrie est principalement stimulée par la concurrence. Le type de propriété a moins d'effet sur l'efficience économique. Ainsi, la privatisation d'Air Canada n'est pas essentielle à l'efficience économique de l'industrie canadienne du transport aérien, mais elle ne nuit pas à la réalisation d'objectifs à caractère social.

(7) Effets du type de propriété sur la réglementation

Nous avons également étudié l'effet du type de propriété sur la réglementation. Nous avons conclu que, puisque la société d'État était un important mécanisme par lequel le gouvernement fédéral appliquait sa politique de transport, la réglementation économique devait être conçue de manière à servir de complément à ce mécanisme. Ainsi, la réglementation aurait été de nature très différente si la société d'État Air Canada n'avait pas existé. L'analyse des données nous porte à croire que la propriété publique d'Air Canada a eu un effet très déterminant sur les méthodes de réglementation adoptées au Canada et a donc contribué à accentuer la concentration de l'industrie et de certains marchés. Puisque la réglementation a été influencée par l'existence d'Air Canada, il est inutile de tenter de distinguer les effets de la propriété publique et de ceux de la réglementation sur la concentration des marchés et de l'industrie. La forte concentration de l'industrie et des marchés est plutôt la conséquence globale de la nature (taille et emplacement) des marchés canadiens, de la politique de réglementation et de la propriété publique d'Air Canada.

(8) Moyens de privatisation

Nous avons examiné les diverses façons de procéder, advenant la possibilité de privatiser Air Canada. Nous avons conclu que la formule la plus intéressante consisterait à combiner une vente à l'acheteur le plus offrant et une vente aux employés d'une partie des actions. Cette formule nous apparaît préférable à tous les moyens étudiés parce qu'elle permettrait à un acheteur unique de veiller à ce que la direction du transporteur effectue des changements efficaces et difficiles en fonction de l'évolution de la réglementation et des marchés, et parce qu'elle contribuerait en même temps à stimuler l'esprit de collaboration des employés-actionnaires et à leur donner bon moral.

ABSTRACT

A. Questions Addressed

In this study we set out to establish the separate effects of each of government ownership and economic regulation on the structure of the Canadian airline industry and on the performance of transcontinental and regional (existing in 1981) carriers. The research was designed to distinguish the inefficiency generated by government regulation from that which might arise from public ownership in the airline industry. It also attempts to understand the symbiotic relationship between regulation and public ownership since the existence of a crown carrier can and does influence both the extent of regulation and regulatory practices as well as the structure of the industry. It is a retrospective study using an historical data base to measure and assess the different impacts of ownership and regulation. We do not perform any prospective analysis on the alternative choices of regulatory policy or form of ownership.

In the study we use economic efficiency in the allocation of resources as the yardstick of performance. Despite the fact that in Canada the perspective has often been that equity should have an equal place or be considered in addition to efficiency, we demonstrate that in the case of an assessment of Canadian air transport, efficiency should be ranked first.

From a review of the established literature, we found the predicted consequences of regulation and public ownership are similar; higher costs, lower productivity, inefficient capital-labour ratios, and an excessive use of capital. Economic regulation, however, is industry-wide whereas the results of crown ownership or a particular form of ownership are applicable to only select firms. In Canada, we have, even within publicly owned firms, sufficient variation of the de facto degree of control as well as periods of public and private (meaning private sector or publicly held shares) ownership of the same carrier. We therefore argue that it is possible to distinguish the effects of regulation and public ownership even on the same variables.

Our approach is to use the residuals of estimated productivity and cost functions to capture the differential effects of regulation and crown ownership upon costs and productivity. With the parameterization of the effects of other variables on costs and productivity, we are able to mitigate the chances of obtaining spurious results by comparing residuals rather than the nominal values of costs and productivity.

We undertook research in four areas: 1) what were the effects of public ownership and regulation of air carrier performance?

2) what were the effects of public ownership and regulation on airline markets? 3) what is the effect of public ownership (especially of Air Canada) on regulation and regulatory practices? 4) what is the role of public ownership versus other policy instruments in achieving Canada's air transport goals?

B. Methodology

The method we used to address these questions just posed was to develop a set of analytical results from cost and productivity models as well as set of institutional characteristics. The matrix of institutional information which includes industry and regulatory characteristics details major events both within and affecting the industry and individual carriers. We correlate both statistically and intuitively the set of results from our analytical models with the matrix of institutional information and attempt to attribute performance differences to the regulatory environment or to the ownership status.

We employ a two-phase approach. In the first phase we use our panel data set (time-series data on a cross-section of firms) covering the period 1964-1981 for Canada's two national and five regional air carriers to measure and compare the economic performance of the privately and publicly owned carriers. The models we employ explicitly control for inter-firm differences in prices, scale of operation, network, output mix, and other characteristics of the operating environment. After making an attribution of performance differences to these operating characteristics, we are left with residual or "unexplained" productivity differences. Using statistical analysis of these residuals, we are able to determine with some degree of accuracy, the effects that ownership status and regulatory policy have had upon performance.

In the second phase we supplement the purely statistical approach with qualitative data. The qualitative data are drawn from the institutional data matrix in which we have detailed events such as ownership changes, fleet acquisitions and retirements, strikes, significant changes in management, route changes, and policy and regulatory changes. These are compared with the residuals from the statistical analysis to better understand the nature and extent of the impact the institutional developments have had upon carrier performance.

Our assessment of Canadian airline performance begins with a measurement of total factor productivity. TFP is defined as the amount of aggregate output produced by a unit of aggregate input. It differs from simpler concepts of productivity such as output per man hour, by recognizing first of all that more than one type of output can and is produced and secondly that inputs other than labour are used in producing airline services. TFP recognizes and weights appropriately the various inputs and individual inputs of different quality and corrects for the output problem by giving higher quality outputs a greater weight in the aggregation of outputs into a single measure. Productivity is a mirror image of cost efficiency and the productivity analysis serves as a useful and relatively inexpensive initial step prior to the more expensive and sophisticated cost function analysis. The cost functions are subsequently used to investigate issues such as economies of traffic density, economies of scale and scope as well as examine the impact of alternative regulatory policies and ownership choices on carrier and industry performance.

Airlines produce several different outputs and use inputs of varying quality. The outputs are produced over routes of varying size and length and within markets of different densities. Input productivities have also changed over time particularly as new technology was adopted. It seems reasonable that a realistic characterization of an industry's cost structure requires not only the incorporation of many outputs and inputs, but also the special characteristics of the route networks and changes in input productivities. The cost function which we adopt and subsequently estimate in fact allows us to measure all the relationships which we have alluded to.

To incorporate all of the issues relating to multiple outputs and inputs as well as variability across route and market characteristics, we utilize in our cost analysis a translog cost function incorporating three outputs, multiple inputs and hedonic adjustment functions for the outputs. The airline cost function is estimated using a panel data set that is, a cross-section of airlines tracked through several time periods. The cost function also has a technological change factor attached to each input price as well as a general time trend variable. From the cost function we are able to develop measures of economies of scale, economies of traffic density and inter-product cost relationships. Economies of density measure the proportionate change in costs with a proportionate increase in outputs with the size of the networks (points served), output attributes and input prices held constant. Economies of scale measure the proportional increase in outputs and points served made possible by a proportionate increase in all inputs with output attributes and inputs prices held constant. The examination of inter-product cost relationship involves the evaluation for each pair of outputs of the change in costs of producing one output while varying the amount of another output.

C. General Findings

(1) Results of the Total Factor Productivity Analysis

The analysis of total factor productivity revealed initially two interesting sets of results. First, while the gross TFP measures indicate that Canada's regional air carriers are less productive than either of the two national carriers, CP Air and Air Canada, after controlling for output and network (but not capacity), the regionals are in fact more productive. Secondly, if one additionally controls for the level of the capital stock, all carriers have roughly equal levels of residual total factor productivity. This result suggests that Air Canada and (to a lesser extent) CP Air, have operated in the past with non-optimal levels of capital stock over the period of our data set, 1964-1981. The result of the regional air carriers being relatively more economically efficient than either Air Canada or CP Air implies that they have a lower cost structure. Furthermore, a comparison between Air Canada and CP Air revealed that CP Air's residual TFP was on average approximately 23 per cent higher than that of Air Canada. The differences in residual TFP between these two national carriers disappear once the level of capital stock is controlled for. The conclusion is that the inefficiencies were the result of over-expansion by Air Canada. With the data available to us, it is difficult to determine precisely where, in what aircraft, and to what extent Air Canada over-expanded capacity; we suspect it occurred with both the number of aircraft and the purchase of larger aircraft than in fact the market required.

The productivity analysis also identified the contribution of each of the selected output and network variables to factor productivity. Generally, the results show that on average, expanding the scale of output, the output share of charter operations, and the stage length tend to contribute positively to increasing total factor productivity and hence lowering costs. Expanding the number of points served and the level of the capital stock have exactly the reverse effect, lowering productivity and hence raising costs. Finally, the TFP analysis suggests that the airline production technology would be characterized by positive economies of density, constant returns to scale, and significant stage-length economies.

The TFP models provided an efficient first step in assessing the productivity and performance of Canada's air carriers. From these models we proceeded to analyze the cost structure using the multiple output, multiple input cost model, in which we could control for differences in network and market characteristics.

(2) Results of the Cost Function Estimation and Analysis

From the cost analysis, we found a number of important and interesting results. First, with the exception of Nordair and Air Canada, all other air carriers exhibit constant return to scale. Nordair exhibits weak statistical evidence of increasing returns while Air Canada exhibits weak evidence of decreasing returns. The general conclusion would be however, of constant returns to scale, evidence of significant economies of density for all air carriers except Air Canada, and positive cost complementarity between scheduled passenger services and charter services only if the proportion of charter services is less than 5 per cent in total output. Finally, of the firm's output characteristics we examined, stage-length appears to be the most important in affecting costs. The minimum cost firm size appears to decrease rapidly as stage-length decreases.

We find that the regional carriers have been more economically efficient than either Air Canada or CP Air. The apparent poor performance of Air Canada is due to an over-investment in capacity to provide services which it may have had to do under its government ownership. Once we control for this over-investment, all carriers have roughly similar levels of productivity. Air Canada was also found to have the highest level of excess capital stock, followed by the regional carriers. This latter result appears to be a direct consequence of the way in which the Regional Air Carrier Policy was introduced in 1967.

In general, air transport in Canada is subject to constant returns to scale indicating that by itself, adding new destinations to a carriers network will not reduce unit costs. It also implies that despite its size, Air Canada may not have a cost advantage over other Canadian carriers. In contrast, significant economies of density exist (except perhaps for Air Canada). Carriers can reduce unit costs by increasing traffic within existing markets. This can occur by altering prices, and better seat management. Similarly, adding a new point with high-traffic density can reduce system average costs. These findings seem to underscore the importance of a network with good traffic feed. Good feed can increase traffic density for a given carrier. A properly designed hub and spoke system which effectively increases the density of any given network link, could be desirable from a cost perspective.

Charter and scheduled passenger services are complements in production only for fairly low proportions of charter services. The regional air carriers, with an output mix often consisting of 50 per cent charter services, experienced no such complementarity. In fact, these carriers suffered cost inefficiency for their scheduled services because of the presence of large portions of charter services. An intuitive explanation for this result is as follows. The scheduled carrier can make some contribution to overhead by flying the occasional charter in off-peak periods; weekends perhaps, or slow months of the year. Aircraft acquired for scheduled services are paid for in part by charter services. In contrast, the regionals could not rely heavily on the idle time of aircraft purchased or leased for their scheduled services for two reasons: first their charter services required large long-haul oriented aircraft or smaller and short-haul oriented aircraft were required for their scheduled service routes, and second since they produce a very high proportion of their total output in charter markets they cannot rely on idle time of aircraft used for scheduled services. As a consequence they were required to acquire aircraft dedicated to the large amount of low fare charter services and this did not have a positive impact on lowering the costs of scheduled services.

(3) Effects of the Regional Carrier Policy

The results of cost and productivity analysis led us to conclude that the Regional Carrier Policy had been very costly for Canada. The policy restricted carriers to particular geographic regions and thus limited their ability to expand scheduled services and increase stage length. There was a clear incentive for the regionals to seek growth in charter markets. They did so and as a result Canada's industry-wide costs of air transport were higher than they need have been. Therefore, we feel that the abolition of the Regional Carrier Policy by the May 10, 1984 Policy was a step in the right direction. The new air policy provided opportunities to carriers to adjust their networks to find the optimal stage length and set of feeder routes to increase their route densities and to adjust the mix of scheduled and charter services.

(4) Effect of the Crown Ownership of Air Canada

Using the results of the total and variable cost models we attempted to measure the effect of government ownership on air carriers. In particular, the total variable cost function was used to identify the affects of excess capital stock (caused by government ownership and regulatory policy) on the cost efficiency. During the 18-year period (1964-1981), we have found that crown ownership reduced the cost efficiency of Air Canada by approximately 18 per cent of total cost. This 18 per cent is an average for the entire sample period 1964-1981. The actual cost savings by privatization even in 1981 would have been much smaller than this number because Air Canada has improved its economic efficiency since the passage of the new Air Canada Act (Bill C-33) in 1977. If we were to translate the 18 per cent in terms of Air Canada's 1981 total cost level, the cost savings amounted to $370 million. This in turn is equivalent to about 10 1/2 per cent of the industry's total costs. Of this 18 per cent cost inefficiency, approximately 15 per cent was due to the inefficient level of capital stock and that the remaining 3 per cent was due to the inefficiency of the variable inputs such as labour, fuel and other purchased materials. We did find that there has been a substantial reduction in the cost inefficiency since the new Air Canada Act was introduced in 1977. It is no secret that the management of Air Canada under the toolage of Claude Taylor has significantly improved the performance and efficiency of the air carrier after that year.

We have also found that with privatization there would be a tendency to an industry-wide reduction of labour input prices.

This reduction we have calculated would have saved the industry approximately $50 million in 1981. These two elements together amount to an average annual savings of approximately 12 per cent of total industry cost for the sample period 1964-1981. An additional $26 million is lost if we take into account the dead-weight loss (of welfare) caused by charging fares which were 12 per cent higher than the economically efficient fares. This 12 per cent is the measure of the cost inefficiency due to crown ownership but does not take into consideration the effects of the new Air Canada Act introduced in 1977 which made Air Canada substantially more market oriented. Therefore the cost inefficiency due to crown ownership in 1981 is likely to be smaller than the 12 per cent of total industry cost. In fact, in our other study the cost simulation models have estimated the efficiency gain from privatization at 6.7 per cent of total industry cost if Air Canada were privatized in 1981; this figure is based on a short-run adjustment by Air Canada toward an optimal route structure and fleet size. Therefore, the 6.7 per cent might be viewed as the efficiency gain achievable in the short-run while the long-run efficiency gain lies between 6.7 and 12 per cent of the total industry cost.

(5) Effects of Regulation and Regulatory Relaxations during the 1977-1981 Period

We determined that the effect of regulation is to increase the total cost of the industry and individual carriers. Air Canada and CP Air have an increase in total cost of approximately 7 per cent while the regional carriers have incurred an increase in cost of approximately 17 per cent much of it due to the Regional Carrier Policy. The weighted average of these two figures is about 9 per cent of industry total cost. This 9 per cent cost inefficiency was a result principally of the excess capital stock the carriers were induced to use in a regulatory environment.

We were not able to determine any significant reduction in labour input price arising from the regulatory liberalization which took place between 1977 and 1981. However, we do speculate on the basis of what has occurred in other countries which have deregulated or moved to a more liberalized regulatory structure that the long-run equilibrium price of the labour input would decrease by as much as 20 per cent. This amounts to about 6 per cent of total industry costs.

The gains in cost efficiency and a reduction in labour input price together puts the cost of the inefficiency as a result of regulation at approximately 15 per cent. This 15 per cent is an average figure for the entire sample period 1964-1981. In the period from 1977 to 1981, we have found that, except for Quebecair, all air carriers have improved their cost efficiency due to both regulatory relaxation and an introduction of competitive market forces. The percentage increase in cost efficiency is positively correlated with carrier size: the lower bound figures are 7.3 per cent for Air Canada, 5.4 per cent for CP Air, 4.1 per cent for PWA, 2.4 per cent for Nordair and -0.5 per cent for EPA. The total industry savings per year calculated on the basis of 1981 costs found to be between \$222 million and \$364 million. We argue that \$222 million can be used as a measure of the lower bound of an improvement. This figure implies that from 1977 to 1981 of the approximately 6.4 per cent of the total inefficiency cost of regulation, 15 per cent has been removed. Therefore, the remaining inefficiency cost is at most 8.6 per cent as of 1981. (That is very close to the 8.8 per cent cost savings obtained by the cost simulation exercise in Gillen, Oum and Tretheway (1985a). This is equivalent to a savings of approximately \$307 million based on the 1981 total cost of the industry. An additional welfare gain of \$11 million could be expected if the cost savings lead to price reductions. This total saving includes the effects of a reduction of labour input prices, elimination of the excess capital stocks, a network readjustment and the rationalization of the output mix. With the significant regulatory changes which have occurred since 1981 it is very clear that the gains in cost efficiency from further moves toward deregulation are likely to be less than the 8 to 9 per cent we measure here.

(6) Ownership vs. Other Instruments

In our analysis of the importance of publicly owned firms versus private firms, we found that publicly owned firms are not necessary for achieving non-economic goals. Without regulation, publicly owned firms are not sufficient (except with large subsidy) to ensure that such goals are achieved. Either regulation or some form of subsidy is needed in order to get a carrier, regardless of its ownership form, to continue an uneconomic service. This leaves the question as to whether one needs to continue to use ownership and regulation to meet other goals. We argue that public ownership is neither necessary nor sufficient to achieve such goals. Regulation is sufficient, but we pay a high price in terms of economic efficiency to use it. An alternative exists to regulation. That is, direct subsidy. This policy instrument has been used successfully to maintain small community service in the U.S. and other countries while simultaneously achieving the economic efficiency benefits of deregulation.

From a review of Canadian railroads and the air carriers in Canada, the U.S. and Australia, we concluded that the publicly and privately owned transportation carriers have responded to the changes in the operating and competitive environments in a remarkably similar manner. This leads us to conclude that what is important for inducing an industry to be efficient is its competitive environment. The form of ownership has less impact on economic efficiency. Therefore, the privatization of Air Canada is not essential to make the Canadian airline industry economically efficient, nor is it harmful with respect to fulfilling non-economic social goals.

(7) Effects of Ownership on Regulatory Structure

We also investigated the effect that ownership had on the regulatory structure. We concluded that because the crown carrier was used in a significant way as a policy instrument by the federal government, economic regulation had to be designed to complement it. Hence, regulations would have been different had there not been publicly owned Air Canada. From the evidence we have reviewed, we believe that the crown ownership of Air Canada has influenced in a significant way the regulatory structure practices in Canada, and thus contributed to an increase in concentration of the industry and of specific markets. Since the regulations have been influenced by the existence of Air Canada it is meaningless to attempt to decompose the ultimate effects on markets and industry concentration into two components; that is, ownership and regulatory policy impacts. Rather, the highly concentrated industry and markets are a joint product of the nature (size and location) of Canadian markets for regulatory policy, and the crown ownership of Air Canada.

(8) Methods of Privatization

If one is going to privatize Air Canada, we addressed the question of alternative methods of privatization. We concluded that the most attractive method of privatization appears to be a combination of sale to the highest single bidder with a partial sale of stock to employees. This method is preferred to all other methods reviewed because a single bidder would be able to exert control over the carriers management to make effective but tough adjustments to the changing regulatory and market conditions while increasing the cooperative spirit of the owner employees and boost employee morale.

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CHAIRMAN'S FOREWORD

This study was undertaken as a part of the Council's project on government enterprise. The overall aim of the project is to improve our understanding about federally and provincially owned and controlled entities which operate at arm's length from government and have important commercial functions. The project is attempting more specifically, to address two questions: What is the appropriate role of government enterprise as one of a number of instruments of public policy? And, second, how should the apparatus of control within government be structured so as to realize the full potential of this instrument?

The research initiated for the project has included both the examination of general questions pertaining to government ownership and the investigation of the performance of particular firms and particular sectors. The present study falls into the latter category. It looks back at the performance of the Canadian airline industry and attempts to estimate the impact of regulation and of public ownership on the structure of the industry and the performance of individual carriers. While the findings of the study are of interest, it should also be seen as a contribution to the growing body of literature devoted to the difficult problem of how to quantify the effects of specific government initiatives.

The present study builds on work which the authors, David Gillen, Tae Oum and Michael Tretheway, have been pursuing for many years. Financial support for this study has come both from the Economic Council of Canada and Consumer and Corporate Affairs Canada.

Judith Maxwell
Chairman

AUTHORS' FOREWORD

This research was undertaken with the joint financial support of the Economic Council of Canada and Consumer and Corporate Affairs Canada. While this work constitutes significant "value added", it necessarily draws on a foundation of several strands of research which the three of us have been pursuing, both independently and jointly, since 1977.

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The views expressed herein are those of the authors and not of the Economic Council of Canada, Consumer and Corporate Affairs Canada, or either of the academic institutions with which the authors are affiliated.

CHAPTER I - INTRODUCTION

A. The Perspective of the Study

This is a retrospective study of the effects of economic regulation and government ownership on the performance of the Canadian airline industry. In particular, it sets out to establish the separate effects of these on the structure of the industry and the performance of carriers, collectively and individually. In the study, the efficiency with which resources are allocated and employed is used as the yardstick of performance.

The use of efficiency as the measure of performance is not one that is universally accepted in Canada for assessing industrial or government policy. Much of the criticism levelled at importing U.S. airline deregulatory policy into Canada is based upon the notion that the U.S. economic perspective is too narrow. In the U.S., the view in general is that if the solution to market failure itself causes inefficiencies, this is a sufficient condition for getting rid of that solution.

In Canada the perspective has often been equity in place of, or in addition to, efficiency. How then does one judge in Canada whether to alter regulatory policy or Crown ownership? We argue that, in the assessment of the Canadian air transport industry, efficiency should be ranked first. This judgement is made on the basis of two acts of Parliament and one "failed" bill.

The 1967 National Transportation Act clearly broke tradition, and based upon recommendations of the MacPherson Commission, stated that efficiciency within the transportation sector in general, or a specific mode in particular, were of primary importance. Any issues of redistribution were to be handled through direct payment by government. The 1977 Air Canada Act clearly stated that the crown carrier was to be efficient and have a profit orientation. Finally, Bill C-33, a bill which sought to change in a fundamental way the focus of the 1967 National Transportation Act, failed to pass parliament. This bill grew out of the disenchantment of some regions, particularly the West, with the 1967 Act. These regions argued for special status, special circumstances and the like, and were fundamentally unhappy with a market solution to the allocation of transportation resources. That the bill failed reaffirms, (a) the market efficiency orientation (of the 1967 Act), which underlies transportation policy, and (b) the focus firstly upon efficiency in transportation.

Even if one chooses to rank equity over efficiency in transportation policy, one must know the efficiency cost of pursuing another objective. Only with this awareness can intelligent decisions on tradeoffs between the two goals be made.

B. Purposes of Regulation and Crown Ownership

Air policy in Canada and the development of regulatory policy were very much tied to the "National Policy" of the federal government. Air Canada (called Trans Canada Airlines until 1964) was created to ward off the perceived expansionary tendencies of American carriers and to establish and maintain trans-continental inter-city passenger and mail service. The regulatory framework was created almost simultaneously with the Crown airline. It was designed to harmonize the activities of the Crown and other carriers in Canada, to be promotional and protective. This in effect meant cooperation not competition. The primary role of both the Crown carrier and regulatory policy was the provision, continuation and maintenance of a high quality air service to all regions of Canada. The regulatory system of limiting private carriers to specific areas or routes provided the framework for the Crown carrier to cross-subsidize between routes and regions to provide high quality uniform service across the country.

The objectives of Crown ownership within the regulatory structure were established as an 'agent of government', internal regulator and the provision of social services. Minor objectives included providing a Canadian presence in international markets. Hence, the Crown carrier was not expected to be as efficient as its private counterparts, although it was expected to cover costs.

As markets grew and the industry matured, the reasons for establishing the Crown carrier gradually disappeared. At the same time, a new 'competitive' philosophy entered transport policy. In our approach, therefore, we do not deny that regulation and crown ownership were legitimate instruments designed to fulfill particular purposes. But these instruments can still result in inefficient resource use and it is this cost we set out to distinguish and measure.

C. Crown Corporations: The Efficiency of Public Corporations

There is an increasing and developing literature in economics which examines and estimates the efficiency costs of government regulation

[Regulation Reference, Economic Council of Canada, 1980; Wilson, 1980; Needham, 1983]. The economic consequences of [economic] regulation depend upon both the type of regulation - price, entry, quality - and its enforcement. The impacts of regulation upon airlines have been examined by a number of authors [Douglas and Miller, 1974; Bailey, Graham and Kaplan, 1985]. They include excessive scheduling competition due to price regulation, monopoly behaviour generating pricing insensitivity and higher factor payments, lack of innovation, inefficient size and traffic mix, inefficient route network and a lack of variety in price-quality packages.

There is a less well-known but equally well-established literature on public corporations. Borcherding, Pommerehne and Schneider, (1982) cite two approaches used to explain the relative efficiency between public and private firms. The property rights approach explains the difference between public and private firms as the difference in incentives to be more efficient. These are due to variations in the ability of owners to monitor management and the divergence in the goals of owners and managers. An alternative, public choice approach, focuses upon political coalitions and their effect upon input usage, returns and/or product quality.

The property rights approach notes the fundamental difference between public and private firms is that owners of public firms [citizens] suffer from a paucity of information and have trouble monitoring the behaviour of the bureaucracy who act as their agents. There is a real practical problem in transferring rights among individuals. Therefore, the hypothesis is that managers of public firms will not adopt the most efficient input combination because they cannot realize the gains from their efforts. Hence public firms will be less efficient. Borcharding et al. (1982) review the findings of empirical studies of public firms in various countries and industries and find a consensus that private production is more efficient than either publicly owned or managed firms. The reasons include: over-capitalization, inefficient pricing principles, management which lacks foresight and has long periods of tenure, and a tendency to favour business over consumers and organized [political] groups over unorganized.

The public choice approach focuses upon public institutions and public bureaucracies which operate institutions. It provides similar hypotheses and evidence. This literature argues that public firms not only have higher production costs, but also higher levels and quality of output. Borcheding et al. (1982) argue public employees can effectively coalesce and ultimately alter both the substitution possibilities with other factors and the derived demand schedule for their services. As a result, capital-labour ratios, absolute capital intensities and wages will all tend to be higher in public organizations. This will lead to higher costs, which it is hypothesized, are a consequence of higher wages, reduced productivity, and differences in the characteristics of the output of public firms.

The evidence from the numerous studies examined in Borcherding et al. (1982) confirm the hypotheses of both approaches; private production is more efficient than public production; and public sector wages are higher than their private sector counterparts.[1] The argument is also made that

[1] There is a consensus in the literature and empirical support that public firms, such as Air Canada, will be less efficient. But as Baldwin (1975) argues, Air Canada was used as a political tool and therefore there is no objective of cost minimization as the firm seeks to ensure its survival by maximizing factor input support. He also finds evidence that the efficiency of the public firm increases when faced with competition. These efficiency gains are mitigated in the presence of subsidies or economic regulation.

competition between private and public firms reduces inefficiency and that the difference in unit cost in the presence of competition between private and public firms is insignificant (throughout the study we use the terms government ownership and public ownership interchangably).

The potential consequences of regulation and public ownership are similar; higher costs, lower productivity, inefficient capital-labour ratios, excessive use of capital. Therefore, it is difficult to distinguish between the effects of crown ownership and those of economic regulation. Regulation is industry-wide whereas the results of Crown ownership are applicable to select firms. Fortunately, in Canada, there is variation in the de facto degree of control, even within publicly owned firms, as well as periods of public and private (meaning private sector or publicly held shares) ownership of the same carrier. We therefore argue that it is possible to distinguish the effects of regulation and public ownership.

The approach taken in this study is to model the productive process and use residuals or deviations from the model to capture the differential effects of regulation and Crown ownership upon costs and productivity. The parameterization of the effects of other variables on costs and productivity mitigates the chances of obtaining spurious results. This is because residuals are compared rather than nominal values of costs and productivity.

D. Questions to be Addressed

The theme of this report is the identification and measurement of the effects of government regulation and crown ownership on carrier, industry structure, and performance. The research was designed to distinguish any inefficiency generated by government regulation and public ownership in the airline industry. It also attempts to understand the symbiotic relationship between regulation and public ownership. In the past these two institutions were treated as being independent, but the existence of a crown carrier can and does influence both the extent of regulation and regulatory practices, and the structure of the industry.

Research is undertaken in four areas:

i) What is the effects of public ownership and regulation on air carrier performance?

ii) What is the effects of public ownership and regulation on airline markets?

iii) What is the effect of public ownership (especially of Air Canada) on regulation and regulatory practices?

iv) What is the role of public ownership versus other policy instruments in achieving Canada's air transport goals?

E. Overview of the Approach

The methodology used in addressing all four of these questions involves development of a set of analytical results from cost and productivity models which is combined with a set of institutional (industry and regulatory) characteristics. The latter details major events affecting the industry and individual carriers. The analytical and institutional information is correlated, both statistically and intuitively, to attribute performance differences to the regulatory environment or to ownership status.

The research plan to address the first question (distinguishing the effects of regulation and crown ownership upon carrier performance) has two phases. In the first phase, a "panel" data set is used for the individual Canadian transcontinental and regional carriers for the years 1964-81 to measure and compare the economic performance of the privately and publicly owned air carriers. The performance measures are developed from cost and productivity models based on economic theory. The models control for interfirm differences in prices, scale, network, output mix and other characteristics of the operating environment. After making an attribution of performance differences to these operating characteristics, residuals or "unexplained" productivity differences remain. Statistical analysis of the residuals is used to determine the effects that ownership status and regulatory policy have had upon performence.

The purely statistical approach of phase one is supplemented in phase two with qualitative data. First an institutional "data matrix" is developed which details events such as fleet acquisitions and retirements, strikes, significant changes in ownership, management, routes, policy and regulation. These are compared with the residuals from the statistical analysis in an attempt to learn more about the impact institutional developments have had upon carrier performance.

The regulatory environment and ownership status can also have indirect effects on performance both by altering the market structure, question (ii), and by there being a relationship between crown ownership and aviation policy and regulation, question (iii). Again, a two phase approach is utilized to investigate these issues. First, the effects of regulation and ownership on market concentration and the output and network characteristics of carriers are identified. In the second phase the costs of these inefficiencies are measured.[2] The relationship between ownership status and the direction which air transport and regulatory policy take is established through an examination of the institutional information. Not only is regulatory decision-making examined, but also changes in decisions following passage of the 1977 Air Canada Act.

The last issue examined is the role of ownership versus other policy instruments in achieving particular goals. The goals that have been set out for the industry and crown carrier are established, as well as how these have changed over time. Particular attention is paid to differentiating the roles of regulation and crown ownership.

[2] Market concentration can be examined on either a system-wide basis or in specific city-pair markets. The latter, despite being important in policy analysis, were not considered here because of a lack of access to carrier specific city-pair market information.

Chapter II - THE INDUSTRY AND ITS INSTITUTIONAL SETTING

A. Introduction

This chapter provides a brief review of Canadian air carriers and the evolution of both the industry and government policy toward it. The effects of regulation and public ownership, and the role of public ownership in shaping regulation are then examined.

B. A Description of the Canadian Air Carriers

Two distinguishing characteristics of the Canadian airline industry are the level of concentration and the degree of government ownership. Air Canada dominates Canadian air transport by all measures in all markets, whether total or only domestic traffic is considered. Air Canada has been 100% federally owned since its inception and its directors are appointed by the Federal Cabinet.

PWA, the third largest carrier, started as a privately owned airline with a base in British Columbia. In 1974, the Province of Alberta acquired 100% ownership of PWA and moved the headquarters to Alberta. PWA now operates extensive networks out of both Calgary and Edmonton in Alberta as well as Vancouver, B.C. and Winnipeg, Manitoba. At least in part to enable the carrier to finance growth through equity, PWA was sold to the public in December, 1983. The province retained 15% of the shares but this has been reduced to 4%.

Nordair also started as a privately owned carrier but was acquired by Air Canada in 1978. However, it continued to operate as a subsidiary and was not merged into Air Canada. As part of the new Air Transport Policy announced on May 10, 1984, Air Canada was to divest itself of its 85% of Nordair as soon as possible. Bids were received and the Federal Cabinet approved the sale to Innocan Inc. and other investors and thus set the process in motion for a return of Nordair to the private sector. In 1985, a majority interest in Nordair was purchased by CP Air from Innocan, with Quebecair acquiring the remaining shares. With Quebecair's sale to Nordair Metro in 1986, the Quebecair shares of Nordair were sold to CP Air, which now has complete control.

Quebecair also started as a private operation. In the late 1970's and early 1980's, it experienced financial difficulties and the government of Quebec started to acquire and exert control over it. Effective control was obtained in July, 1981, and private interests were bought out in 1983. In 1986, Quebecair was sold by the province to Nordair Metro and its executives. Nordair Metro, in turn, is 35% owned by Nordair and thus CP Air.

Of the six major Canadian carriers providing scheduled services only Canadian Pacific Airlines (abbreviated to CP Air hereafter) owned by the giant conglomerate CP Limited, and EPA have been purely private operations. In April 1984, CP Air announced its acquisition of EPA which was eventually merged into it. A seventh carrier could be added to this list, Wardair. Privately owned Wardair did not operate scheduled services until 1985. It has been a charter carrier, shifting its fleet from popular sunspot destinations in the winter to transcontinental and international flights in the summer. Wardair has been instrumental in pressing for removal of some of the government imposed constraints designed to fence off low fare discretionary travel from higher fare "must-go" traffic. These constraints take forms such as advance purchase and minimum stayover requirements. The carrier is now able to sell up to one third of its seats on charter flights without advanced purchase or reservations. Much of Wardair's traffic travels at fares significantly below standard economy fares.

Table 2-1 summarizes the market shares of the seven carriers in the year 1982, before all the ownership changes took place. Air Canada services much of Canada's transcontinental traffic, almost all of its transborder traffic, operates several purely regional routes, and flies international routes, especially to Europe. Similarly, CP Air has traditionally provided transcontinental services, operates a sizable feeder network to small cities around a Vancouver hub, and carries international traffic to the Pacific rim and to a lesser extent to Europe. CP Air's acquisitions of EPA and Nordair has given it a greater feed network in central Canada and the maritimes. Both Air Canada and CP Air provide modest amounts of charter services in off-peak periods.

Table 2-1

Market Shares
Canadian Airlines, 1982

	Ownership 1982	Ownership 1986	Revenues (millions of Canadian dollars)	% of Total
Air Canada	Federal Government	Same	$2,171	56%
CP Air	CP Ltd.	Same	851	22%
PWA	Province of Alberta	Private*	315	8%
Wardair	Private	Same	271	7%
Nordair	Air Canada	CP Air	113	3%
EPA	Private	Merged into CP Air	93	2%
Quebecair	Province of Quebec	Nordair Metro & private investors	69	2%
Total			$3,883	100%

* Alberta retains 4% c. stock.
Source: International Civil Aviation Organization, 1982 Traffic Statistics and 1982 Financial Statements, Wardair 1982 Annual Report, Eastern Provincial Airlines.

The former regional carriers did not provide any international scheduled services other than a few "transborder" routes to the U.S. They operated purely regional route structures. PWA, the largest, continues to operate out of hubs in Vancouver, Edmonton, Calgary and Winnipeg. PWA serves a few transcontinental routes, but in the past had been restricted to multistop service. Multistop capacity restrictions had also been applied to many of the routes that link up its four hubs. EPA's network is largely focused on the maritimes. Nordair serves northern Ontario and areas of Quebec northwest of Montreal. In contrast to Air Canada and CP Air, the regional carriers except EPA have operated substantial amounts of charter services. This is not surprising, given the historical lack of growth opportunities in the more highly regulated regional markets for scheduled traffic.

Canada has approximately 75 third level carriers operating routes linking small communities to an airport served by a regional or transcontinental carrier. These carriers differ substantially. Trans North Air provides services in the Yukon and Northwest Territories. Air BC links several communities in British Columbia with Vancouver. Air Ontario (part of the equity of which was purchased in October 1985 by Air Canada and PWA) operates services out of Toronto to medium size cities such as London and Ottawa, often sometimes in competition with one of the larger carriers.

C. Evolution of the Industry and Government Policy Toward It

The development of 'air policy' and the regulatory framework has been very much tied to the 'National Policy' of the federal government and the establishment and growth of the Crown air carrier.

From the 1930's to the 1960's, transportation policy generally, and air transport ownership and regulation in particular, were viewed as instruments of government to promote economic development, act as an input into economic growth and serve in developing a Canadian identity. The dominant view was that the market was too sparse and the economy too small and narrowly based to support a number of carriers. It was felt that either services between population centres would not develop, or if they did, one or two firms would monopolize the service. Government therefore sought to regulate and use the industry to establish and maintain a national air transport network, to provide service to regional centres and remote areas and to promote economic growth. Policy, which developed on the belief that the industry exhibited some increasing returns to scale, promoted the size of the crown carrier at the expense of all others. Government also seemed to have the view that markets were not contestable, that private operators would not respond to opportunities, and that the social returns from the development of the industry exceeded private returns.

In the 1960's the industry and markets had grown and matured. Because economic regulation cut across the broad price-quality spectrum, separate markets (scheduled and charter) emerged based on the relative values of the price and service quality elasticities of demand. The 1967 National Transportation Act's reorientation of the role of the market and emphasis upon efficiency, were necessary conditions for the development of broader services and ultimate move to liberalize or deregulate.

In the 1970's and 1980's, it was becoming increasingly clear to consumer groups, politicians and students of the industry that the elements of the safety net protecting carriers were becoming outdated (e.g., the capacity restrictions on transcontinental service placed on CP Air). The Aeronautics Act and Air Carrier regulations came under increasing scrutiny as the U.S. moved to deregulation and greater product diversity was stiffled in Canada. In addition, an increasingly important segment of the industry had been orphaned. The third level or local service carrier had no policy directive. Their position was very much like that of the regional air carriers before 1966.

Prior to the mid 1960's, regional carriers had grown, developed networks and updated equipment without great deal of information as to where they fitted into the 'regulatory scheme'. As the regions of Canada developed and because resources could not respond to market forces due to regulation, there was a clear need for a statement of policy. The Regional Air Carrier Policy was designed to facilitate growth in both networks and service quality of the regional carrier, albeit in a tightly controlled environment. The five regionals at that time - PWA, EPA, Transair (later merged into PWA), Nordair and Quebecair - were to provide service to remote communities within designated geographic areas. They were to supplement the trunk carriers, but not compete with them. The regional carriers were given monopolies on nearly all routes in specific geographic regions.

There was also a direct subsidy program to meet the objectives of the 'regional aviation policy'. The regionals were able to use the new policy and attendant subsidies to upgrade equipment. This in turn was parlayed into longer routes (to cross subsidize short or thin routes) which eventually ended up reducing service to small centres and providing more service to long haul dense markets. The resulting route structure was a result of an attempted shift from direct to cross-subsidy (Baldwin, 1975, ch. 4). The regional carriers were also induced into a greater proportion of freight and charter than the trunk carriers.

The most recent phase in the evolution of aviation policy in Canada began in approximately 1975. It was characterized by deregulatory moves in the U.S., a new Air Canada Act, a relaxation of rigid fare controls, a removal of capacity constraints on C.P. Air, the introduction in 1984 of a new aviation policy to substantially relax the restrictive domestic regulatory environment and in 1985, a proposal to deregulate the industry. These moves are now discussed.

In the early 1970's the Domestic Passenger Fare Investigations were held by the Civil Aeronautics Board (CAB) in the U.S. Testimony and evidence on air carrier fares and performance provided during the course of these hearings ultimately led to the Kennedy hearing in the mid-70's. These hearings investigated the issue of deregulation. The U.S. evidence illustrated that regulation had inflated costs and fares and that fares in less regulated markets were lower. This evidence of inefficiency in the industry was a sufficient force to lead to U.S. deregulation in 1978. The resulting fare reductions were to have a significant impact upon transborder traffic. This was a major factor in the decision to review regulatory policy and the regulatory process in Canada.

The moves to relax airline regulation in Canada began slowly. The charter market was the first to undergo some change. The process of change also brought more into the public eye the entrenched position of the ATC and the incumbent carriers. Reschanthaler and Stanbury (1982) trace the evolution of policy changes with regard to international and domestic charters. They point out that pressure from Wardair was important in obtaining many reforms. The incumbent carriers, particularly the two trunk airlines, opposed any changes, particularly in domestic charters. The Regional carriers were confined to geographic limits by 'policy' and yet in the same policy a 'regional carrier's international charter operations could not jeopardize domestic route operations'. Furthermore, the ATC in making charter operating awards to the regionals would first consider whether there was any adverse effect on the trunk carriers.

The changes began with the adoption of international Advanced Booking Charters (ABC) in January, 1973.[1] From 1974 to 1977 charters became increasingly competitive, rates fell and the juxtaposition with domestic service and prices raised many questions regarding the performance of the regulatory system.

In 1977 another important Act was passed, the new Air Canada Act. Air Canada (called TransCanada Airlines up to 1964 when the name was changed) was formed in 1937. The private sector was viewed as unable or unwilling to provide a set of services deemed to be in the public interest. In the Air Canada "contract" the government instructed the airline to perform public services at an average cost. It was not a commercial venture and was not to maximize profits. In this way the airline was an instrument of local, regional, and national transport policy. It was also used as an instrument of other national policies such as bilingualism, government decentralization and promoting industrial and regional development.

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[1] An ABC charter ticket could be sold to any individual. Prior to ABC, tickets could on' be sold to members of an affinity group, such as a club. This requirement severely limited the availability of charter fares to the public.

The Air Canada Act of 1977 formally recognized the changing market and industry conditions and the impact of external events. It changed the goals and structure of the airline to better function in a mature market. Two themes contained in the Act were market orientation and equality before the regulatory board. What was the effect of this new Act on fares and performance? Perhaps the single most important result of the new act was to change the psychology of people in Air Canada (particularly middle management), in government, and among the regions regarding the airline and its role. In particular profits and efficiency are now important and services previously supplied by Air Canada were viewed as being capable of being supplied by other carriers. The new act implictly removed some exit barriers by focussing upon profits and efficiency.

The changes in the Air Canada Act also provided a necessary change to make the industry more contestable. The continuing strict regulatory environment still imposed significant entry and exit barriers. The Act, however, by changing the objective focus of the crown carrier, providing it with a [financial] structure with which it could compete, meant that markets as well as other carriers no longer needed to be fenced to allow the crown airline to carry out its social mandate.

Elsewhere in the industry other events were taking place. CP Air had its capacity restrictions gradually relaxed, until 1979, the year in which the capacity restrictions were removed. In 1978, CP's share of transcontinental market capacity was increased from 25 to 35% of the growth in the market. This was further increased to 45% in early 1979. CP also received permission to consolidate licenses, as well as serve additional cities. In March of 1979 all capacity restrictions on CP Air were removed.

The elimination of capacity restrictions for CP Air, the deregulation of the U.S. industry, the actual and potential for diversion of international and transborder traffic to U.S. carriers and the move to allow Wardair to offer limited de facto scheduled service, all made airline management in Canada sensitive to market pressures and forced the ATC and others to reconsider their staunch protectionist attitudes.

In 1984, Lloyd Axworthy, the then Minister of Transport, renewed the initiative of relaxing regulation. He requested the ATC to hold public hearings on domestic and transborder air fare policies, and struck an interdepartmental task force to examine the possibility of deregulation.

The interdepartmental task force was to examine the possibility of adapting U.S.-style airline deregulation to the Canadian environment. At the ATC hearings, the two largest airlines, Air Canada and CP Air, advocated establishing minimum acceptable floors for various discount fares and strengthening fences on discount fares. While the two carriers appeared to be prepared for some price competition and limited new entry, they were strongly against any movement toward an open entry policy. Many ATC officials also appeared to favor "controlled competition" over full deregulation with respect to both fares and entry issues. Consumer groups, such as the Consumers Association of Canada and the government agency, Consumer and Corporate Affairs Canada, took positions largely in favor of deregulation. They were supported by several researchers and academics. The battle line was drawn between the Minister, with support of consumers' organizations and of most regulatory researchers and analysts, and the two major airlines whose views appear to be supported by the ATC and many civil service officials within Transport Canada.

In 1985, the then Minister of Transport, Donald Mazenkowski, presented a white paper, Freedom to Move, which was de facto a plan to move to deregulation of airlines as well as other modes. Legislation (Bill C-126) was introduced in 1986. The May 10, 1984 "New Canadian Air Transport Act" retained the existing legal structure of regulation, but nevertheless gave considerable pricing freedom and improved entry freedom.

D. The Effect of Ownership, Regulation and Regulatory Practices on Air Policy

The discussion above observed that the regulatory structure was put in place to, among other things, ensure the position of Air Canada as an instrument of government.

Crown ownership, specifically federal crown ownership of Air Canada, had a significant impact upon both the development of the industry and the form and method of regulation. The intent of the regulations were both promotional and protective. Government sought to establish and maintain a national (transcontinental) air transport network, provide service to remote areas and regions, and have a Canadian presence in international markets. Intervention was also designed to assure service continuity and protect users from monopolistic practices. Because the Crown carrier was to be an important policy instrument, economic regulation had to be designed to complement it. Hence regulation differed from that which would have existed if there had been only private carriers in the market.

Three important features were the capacity restrictions placed upon CP Air in the transcontinental market, the Regional Carrier Policy, and the power of Cabinet to make route awards for the Crown carrier. Route awards to the Crown carrier took precedence over all others. These characteristics had a significant impact not only upon the nature and configuration of carrier networks, but also upon the degree of concentration found in the industry. These three policies resulted in a minimum of competition between firms, a minimum overlap of services and a limiting of firm growth to the secular growth of the airline market in the particular geographic area. This in turn affected fleet choice, network choice and aircraft utilizatio-n.growth of the airline market in the particular geographic area. This in turn affected fleet choice, network choice and aircraft utilization.

In the absence of government ownership of Air Canada, it is unlikely either the transcontinental or regional carrier policies would have evolved out of regulatory decision-making. It was because Air Canada had been chosen to dominate the industry (to act as an informal regulator) that these policies were put in place to fence regulatory practice. Crown ownership meant making regulatory decisions to first protect Air Canada and second to preserve the rest of the system and established carriers. Even after the new Air Canada Act, which changed the orientation and status of the crown carrier and which implicitly recognized the maturity of the industry, regulation continued to protect Air Canada with defensive decision-making; e.g., the allowed merger with Nordair, the reluctance to expand discount fares in the late 1970's, and protecting Air Canada on the Halifax to central Canada route. In each of these cases, the government was forced to intervene in the regulatory process.

Crown ownership and the Trans Canada Airlines Act of 1937 generated a set of regulations, policies and regulatory practices which significantly increased average route concentration in the system, created inefficiences for other carriers by affecting input choice and the network structure, and prevented carriers, particularly regionals, from realizing traffic density economies. Finally, the regulators, having developed such a protectionist stance and set of regulatory practices, did not respond to signals from the government which wanted to increase [somewhat] competition.

The consequences of regulation on economic performance are established in numerous studies [see Waters, 1976]. The findings provide a consensus that regulation reduces allocative and technical efficiencies and distorts inter-modal competition. Regulated industries tend to be less innovative, have dulled competitive instincts and have higher costs. Transportation users face higher prices as well as a price structure which causes inefficiency. All of these criticisms are based upon a performance criterion of administrative and resource efficiency which, as we have noted above, is generally considered to be too narrow.

Chapter one's discussion of public ownership noted that the conclusions, of both the property rights approach and public choice approach to assessing public production, were that public ownership resulted in behavior and cost levels similar to those generated by economic regulation; in particular overcapitalization, excessive wages, lack of innovation, higher costs and in some cases higher service quality than a private firm would offer.

The assessment of the effects of regulation and crown ownership which follows observe changes in a set of variables and attempt to attribute a particular proportion of the change to regulation and the remainder to crown ownership. The presence of Air Canada has affected the way in which policy was made and the type of regulation introduced. Thus assessing the inefficiency associated with economic regulation is more difficult than similar estimates would be for the United States. There will also be differences in the magnitudes of efficiency gains with a change in economic regulation. For example, a significant source of cost savings with deregulation in the United States was the shift away from scheduling competition to price competition. In Canada, scheduling competition was effectively prevented by the transcontinental and regional carrier policies. Both of these policies were adopted because of the presence of Air Canada. It is clear the sources of any inefficiency resulting from economic regulation will differ between Canada and the United States.

Having reviewed the literature of the effects of regulation and public ownership on performance and recognizing the inter-relationship between the presence of the crown carrier and the form of regulation and air policy, we speculate that the source of inefficiency from public ownership will materialize in the form of higher wages, excess capital providing high levels of service (which favours business travellers). Regulatory inefficiencies will show up in restricted stage lengths, entry controls restricting the ability to realize traffic density economies, inefficient input choices and inappropriate output combinations.

Chapter III - DESCRIPTION OF DATA USED IN THE STUDY

A. Introduction

This study will measure and compare the economic performance of the publicly and privately owned air carriers with an aim to separate ownership and regulatory effects on performance. This statistical work uses both a numerical panel data set (a time series of data on the cross section of Canadian transcontinental and regional carriers[1]) and a set of institutional information. The numerical data set is required both to identify cost structures and to measure productivity. The institutional information is used to explain the impact of policy, ownership and management changes on performance.

B. Statistical Data Description

Variables. The measurement of total factor productivity and estimation of cost functions require data on prices and quantities of outputs, attributes of each output, network variables, and prices and quantities of inputs. An annual data for the seven transcontinental and regional carriers was created for the following years:

1964-81: Air Canada, CP Air, PWA, Quebecair, EPA

1964-79: Transair (merged into PWA in 1980)

1971-81: Nordair (incomplete data for prior years).

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[1] Throughout this study, only Air Canada and CP Air are treated as "transcontinental carriers". Wardair is excluded from our analysis due to lack of consistent data. The May 10, 1984 New Air Carrier Policy removes the distinction between transcontinental and regional carriers by repealling the Regional Carrier Policy.

Details regarding methods of data construction, and sources of raw data are available in Gillen, Oum and Tretheway (1985). This section merely describes the general framework of the data base.

At the time this research was undertaken, output data were not available separately for domestic, transborder and international routes. Therefore, total output could only be disaggregated into three categories: scheduled passenger services (Y_1), scheduled freight services (Y_2) and charter services (Y_3). For each of these output measures we examined a set of variables which described the nature or characteristics of the output. These include average aircraft stage lengths, and aircraft size for each of the three outputs. A network measure was also included for each carrier for each year.

Inputs were aggregated into three categories: labour (L), fuel (F), and capital and materials (KM). The labour input (price and quantity) was measured by a multilateral index (Caves, Christensen and Diewert, 1982) of six subcategories of labour: pilots and co-pilots, other flight personnel, maintenance labour, aircraft and traffic servicing, general management, and other employees. The four fuel types (turbo fuel, aviation gasoline, turbo oil and other oil) were converted into a common measure, the British Thermal Unit (BTU), to create aggregate fuel input.

For each of the eight categories of capital input, a real capital stock series was created using the perpetual inventory method. The opportunity cost of using a dollar's worth of the asset was computed utilizing the capital service price method proposed by Christensen and Jorgenson (1969), modified to reflect Canadian tax laws. This method takes into account the effects on user cost (of a capital asset) of changes in corporate income tax rates, capital cost allowances, investment tax credits, capital gains (or losses) due to changes in the asset price, property tax rates as well as interest and depreciation.

"Materials" input is a catch-all category which includes all other purchased inputs. The GNE deflator is used as a proxy for the price of the materials input. Since there is no public access to the data on carriers' rental payments on flight equipment, these were not included as a part of the capital costs computed above. Instead, because of the way the cost of materials inputs is computed, the rental payments on flight equipment are captured in the materials category. Therefore, in order to avoid the potential bias in our input data, materials was aggregated with the eight categories of capital inputs to create an aggregate multilateral index for capital and materials.

Review of industry trends. The current size and structure of the airline industry in Canada has resulted from regulatory policy and decisions as well as from the domestic and international economic climate. In order to understand the issues as well as assess the results of the analytical models, a brief review of industry trends and descriptive statistics is useful. The trends and directions of carriers provide perspective for assessing the past and prescribing for the future.

Figures 3-1 and 3-2 present the total revenue-tonne-kilometers (RTK) for the transcontinental (Air Canada and CP Air) and regional carriers. Total number of employees are graphed in Figures 3-3 and 3-4. In general, both output and number of employees indicate a rapid growth of all seven

FIGURE 3-1

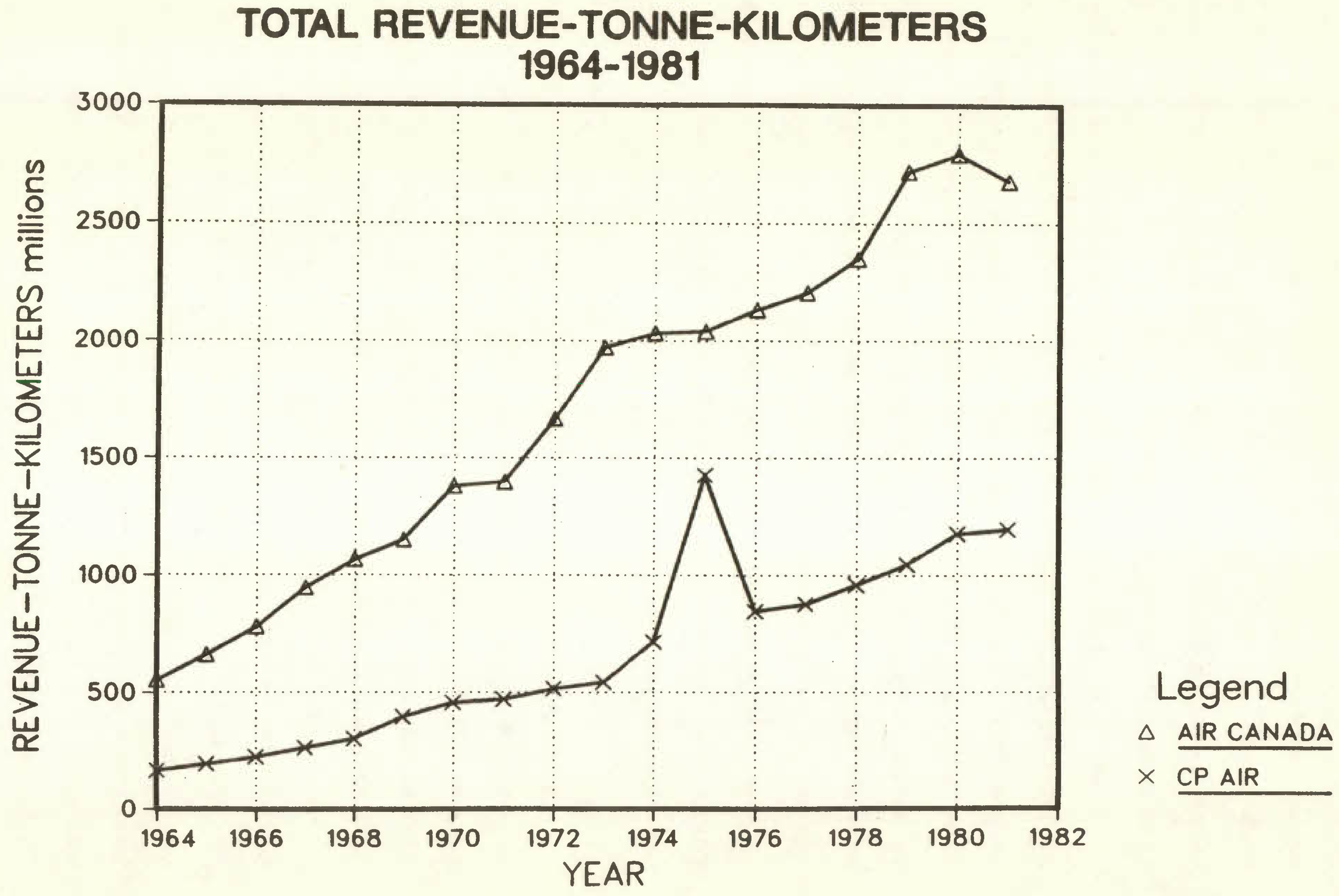

TOTAL REVENUE-TONNE-KILOMETERS
1964-1981
REVENUE-TONNE-KILOMETERS millions
3000
2500
2000
1500
1000
500
0
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
YEAR
Legend
AIR CANADA
CP AIR

FIGURE 3-2

TOTAL REVENUE–TONNE–KILOMETERS 1964–1981

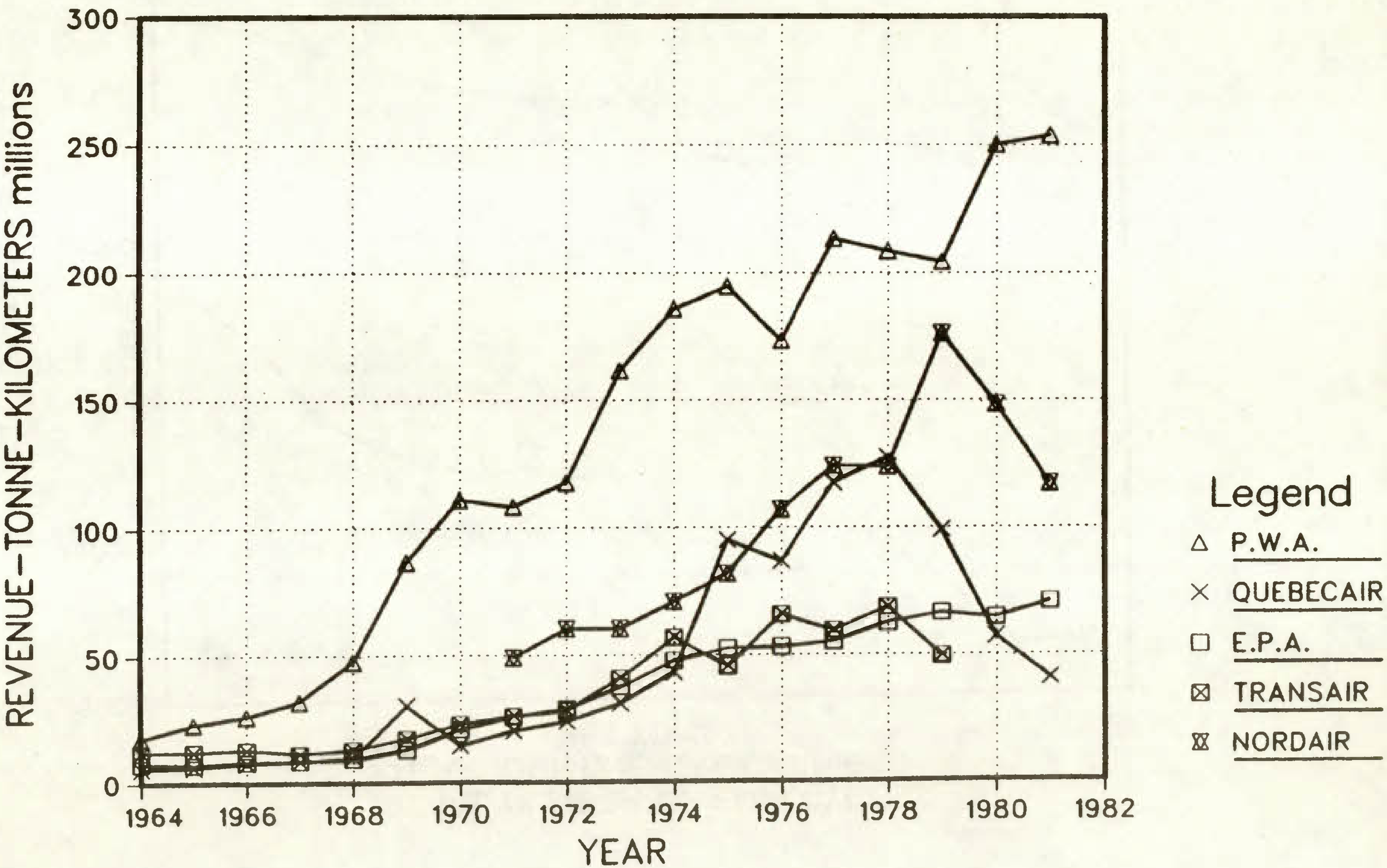


FIGURE 3-3

TOTAL NUMBER OF EMPLOYEES
TRANSCONTINENTAL CARRIERS
1964 TO 1981

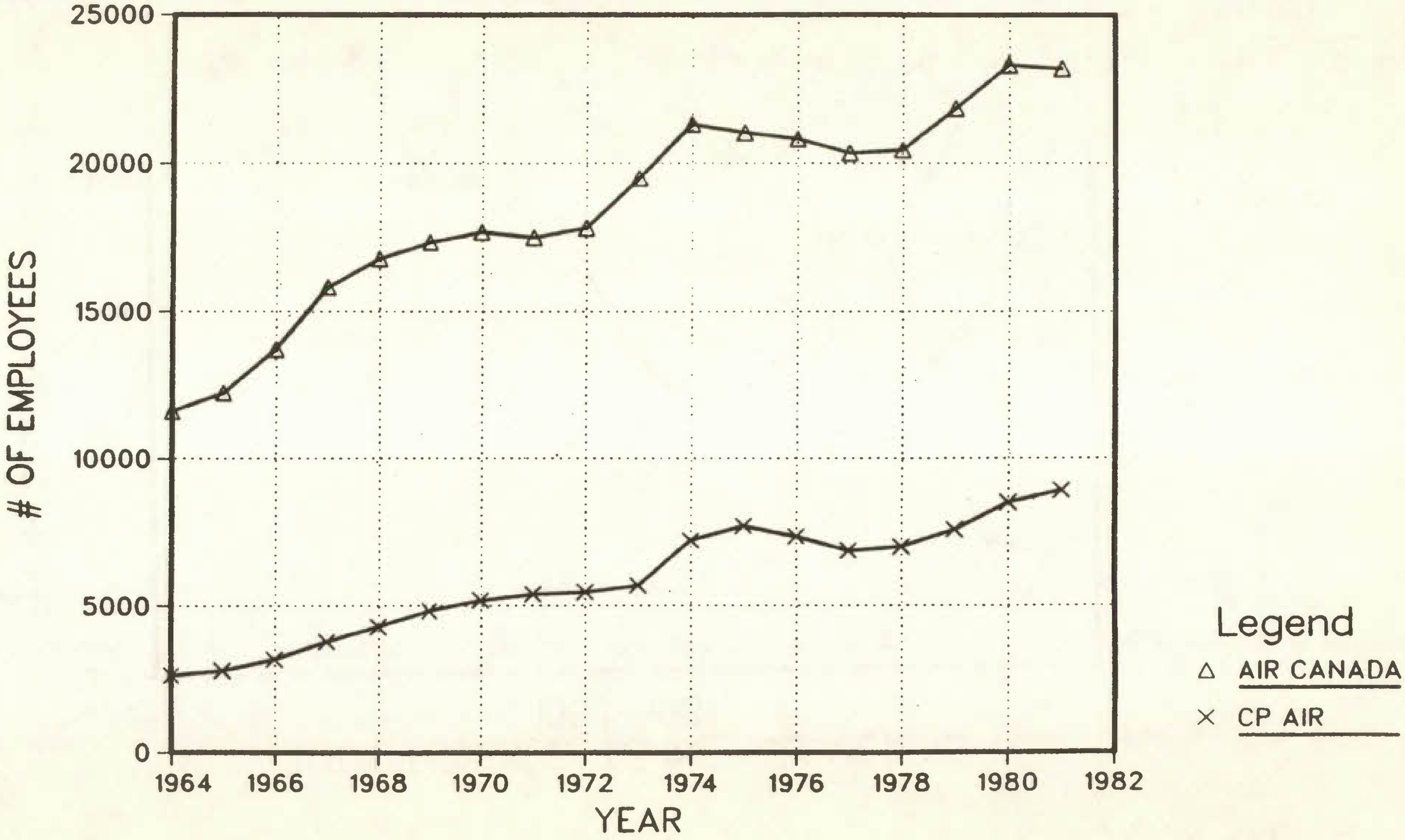
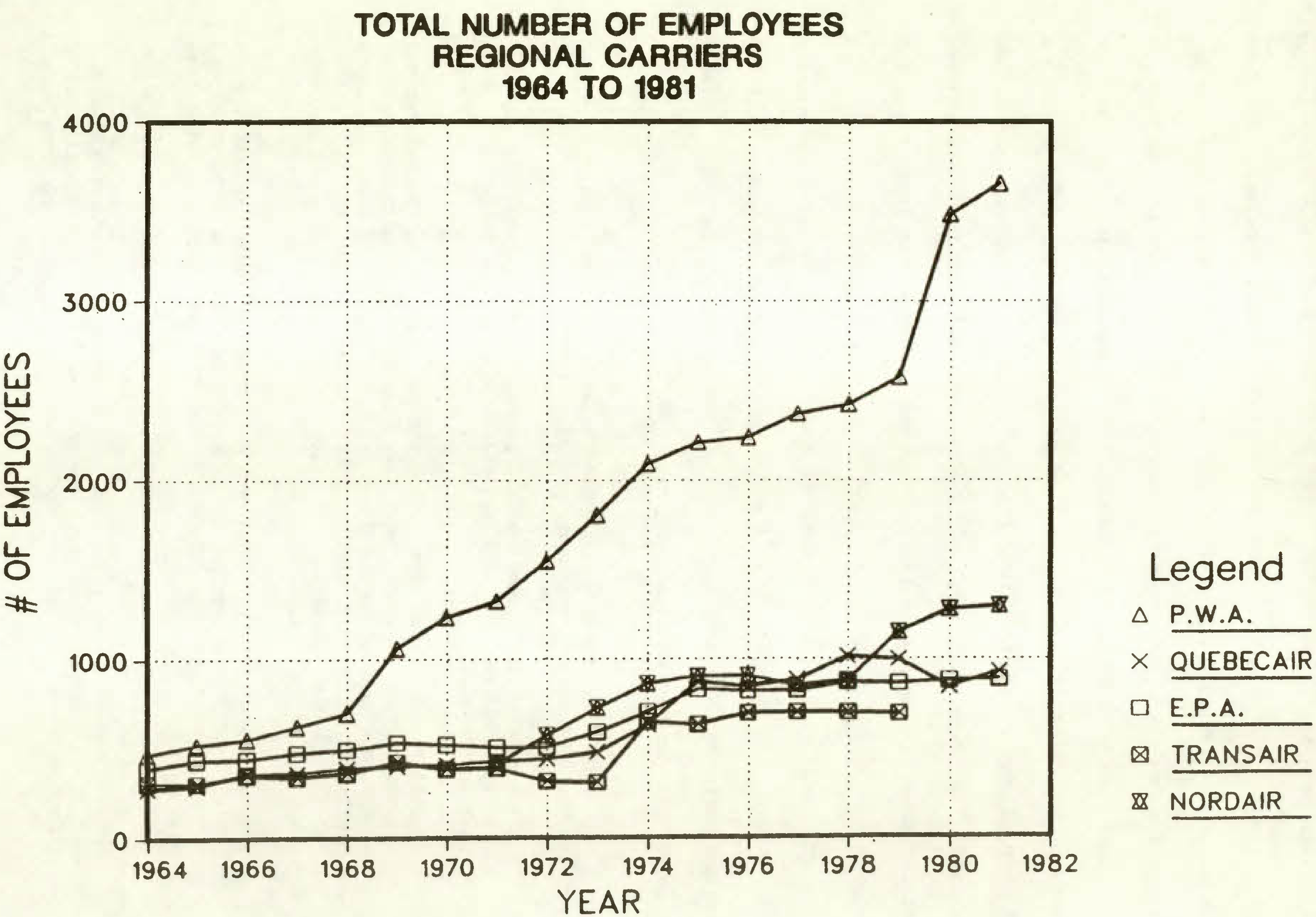


FIGURE 3-4


TOTAL NUMBER OF EMPLOYEES
REGIONAL CARRIERS
1964 TO 1981
OF EMPLOYEES
4000
3000
2000
1000
0
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
YEAR
Legend
P.W.A.
QUEBECAIR
E.P.A.
TRANSAIR
NORDAIR

carriers over the study period. Quebecair and Nordair are exceptions to this trend. Quebecair's output (to a lesser extent employees) has been dramatically curtailed since 1978. Nordair's output has been significantly reduced since 1979. In general, the output growth rates for the Regional carriers have been higher than those of the transcontinental carriers. In particular, PWA's 1981 output is over eleven times that of 1964, and its number of employees grew from about 500 to about 3,700 during the same period. All other carriers, except Quebecair and Nordair, have enjoyed steady growth in both output and number of employees, at least until the 1980's.

Figures 3-5, 3-6 and 3-7 indicate how the shares of scheduled passenger, freight and charter services outputs (in terms of revenue-tonne-kilometers) have changed for each carrier over the study period. Several observations can be made from these graphs:

1. Air Canada and CP Air[2] have been heavily oriented toward scheduled services throughout the study period.

2. Excepting EPA, all other regional carriers are substantially charter-oriented. Since 1978, all regionals have reduced their reliance on charter services.

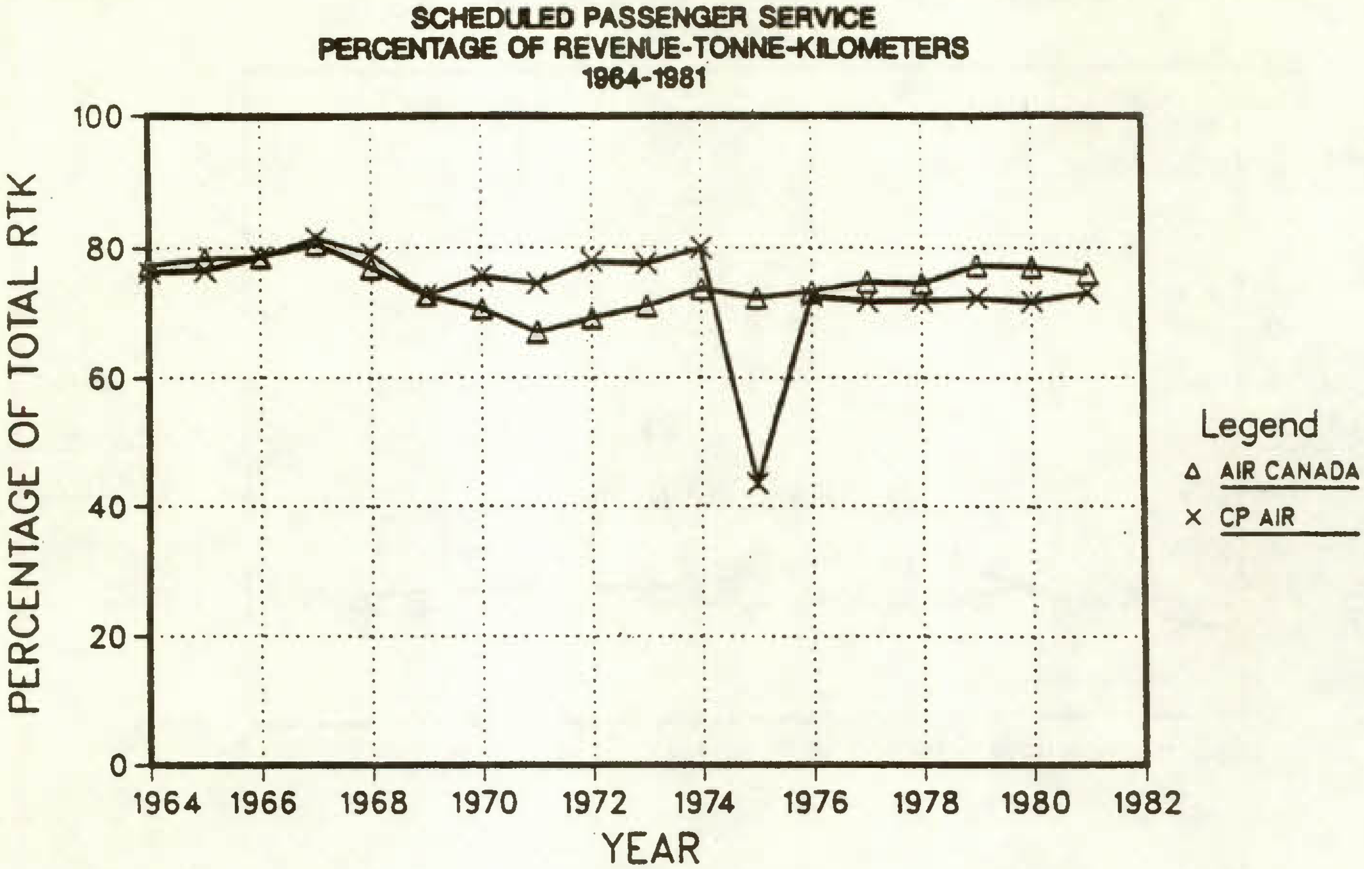
3. In 1964, EPA produced over 50% of its total output in the charter and freight services market. Over time they have focused their energy on developing scheduled services. With equipment changes, route expansion and route trades with Air Canada, by the late 1970's they had the highest relative proportion of scheduled passenger services among all regional air carriers.

4. Quebecair was heavily dependent on scheduled passenger service in 1964. However, it became the most charter-oriented carrier by the mid-1970s. Since 1978 its high proportion of charter services has been reduced.

---

[2] CP Air's exceptionally high percentage of revenue generated from the scheduled freight service in 1975 was caused by the introduction of a combination passenger/freight jet (DC8) between Vancouver and Hong Kong.

FIGURE 3-5


SCHEDULED PASSENGER SERVICE
PERCENTAGE OF REVENUE-TONNE-KILOMETERS
1964-1981
PERCENTAGE OF TOTAL RTK
YEAR
Legend
AIR CANADA
CP AIR
100
80
60
40
20
0
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982

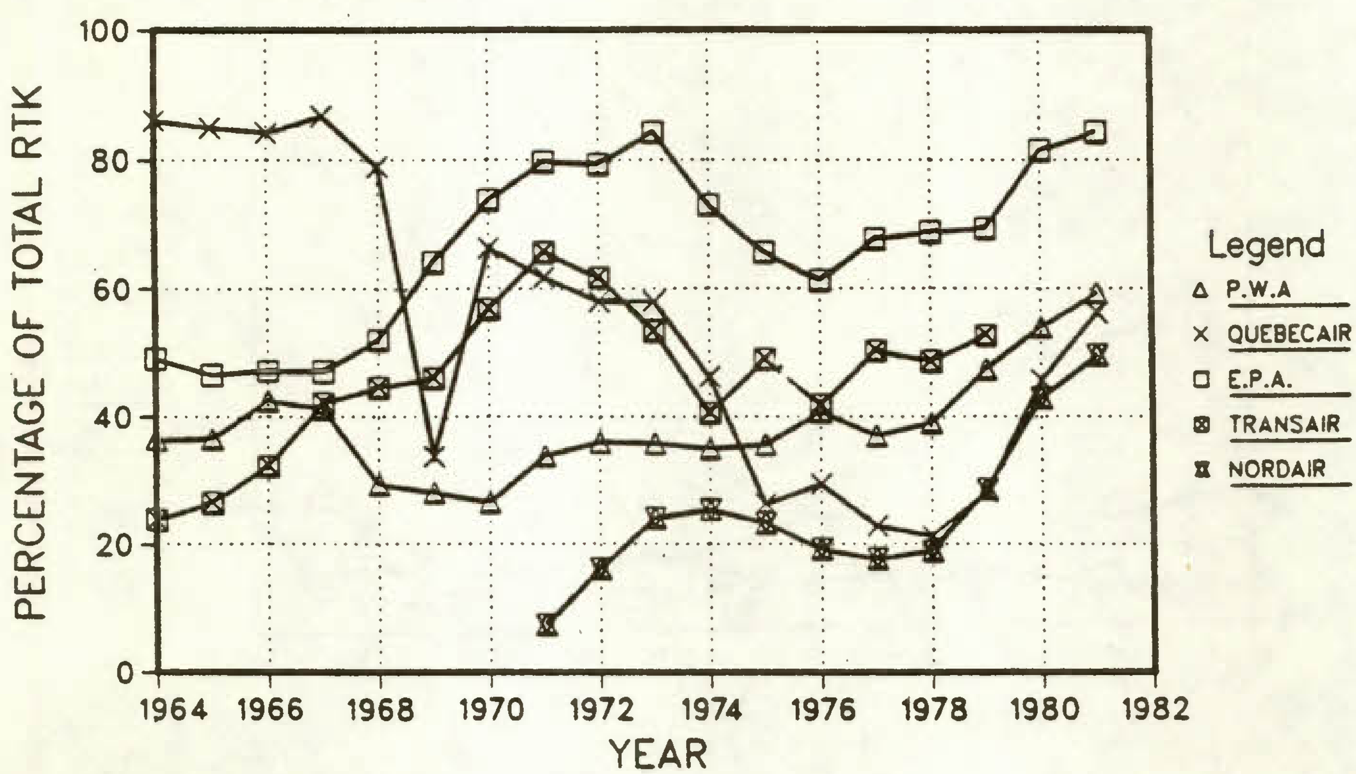

PERCENTAGE OF TOTAL RTK
YEAR
Legend
P.W.A
QUEBECAIR
E.P.A.
TRANSAIR
NORDAIR
100
80
60
40
20
0
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982

FIGURE 3-6

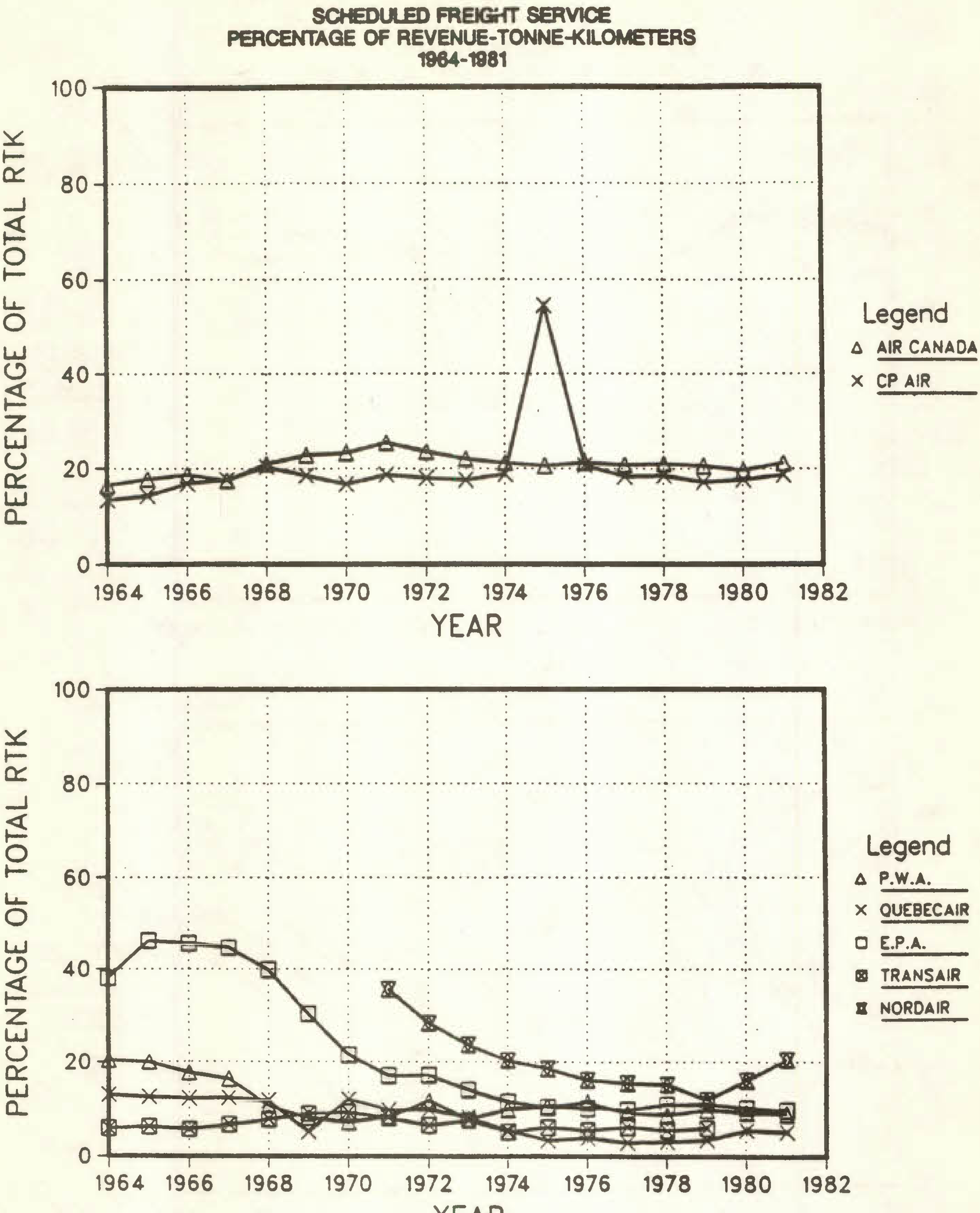
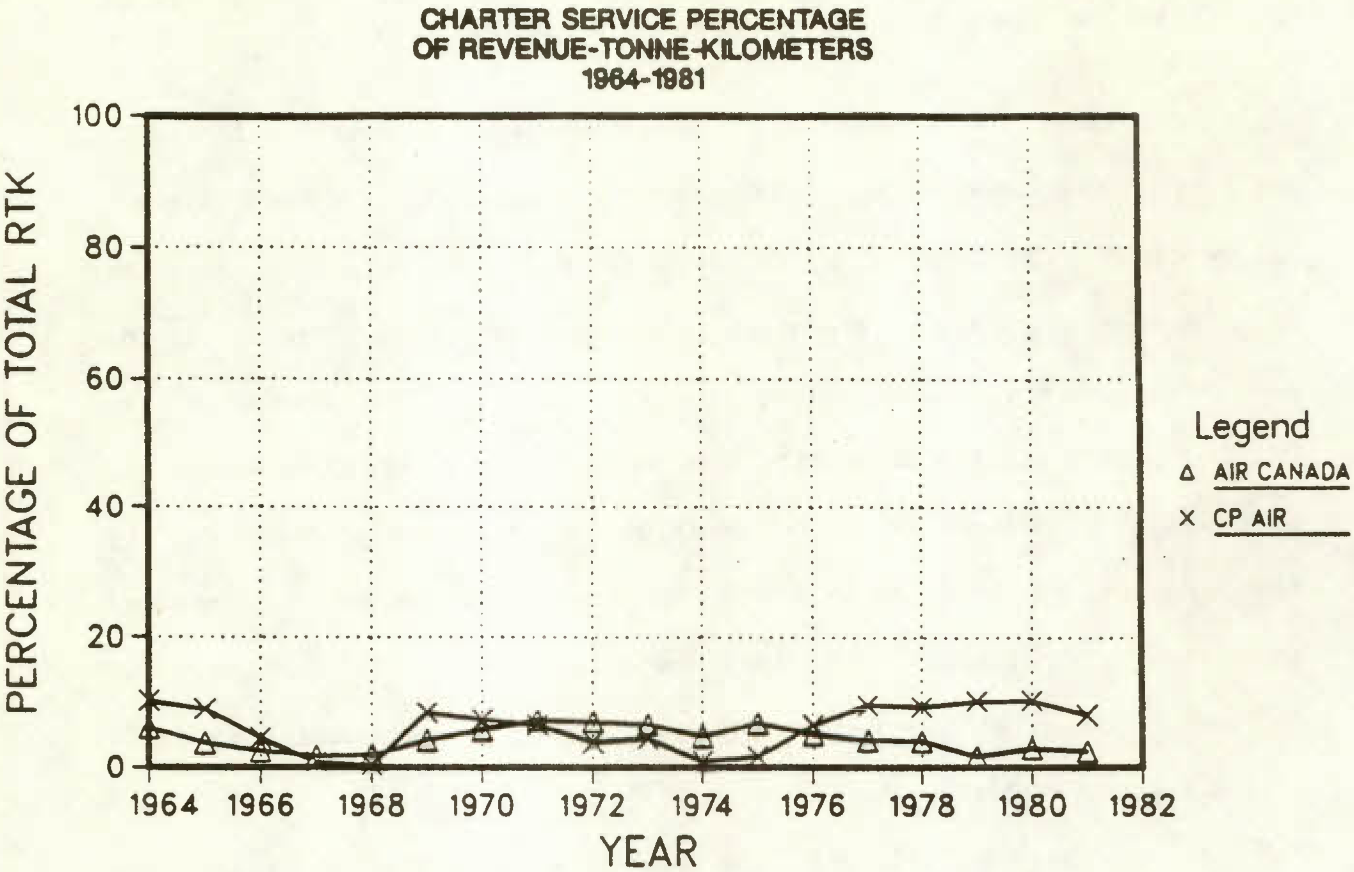
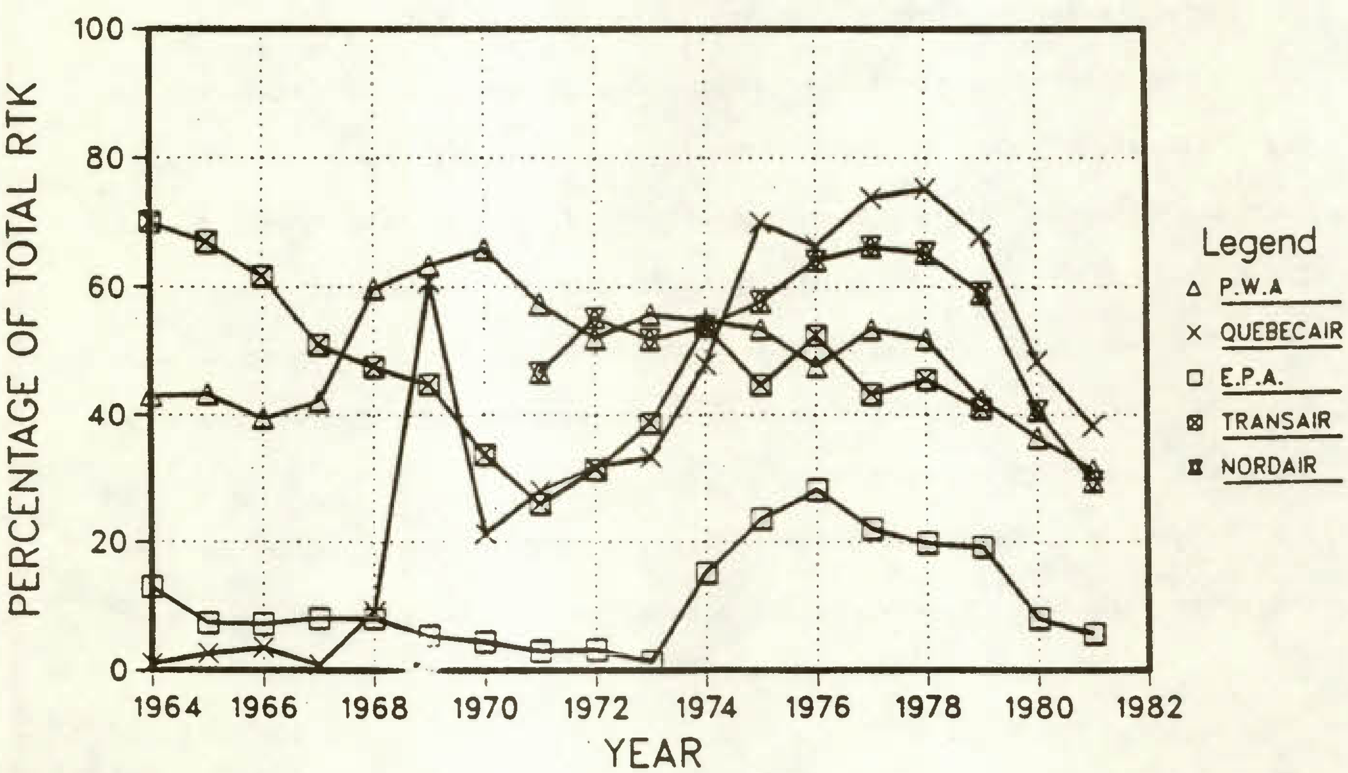

SCHEDULED FREIGHT SERVICE
PERCENTAGE OF REVENUE-TONNE-KILOMETERS
1964-1981
PERCENTAGE OF TOTAL RTK
YEAR
Legend
AIR CANADA
CP AIR
P.W.A.
QUEBECAIR
E.P.A.
TRANSAIR
NORDAIR

FIGURE 3-7


CHARTER SERVICE PERCENTAGE
OF REVENUE-TONNE-KILOMETERS
1964-1981
PERCENTAGE OF TOTAL RTK
100
80
60
40
20
0
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
YEAR
Legend
AIR CANADA
CP AIR


PERCENTAGE OF TOTAL RTK
100
80
60
40
20
0
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
YEAR
Legend
P.W.A
QUEBECAIR
E.P.A.
TRANSAIR
NORDAIR

5. In recent years, Air Canada, CP Air and Nordair have higher shares of scheduled freight output relative to other carriers.

The average annual compensation per employee is illustrated in Figure 3-8. It is evident that over the entire period, Air Canada's average salary was highest followed by CP Air. PWA's average salary has been the third highest since 1977. There are indications of eratic behaviour in the case of Transair's average salary from 1972 to 1974. The reason is that Transair made a massive transition from small piston aircraft to modern jet equipment. To prepare for the transition they hired many people at very high salaries, particularly in general management, pilots and co-pilots and in aircraft and traffic servicing categories. In fact, the number of employees classified in the general management category more than quadrupled between 1973 and 1974.

Figures 3-9 and 3-10 show the average compensation for pilots and co-pilots and for general management, respectively. PWA's average compensation for pilots and co-pilots was somewhat lower than Air Canada and CP Air until about 1974, at which time it approached Air Canada and CP Air. With the exception of the transitional period, 1971-73 for Transair, Air Canada maintained the average salary of the general management category at about $10,000 to $20,000 higher than that of CP Air. It is also noticeable that the average salary of the general management category for PWA has been among the lowest of all carriers.

Figure 3-11 shows the price per gallon of turbo fuel paid by each of the seven airlines. Some variation across carriers is observed because of

FIGURE 3-8

AVERAGE COMPENSATION
OVER ALL LABOUR CATEGORIES
1964-1981

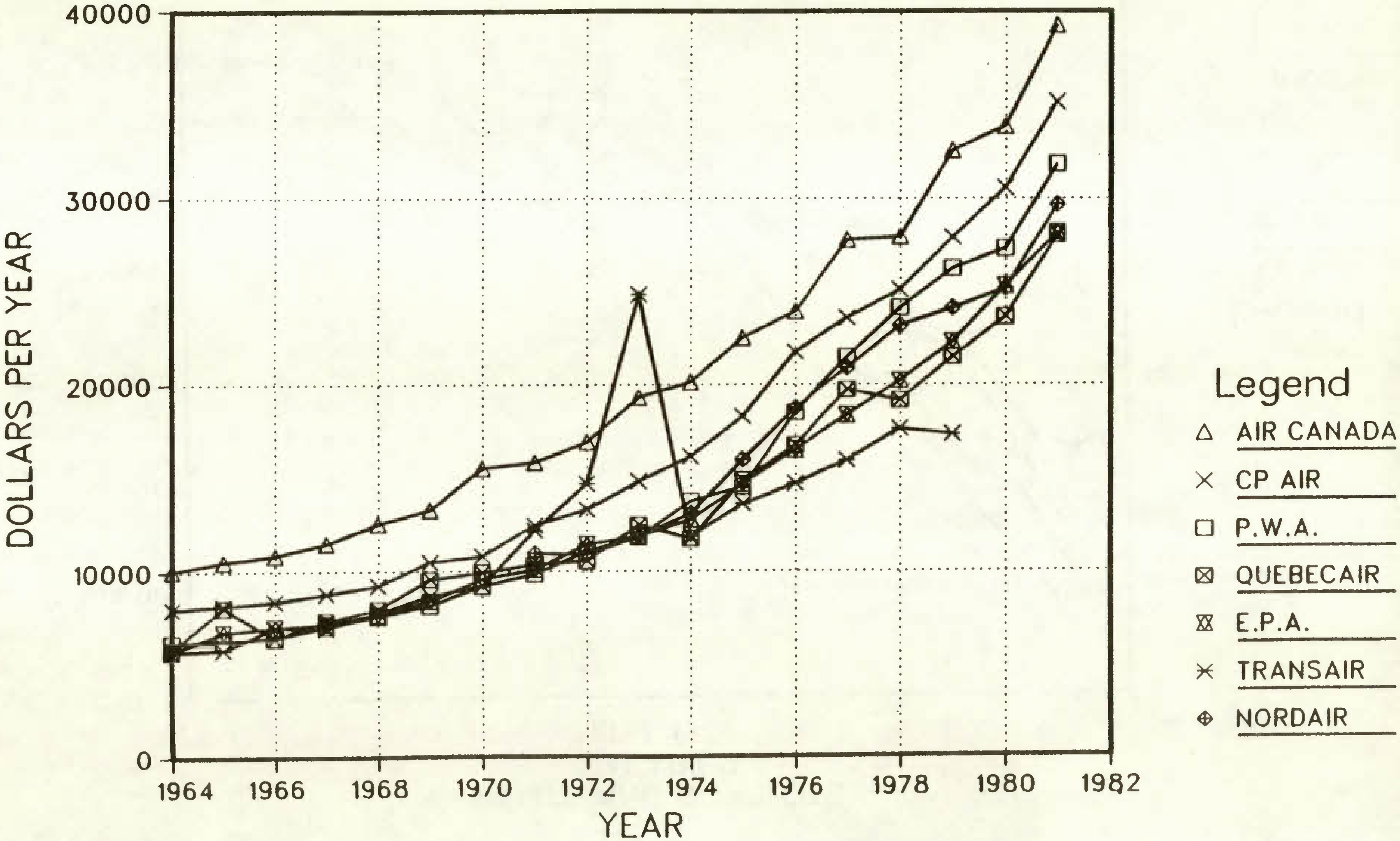


FIGURE 3-9

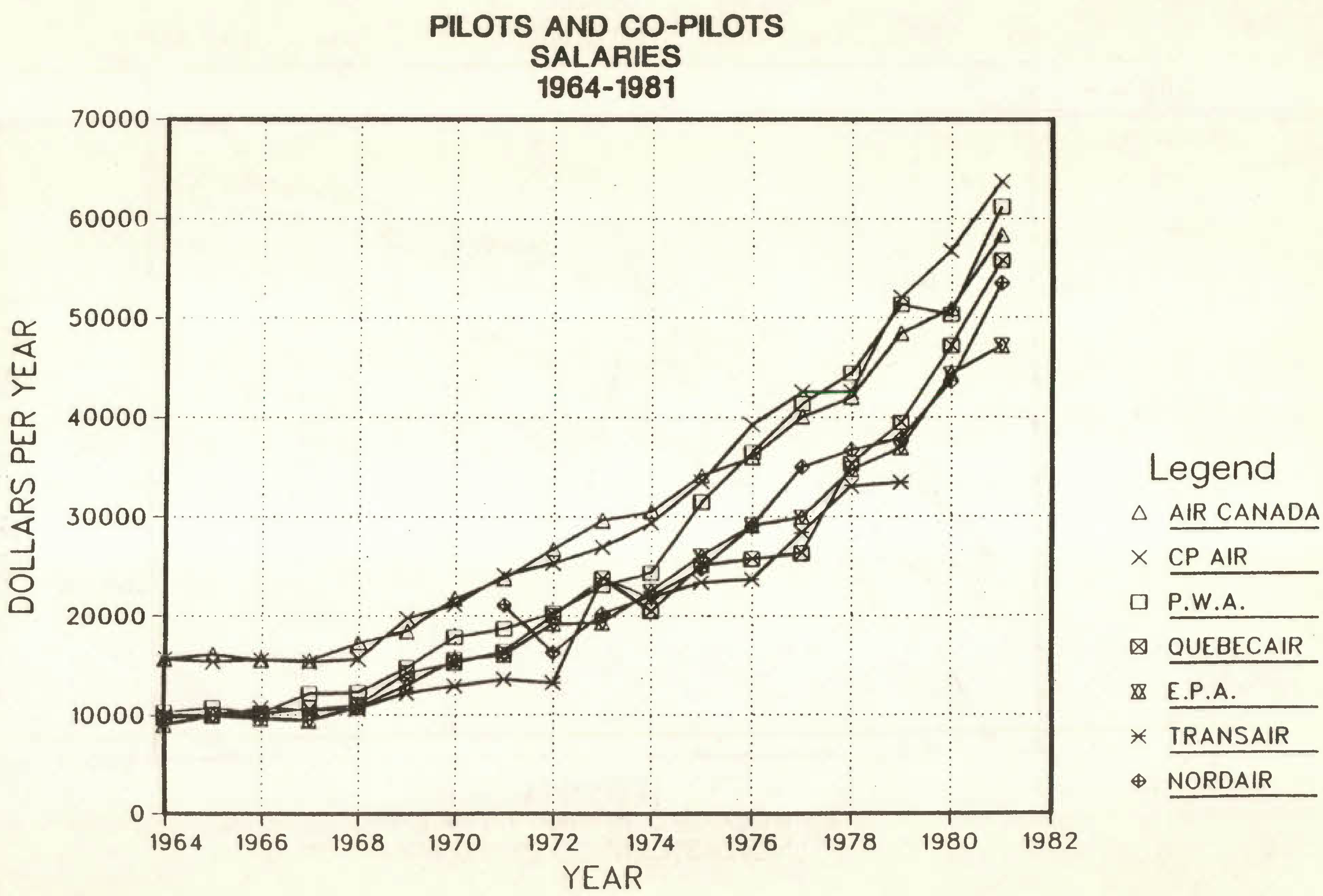

PILOTS AND CO-PILOTS
SALARIES
1964-1981
DOLLARS PER YEAR
70000
60000
50000
40000
30000
20000
10000
0
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
YEAR
Legend
AIR CANADA
CP AIR
P.W.A.
QUEBECAIR
E.P.A.
TRANSAIR
NORDAIR

FIGURE 3-10

GENERAL MANAGEMENT SALARIES 1964-1981

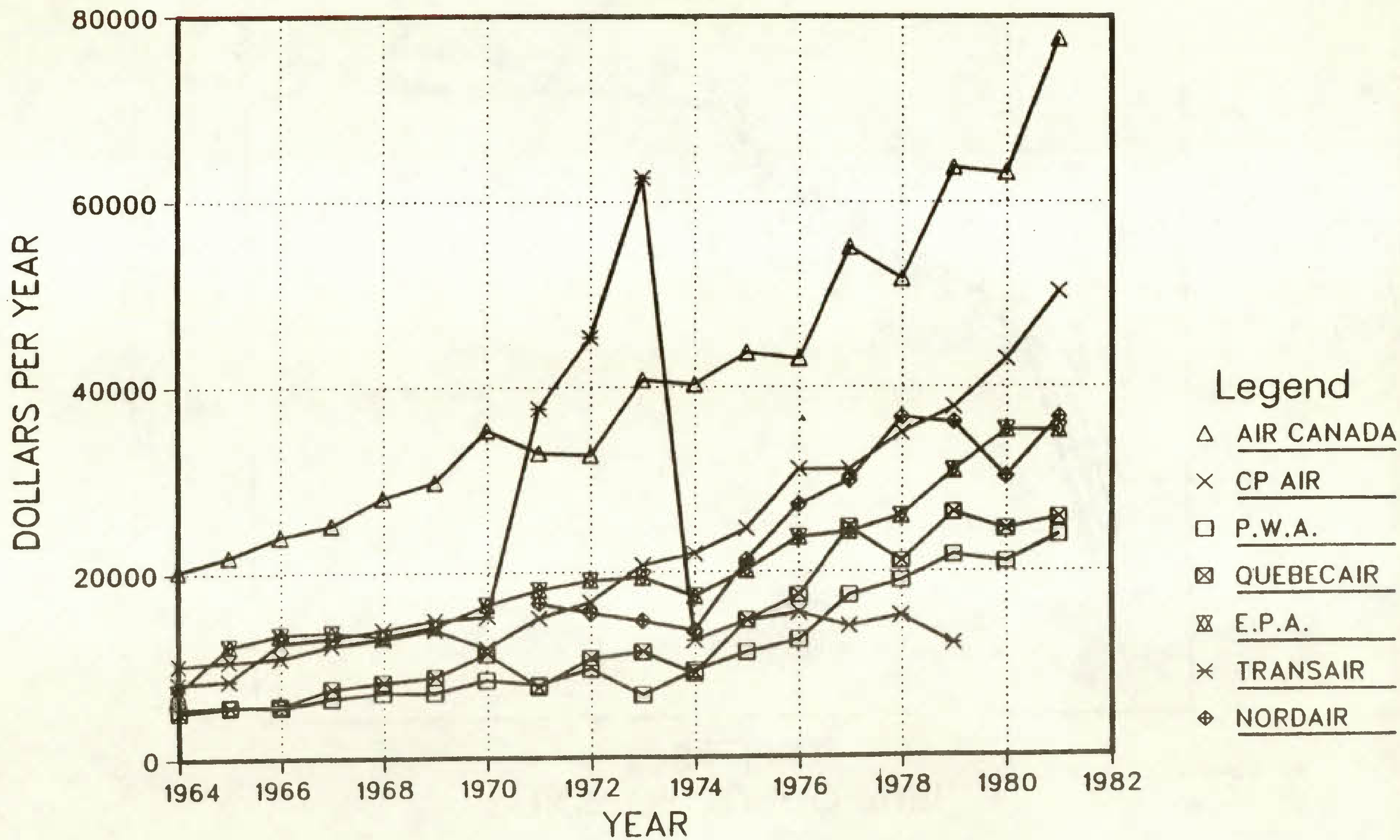
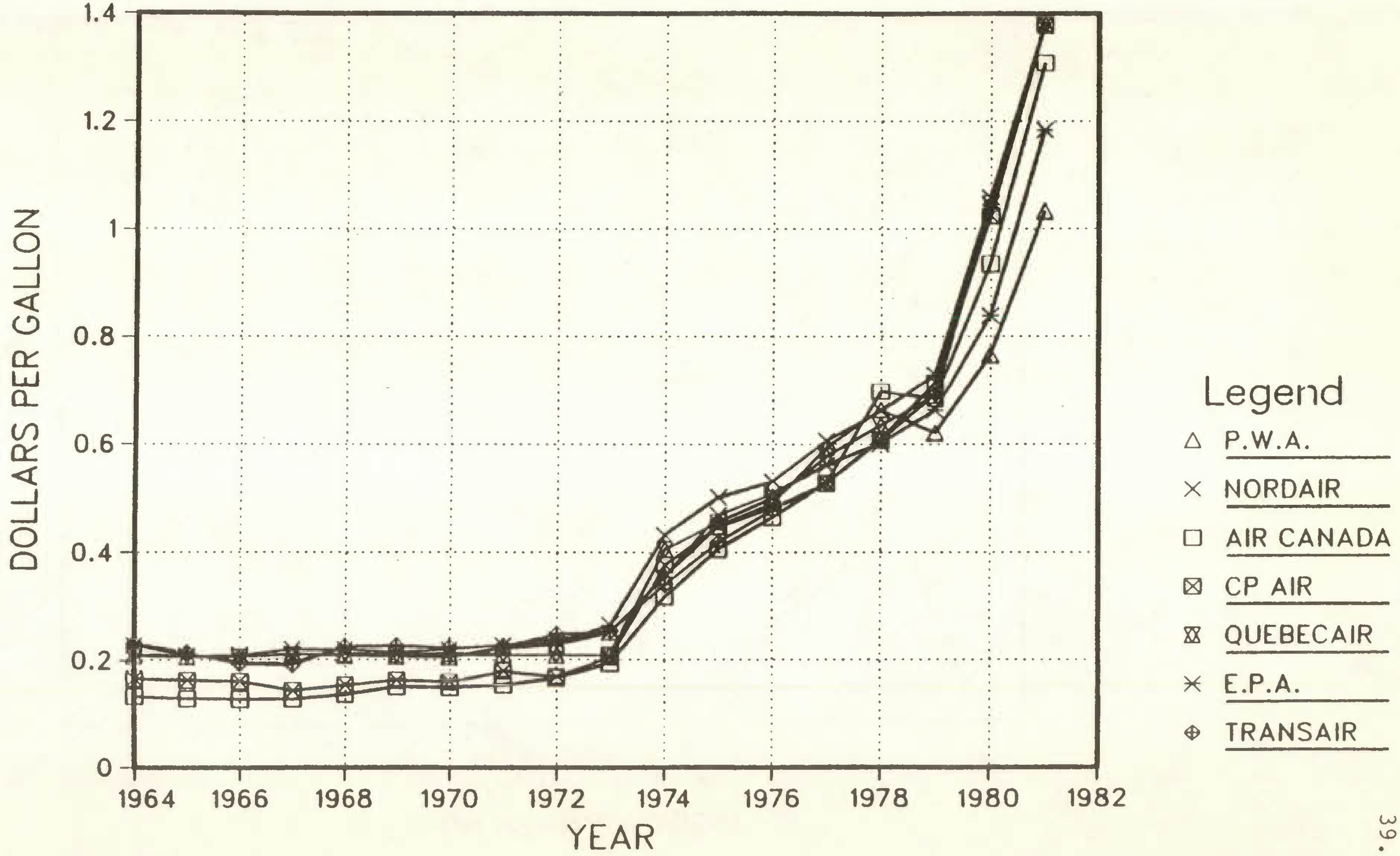


FIGURE 3-11

PRICE OF TURBO FUEL 1964-1981



the difference in the geographical location of their routes. Fuel prices increased dramatically between 1973 and 1974, followed by an upward trend until 1979. Another large increase occurred between 1979 and 1981. Indices of fuel quantities used, reported in Figure 3-12 and 3-13, illustrate that Air Canada was able to reduce its fuel consumption by about 20% between 1975 and 1978 while expanding its output (see Figure 3-1). During the same period, CP Air's fuel consumption did not noticeably vary while they expanded their outputs.[3]

Figures 3-14 through 3-17 are respectively the plots of the number of points served, average load factor, average stage length, and weighted average number of seats per aircraft for scheduled passenger service. These plots indicate, among other things, the following:

1. Both Air Canada and CP Air have primarily long-haul and high density route networks relative to the regional carriers. Although there are some fluctuations over time, there is a consistent trend that the number of points served by Air Canada has increased from 54 airports in 1965 to 64 airports in 1981, while CP Air reduced its points served from 45 in 1964 to about 32 airports in the mid-1970s. CP Air has by far the highest average stage length and the largest average size of aircraft.

2. Among the regional carriers, Nordair has the longest average stage length followed by Transair (until merged with PWA). Quebecair has the shortest stage length. PWA and EPA have similar average stage lengths and utilize similar sized aircraft for their scheduled passenger services.

3. From 1968 to 1970, PWA dropped many of its scheduled points as it increased its emphasis on charter service (see Figure 3-7). This appears to be in response to the 1966 Regional Air Carrier Policy.

[3] This finding of improved fuel productivity for Air Canada should not be interpreted as an overall, or total factor improvement in productivity. Fuel productivity can be improved by overinvesting in new equipment.

FIGURE 3-12

MULTILATERAL FUEL QUANTITY INDEX 1964-1981

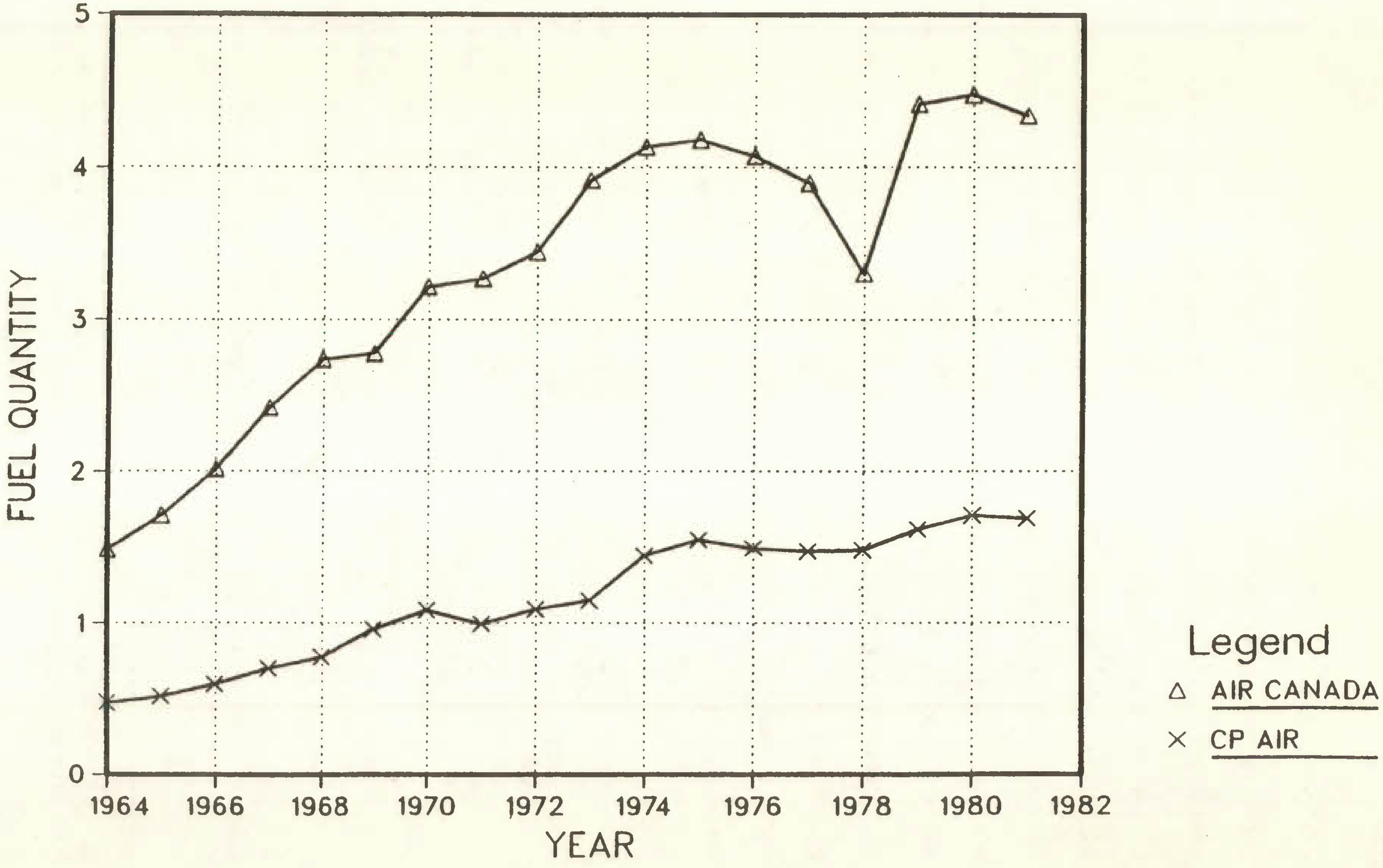


FIGURE 3-13

MULTILATERAL FUEL QUANTITY INDEX 1964-1981

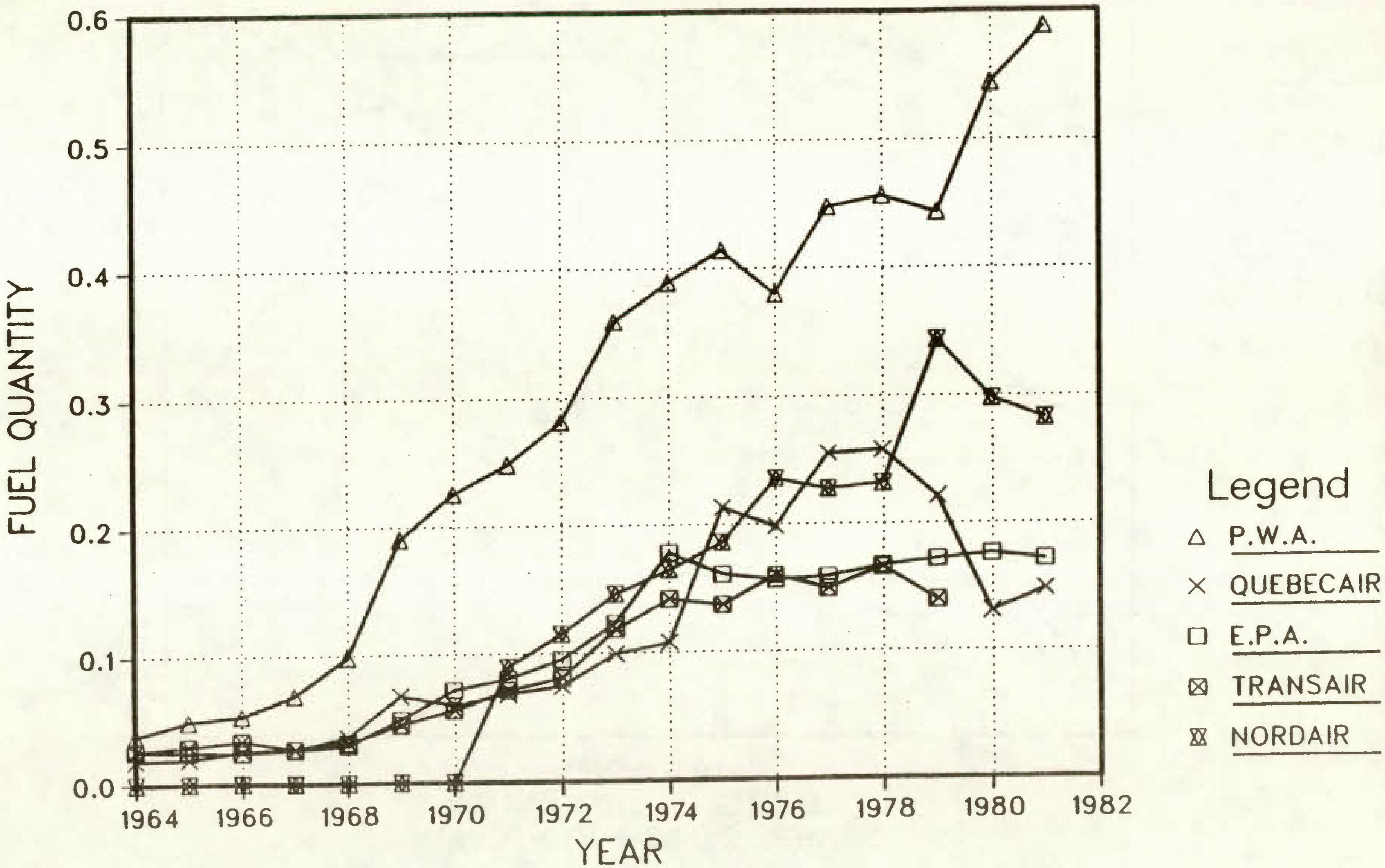


FIGURE 3-14

NUMBER OF POINTS SERVED
BY SCHEDULED FLIGHTS
1964-1981

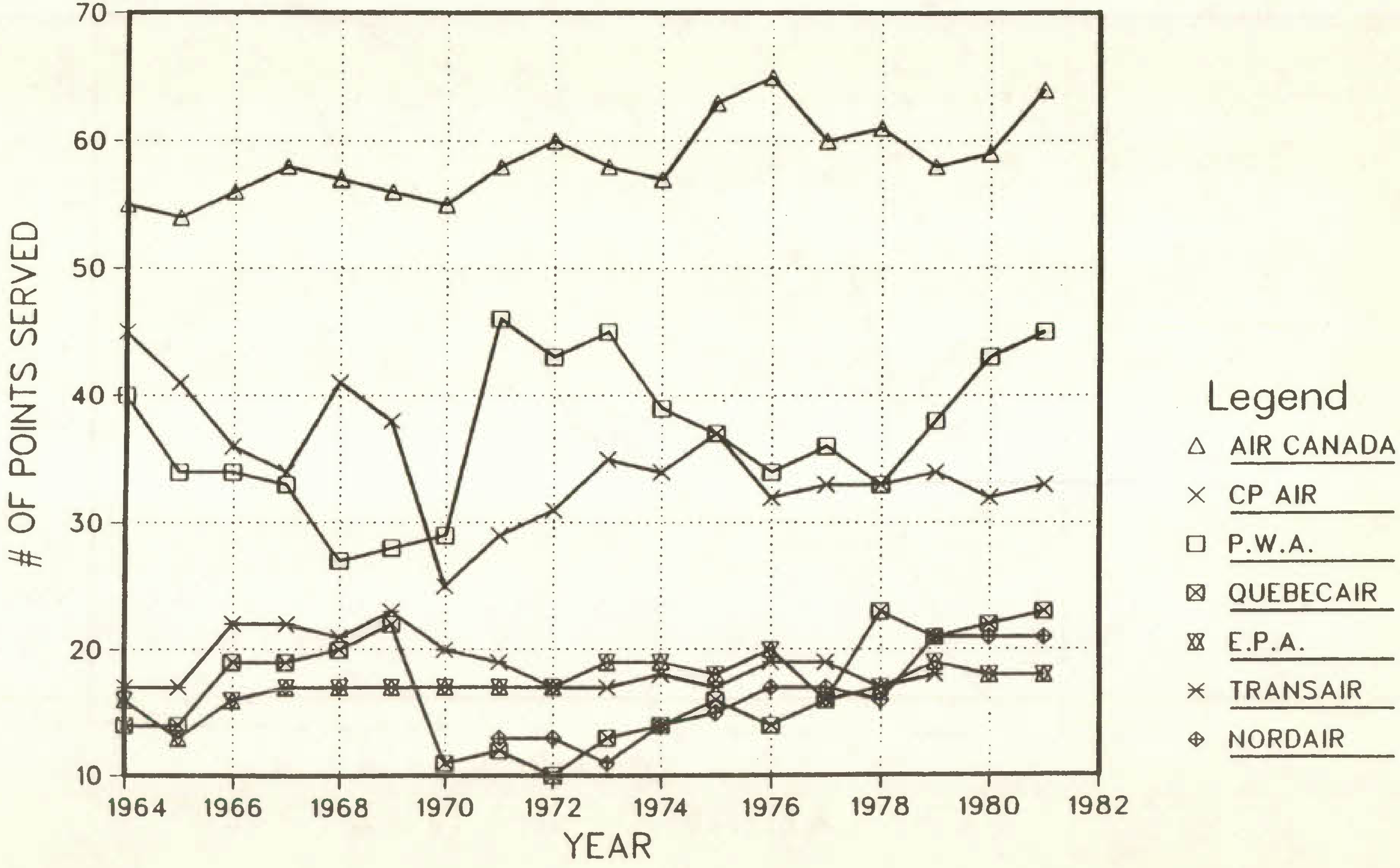


FIGURE 3-15

AVERAGE LOAD FACTOR
FOR SCHEDULED PASSENGER SERVICE
1964-1981

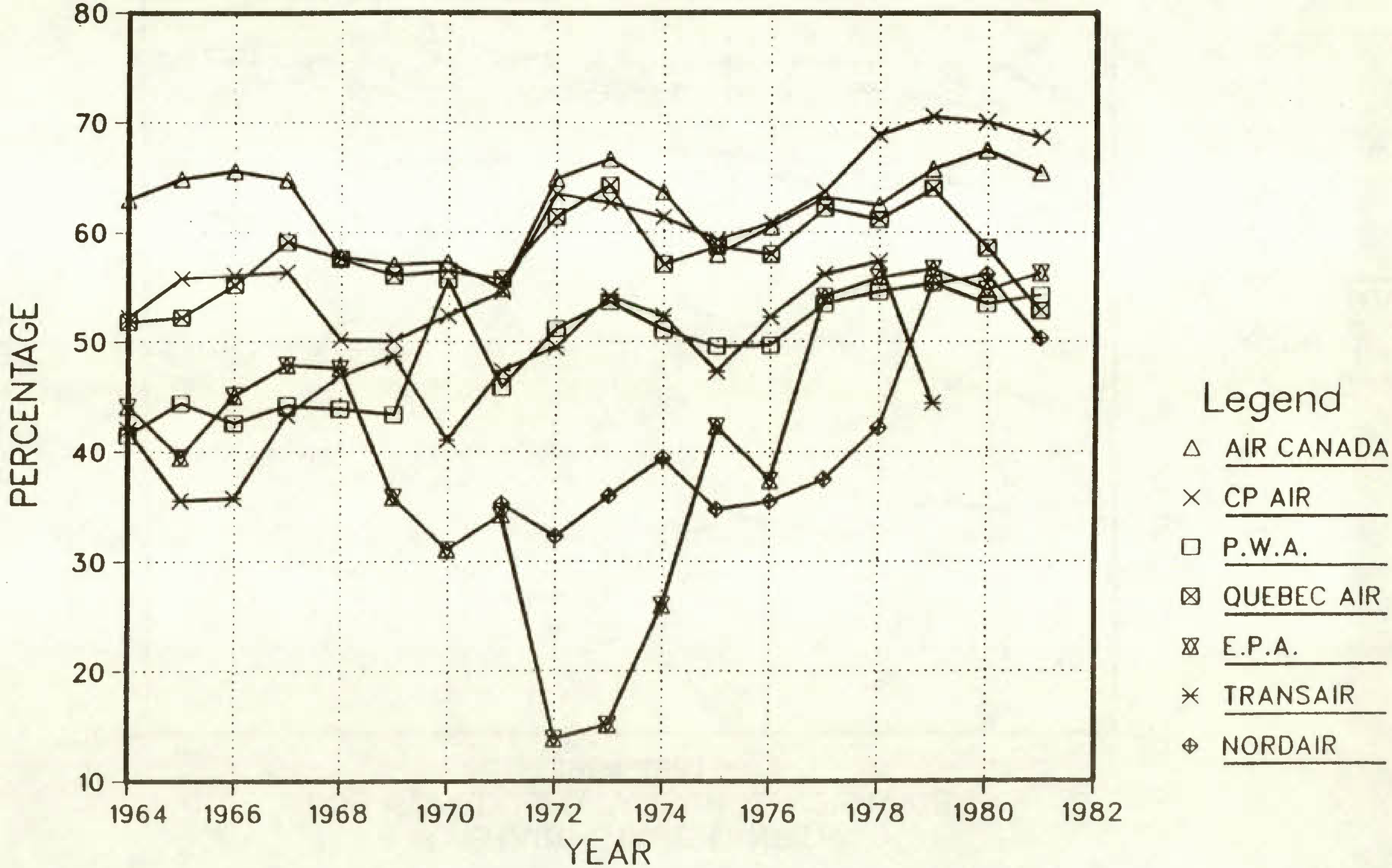


FIGURE 3-16

AVERAGE STAGE LENGTH
FOR SCHEDULED PASSENGER SERVICE
1964-1981

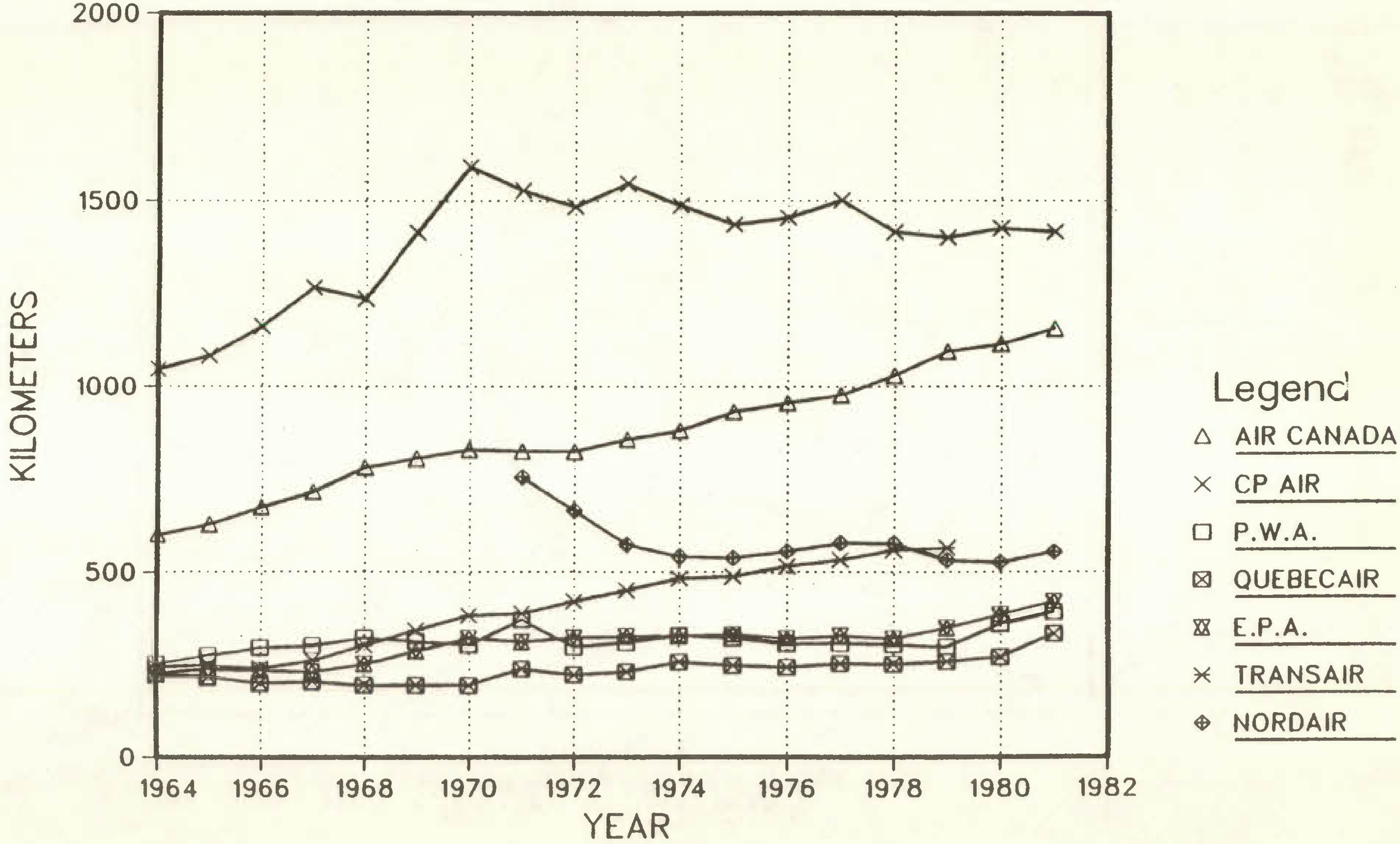
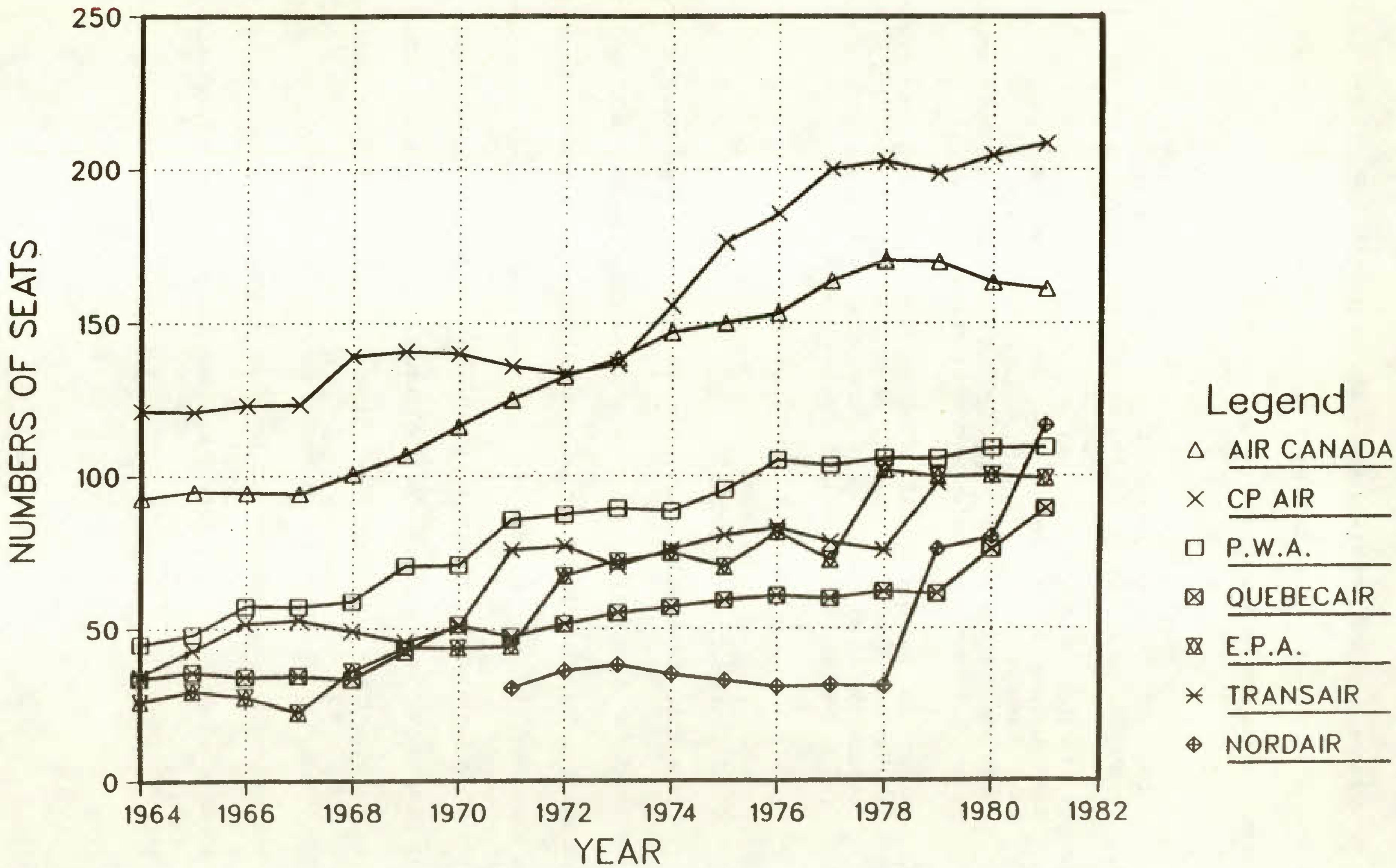


FIGURE 3-17

WEIGHTED AVERAGE NUMBER OF SEATS PER AIRCRAFT
FOR SCHEDULED PASSENGER SERVICE
1964-1981



Figures 3-18 and 3-19 are the plots of traffic density (revenue ton-kilometers of all scheduled sources per point served) for the seven airlines. These can be summarized as follows:

1. Air Canada has enjoyed a substantially higher density than CP Air throughout the study period; in 1980, 39,000 tonnes per point served by Air Canada versus 17,000 tonnes per point served by CP Air.

2. The regional carriers have had a much lower traffic density than the transcontinental carriers. Among the regionals, PWA and EPA have a significantly higher traffic density than the other regionals; in 1980, about 8,000 tonnes per point served by PWA and EPA, versus less than 5,000 tonnes per point served by the other regionals.

3. Except for Quebecair, all other carriers have experienced more or less steady growth in traffic density throughout the study period. Quebecair's traffic density per scheduled point dropped sharply after 1976 as the carrier emphasized charter services.

C. Institutional Data Description

Chapter II provided an overview of transport and regulatory policy. A more complete description of institutional details for each carrier is contained in Appendix B. A chronological list of industry events is given in Appendix C. Annual reports of the carriers (when available), government studies and research reports as well as other published and unpublished material served as the source for the institutional information. Important events reflecting managerial decision-making (such as fleet changes or acquisition) were included, as well as regulatory and policy changes. These affect the environment within which management decisions are made. Changes in stage lengths, aircraft size and the number of points served are good examples.

FIGURE 3-18

DENSITY MEASURE FOR TRANSCONTINENTAL CARRIERS
DENSITY= REVENUE TONNE KM/ POINTS
1964-1981

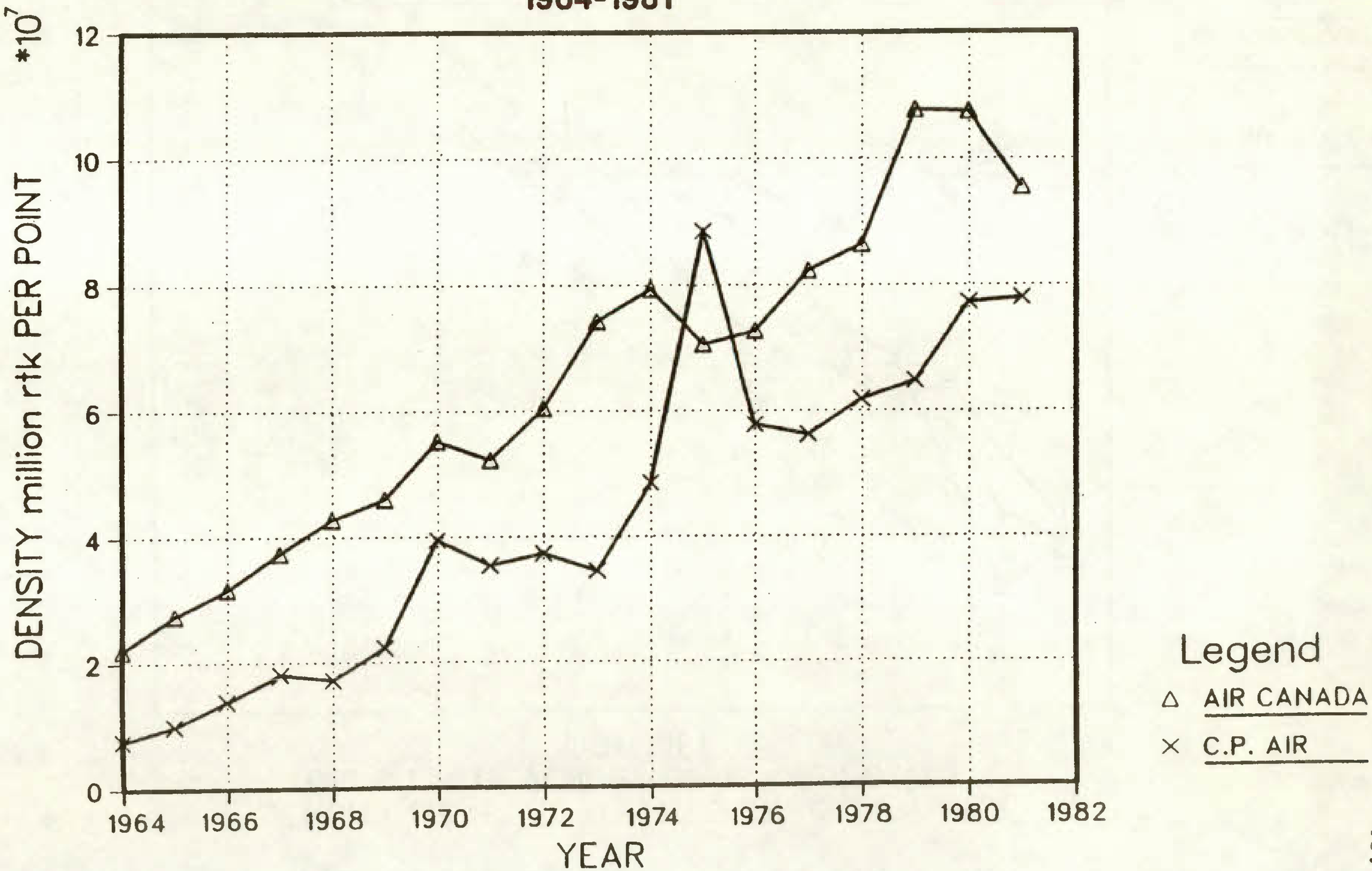
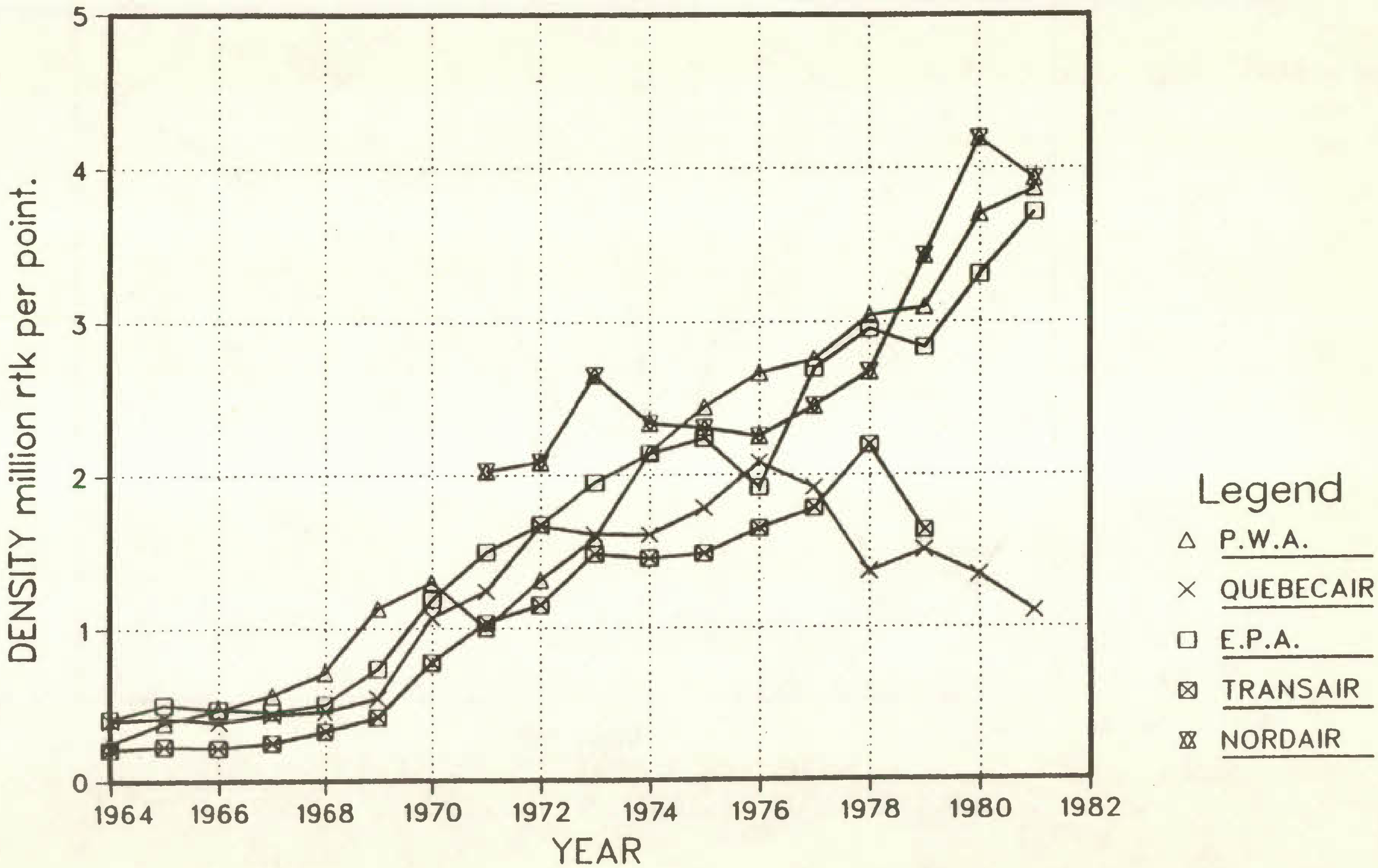


FIGURE 3-19

DENSITY MEASURE FOR REGIONAL CARRIERS
DENSITY= REVENUE TONNE KM/ POINTS
1964-1981



Chapter IV: - ANALYTICAL METHODOLOGY AND RESULTS

A. Introduction

This chapter investigates the economic performance of the Canadian airlines, using two related concepts of performance measures: Total Factor Productivity (TFP) and Cost Functions.

Total factor productivity (TFP) is the amount of aggregate output produced by a unit of aggregate input. It recognizes the nature of airline production in which multiple outputs are produced using multiple inputs. TFP is more widely accepted among economists as a measure of productive efficiency than partial factor productivities such as labour productivity.

Since productivity is a mirror image of cost efficiency, the results of TFP analysis can be used as a starting point to estimate several alternative neoclassical airline cost functions. Productivity analysis is a useful and inexpensive first-step to the more expensive and sophisticated cost-function analysis.[1] The cost functions are then used to investigate such issues as economies of traffic density, scale and scope, as well as to investigate the impacts of alternative regulatory and ownership choices on carrier and industry performance.

---

[1] Past experience indicates that proceeding directly to cost function estimation is wasteful because some data problems are bound to come out. Productivity analysis, due to its index number format helps one detect such data problems at a fraction of the cost, as well as reveals valuable preliminary information on the cost structure. This helps reduce the amount of work required for the cost function analysis. Productivity analysis also has the advantage of being somewhat more intuitive to lay readers than the more complex cost analysis.

In view of the policy orientation of this study, the theoretical and technical discussions of how TFP is computed and why the particular form of the translog cost function was selected are relegated to Appendix A. Interested readers can find complete details in Chapters 6-9 of Gillen, Oum and Tretheway (1985b).

B. Total Factor Productivity

The assessment of Canadian airline performance begins with measuring total factor productivity. TFP is defined simply as the amount of total output produced by a unit of aggregate or total input. It differs from simpler concepts of productivity such as output per man-hour, by recognizing a) that more than one type of output is produced, and b) that inputs other than labour are used. For example, a firm with high labour productivity due to the use of large amounts of capital might not be viewed as being the most efficient in a total input or a "total factor" sense. TFP corrects for the output problem by giving high quality outputs a greater weight in the aggregation of outputs into a single measure. Similarly, it recognizes and weights appropriately various inputs and individual inputs of different quality.

Table 4-1 provides levels of TFP for the seven Canadian airlines, 1964-1981 as well as aggregate output and aggregate input. The series were normalized so that TFP is unity for CP in 1971. This provides a reference point for all comparisons. Numbers greater than unity indicate greater productivity than CP Air had in 1971. Figure 4-1 graphically compares the level of TFP for each carrier. Here the 1964-1981 TFP levels for each

Table 4-1

TFP, Output Quantity, and Input Quantity Indices
(C.P. Air 1971 = 1.0)

	YEAR	TFP Index	Aggregate Output Index	Aggregate Input Index
AIR CANADA	1965	0.62	1.37	2.19
	1971	0.85	2.89	3.41
	1978	1.17	4.85	4.15
	1981	1.07	5.34	4.97
	MEAN	0.88	3.51	3.99
C.P. AIR	1965	0.72	0.42	0.58
	1971	1.00	1.00	1.00
	1978	1.42	2.04	1.44
	1981	1.32	2.50	1.89
	MEAN	1.02	1.35	1.33
PWA	1965	0.49	0.05	0.10
	1971	0.68	0.19	0.28
	1978	0.87	0.37	0.43
	1981	0.76	0.52	0.68
	MEAN	0.62	0.24	0.39
QUEBECAIR	1965	0.35	0.01	0.04
	1971	0.51	0.04	0.08
	1978	0.83	0.21	0.26
	1981	0.46	0.09	0.20
	MEAN	0.56	0.09	0.15
EPA	1965	0.21	0.01	0.06
	1971	0.46	0.05	0.11
	1978	0.75	0.13	0.18
	1981	0.82	0.15	0.18
	MEAN	0.53	0.08	0.14
TRANSAIR	1965	0.47	0.02	0.05
	1971	0.55	0.06	0.10
	1978	0.89	0.13	0.14
	MEAN	0.61	0.06	0.11
NORDAIR	1971	0.85	0.08	0.10
	1978	1.06	0.20	0.19
	1981	0.85	0.24	0.28
	MEAN	0.86	0.18	0.21
	INDUSTRY MEAN	0.89	0.86	0.97

FIGURE 4-1

Average TFP Levels By Airline
Air Canada = 1.0

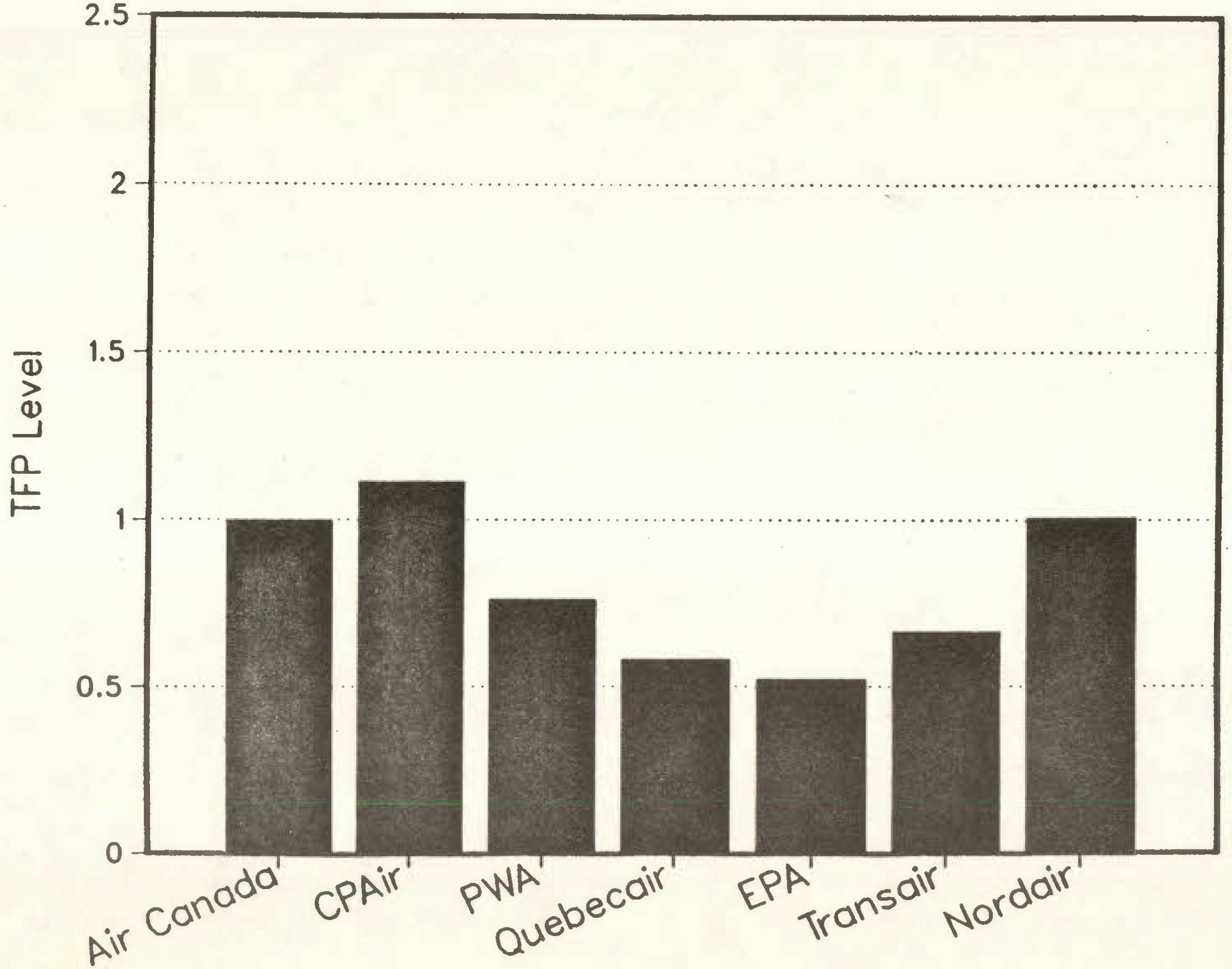
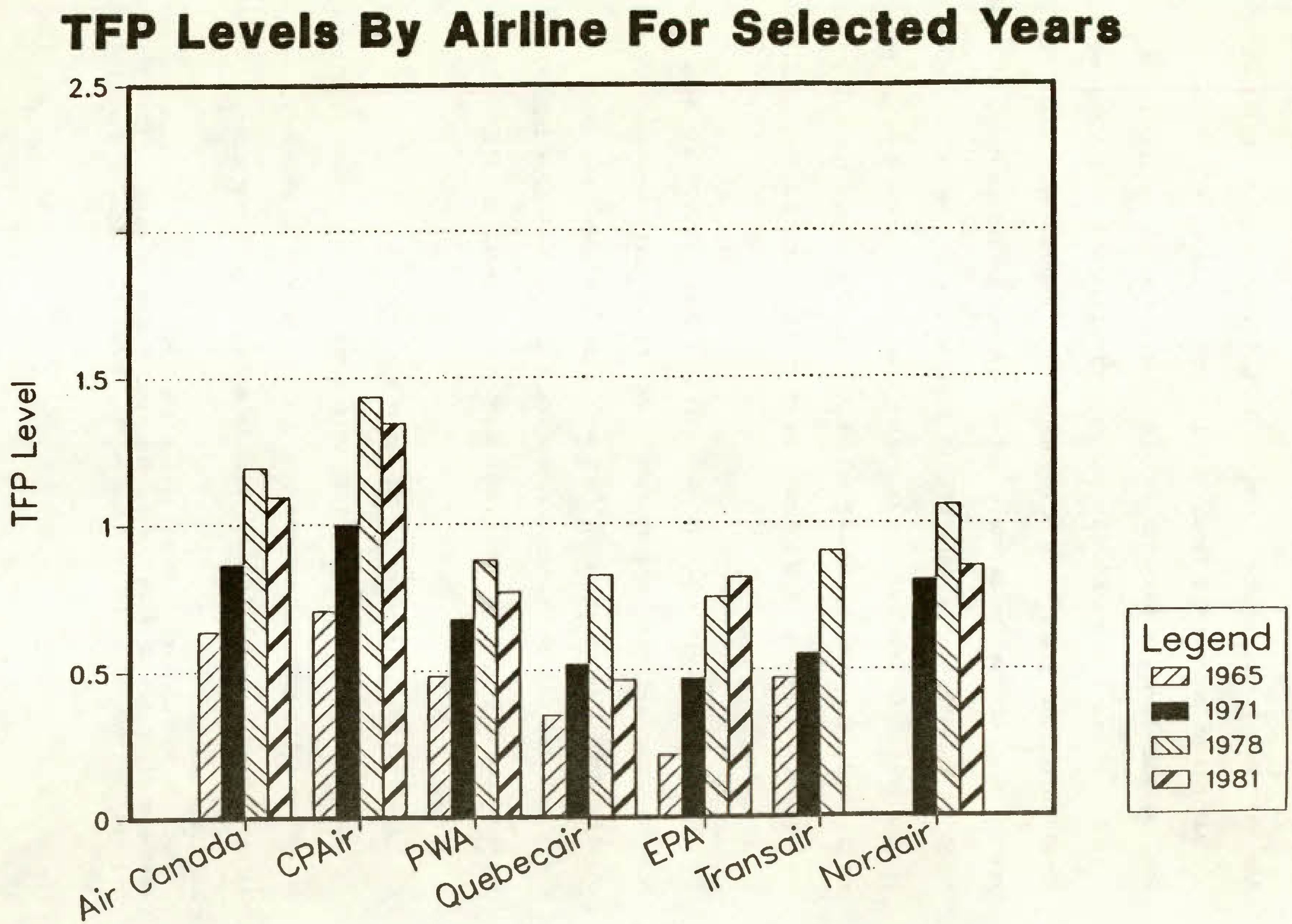


FIGURE 4-2


TFP Levels By Airline For Selected Years
TFP Level
2.5
1.5
1
0.5
0
Air Canada
CPAir
PWA
Quebecair
EPA
Transair
Nordair
Legend
1965
1971
1978
1981

carrier were averaged, except Transair (1964-79) and Nordair (1971-81). CP Air has the highest average level of TFP, 15% above that of Air Canada. Nordair has an average TFP level 2% below that of Air Canada.[2] The remaining regional carriers have TFP levels between 35% and 50% lower than Air Canada. Figure 4-2 graphically portrays TFP levels for carriers in selected individual years. CP Air has had the highest TFP levels in all years. Most of the air carriers had a fall off in TFP in 1981, which no doubt is related to the fall off in traffic due to the recession. The finding that CP's level of TFP is higher than Air Canada's does not necessarily imply that CP is more efficient. Total TFP may differ due to differing characteristics of the operating environment among firms; different stage lengths, for example.

Figure 4-3 plots averages over all carriers of TFP for each year. From this we see that the average level of industry productivity grew steadily from 1964 to 1978; in fact more than doubling. In 1978 the economic downturn and other factors took hold and productivity fell to 1.25 (125% of the 1971 TFP) by 1981; equivalent to the level in 1975.

C. Analysis of Differences in TFP Among Air Carriers

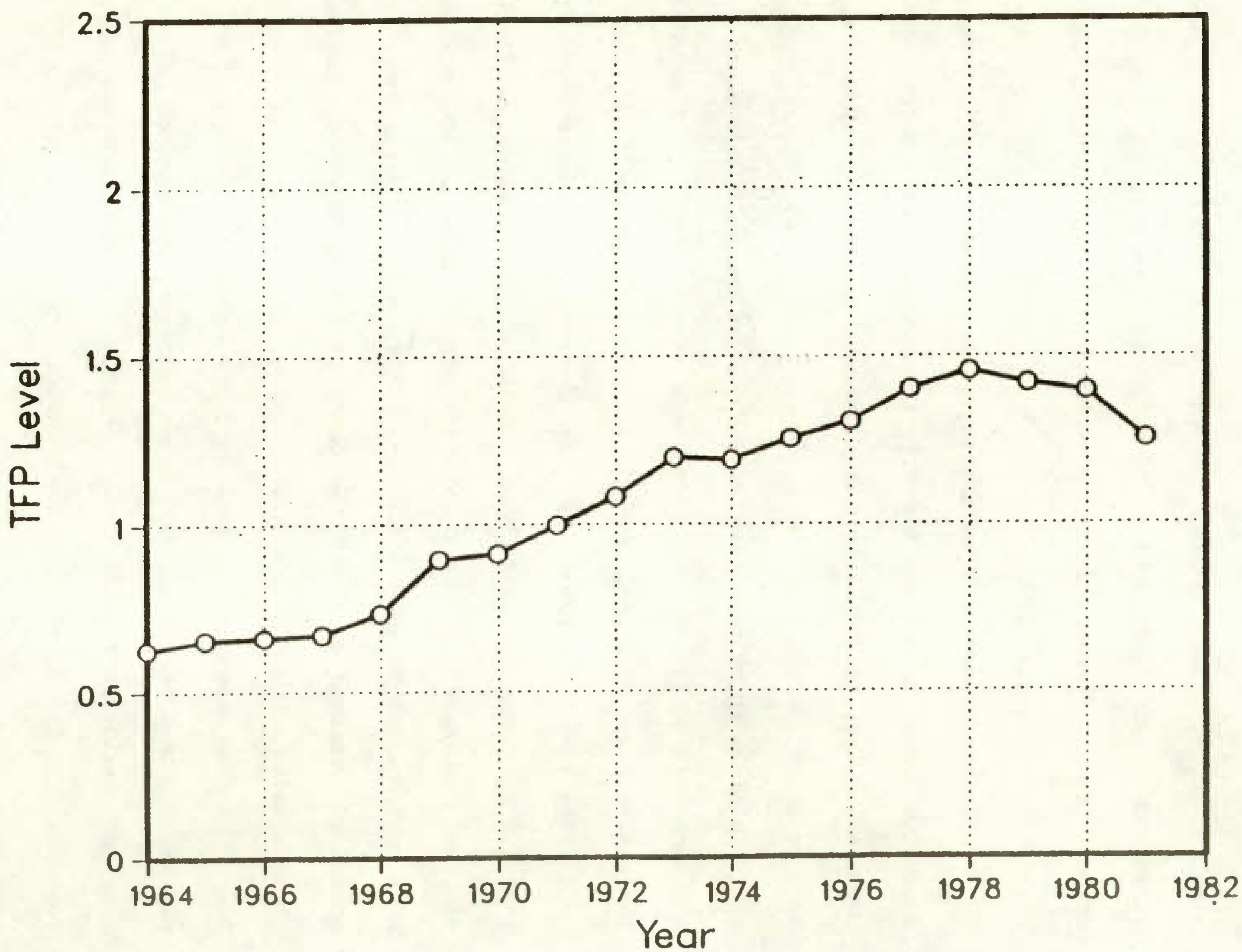
The measure of TFP employed in this study does not translate directly into pure efficiency differences over time or between firms. TFP can also differ due to operating factors, such as average flight stage length, dens-

---

[2] Data for Nordair are missing for 1964-1970. When examining the averages displayed in Figure 4-1, one must recognize that a 1964-1971 TFP average for Nordair would be considerably below the value of 0.98 in the figure.

FIGURE 4-3

Average TFP Levels Of Canadian Airlines
1971 TFP = 1.0



ity of traffic in a market, etc. The TFP results presented above include not only the "efficiency" shift, but also components due to economies of scale and density, network differences, and deviations of prices from marginal costs. These factors can explain, in part, why TFP differs among firms and growth (and decline) of TFP over time. It is desirable to decompose TFP differences into its various sources. Here, this is accomplished by regressing TFP.

Explanatory variables of the regression equation included measures of an output index to account for size and mix of output, points served as a network measure, load factor to capture one aspect of capacity utilization, average stage length, and the shares of freight and charter in total output. In addition to these variables, regressions with firm dummy variables and a measure of the capital stock were investigated. Full details of the TFP analysis and decomposition are provided in Appendix A.

Using the TFP regressions, the elements of productivity differences that can be explained by factors such as stage length can be computed and subtracted from TFP. The result is a TFP "residual" which will differ between firms due to pure efficiency differences. TFP residuals were computed and averaged over all the carriers for each year. In Figure 4-4 these average residuals are plotted along with the average level of TFP. This plot then compares the growth of TFP with that portion of TFP not explained by the model. Both series are expressed relative to 1971.

TFP residuals averaged over time for a single firm are computed and compared with the firm's average level of TFP in Table 4-2. All residuals have been indexed relative to Air Canada to facilitate comparisons. Two

FIGURE 4-4

TFP Levels Of Canadian Airlines
1971 TFP = 1.0

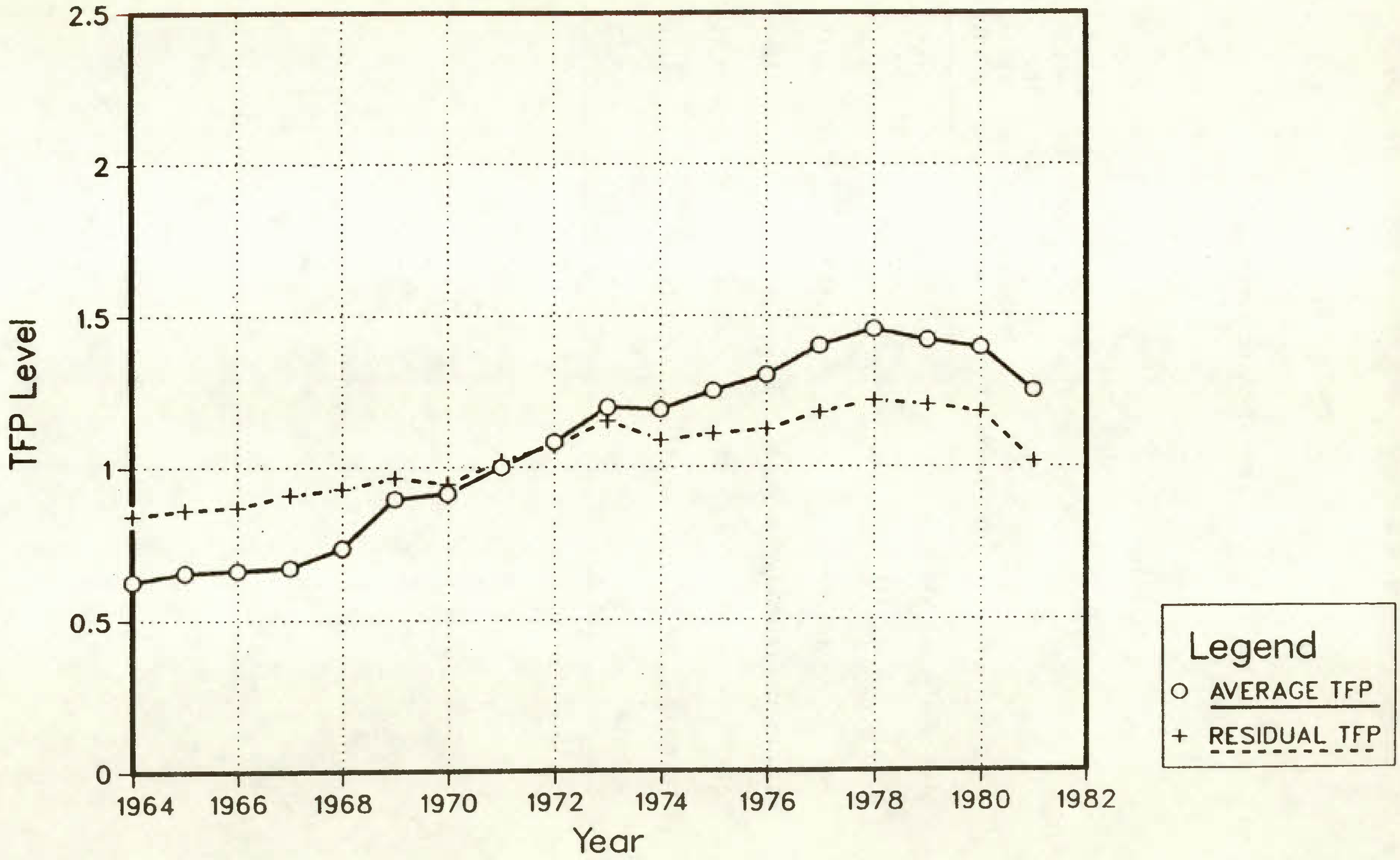


Table 4-2

TFP LEVEL COMPARISONS

Firm		Gross TFP Level	Residual TFP Level	Residual TFP Level (with firm dummy and capital stock variables)
AIR CANADA	(64-81)	1.0	1.0	1.0
CP AIR	(64-81)	1.12	1.23	1.01
PWA	(64-81)	0.76	1.60	1.15
Quebecair	(64-81)	0.58	1.60	1.02
EPA	(64-81)	0.52	1.48	0.95
TRANSAIR	(64-79)	0.67	1.68	1.14
NORDAIR	(71-81)	1.01	1.68	1.17

difference sets of residuals are computed: one controls for the amount of capital each air carrier has while the other does not. The two sets of residuals are plotted in Figures 4-5 and 4-6. These figures should be compared to Figure 4-1.

From these, two interesting sets of results emerge. First, while the gross TFP measures indicate the regional carriers are less efficient than CP and Air Canada, after controlling for output and network (but not capital capacity), the regionals are more efficient. Second, if one additionally controls for the level of capital stock then all the carriers have roughly equal levels of residual TFP. This suggests that Air Canada and (to a lesser extent) CP Air have operated with non-optimal levels of capital stock over the 1964-1981 period. It appears that the airlines were not inclined or not able to adjust their capital stocks to the optimal level.

D. Conclusion from TFP Analysis

The gross TFP measure implies that the regional carriers are less efficient than both trunks. However, it is the residual TFP measure that is a pure measure of economic (technical) efficiency. Once the effects of scale and mix of outputs and network characteristics are netted out, the situation is reversed. The regional carriers are relatively more efficient than Air Canada or CP Air, implying a lower cost structure, ceteris paribus. In addition, CP Air's residual TFP level was on average 23% higher than that of Air Canada (implying greater efficiency for CP Air). These differences in residual TFP between Air Canada and CP Air disappear, once the level of capital stock is controlled for. This implies that most of

FIGURE 4-5

Residual TFP Levels By Airline 1964-1981
Air Canada = 1.0

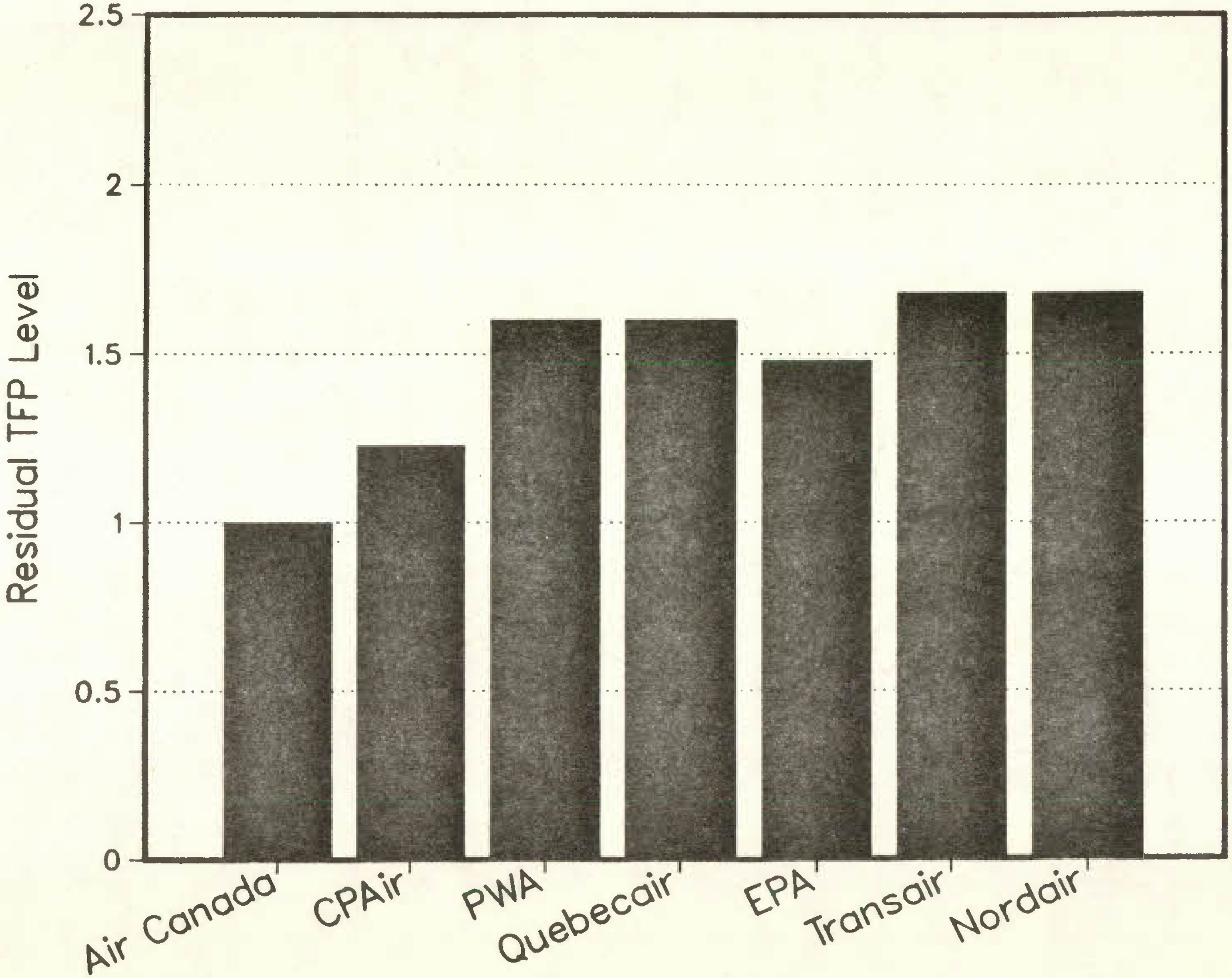
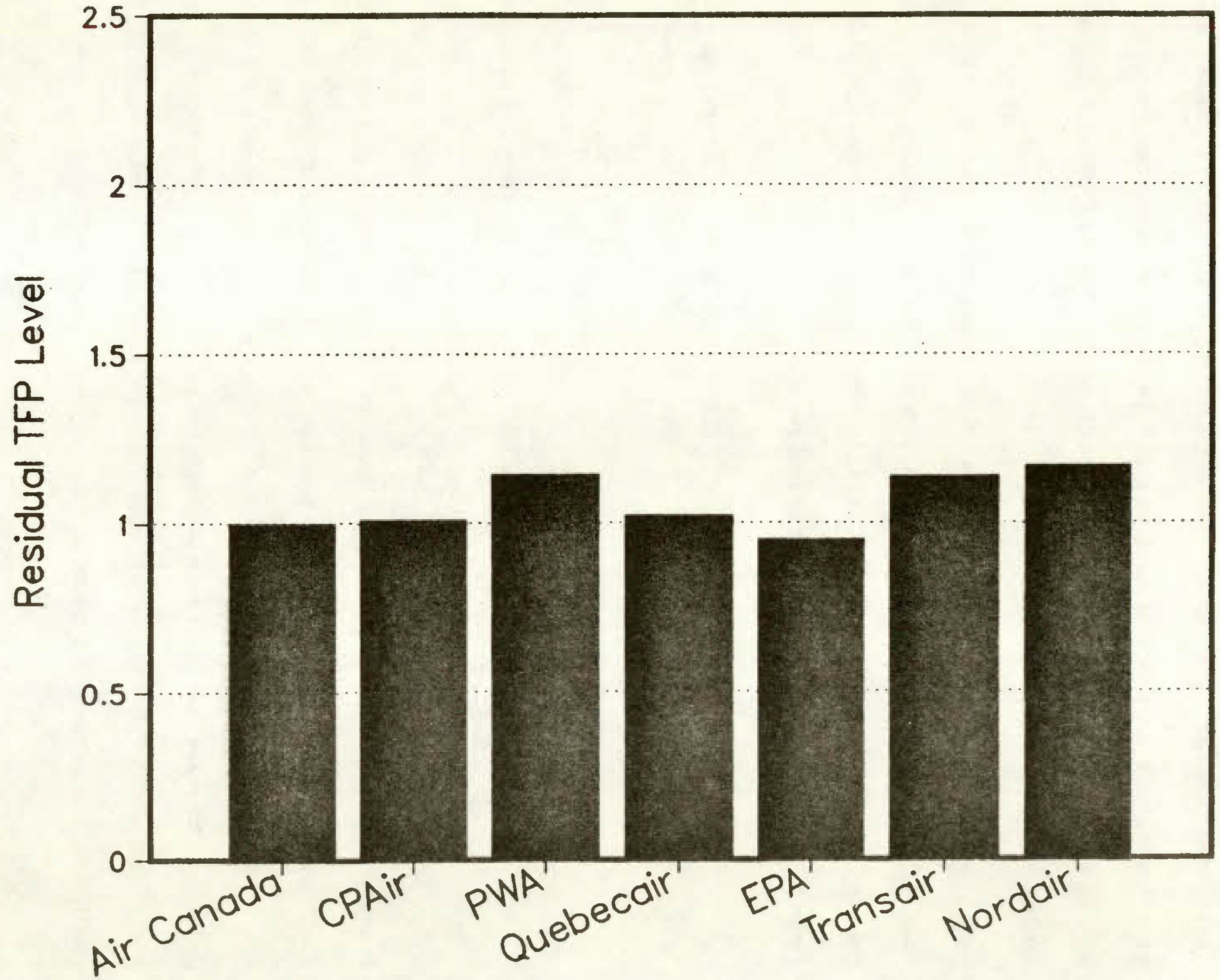


FIGURE 4-6

Residual TFP Levels By Airline 1964-1981
Air Canada = 1.0



Air Canada's inefficiencies relative to CP Air were caused by its relatively greater over-expansion of capacity. With the data available to us, it is difficult to tell precisely where, in what aircraft, and to what extent Air Canada over-expanded its capacity. However, we suspect that it occured with both the number of aircraft and the purchase of larger aircraft than needed. We note, for example, that Air Canada leased out many of its aircraft to Eastern Airlines and parked some wide-body aircraft at a storage facility in the Arizona desert while placing orders for a large number of very expensive Boeing 767s.

Our productivity analysis has also identified the contribution of each of the selected output and network variables to factor productivity. The industry averages of the elasticity of total factor productivity with respect to each of the control variables are:

Variable	Elasticity of TFP with respect to Variable
scale of output	.32
points served	-.22
load factor	.013 (not significant)
stage length	.12
relative freight output	.005 (not significant)
relative charter output	.04
level of capital stock	-.13

Thus, expanding scale of output, charter output share, and stage length contribute to increasing TFP. Expanding points served and level of capital stock have negative effects, while effects of load factor and freight output share are statistically insignificant.

The models of TFP developed for this report suggest the following about airline production technology:

a) Increasing returns to traffic density

b) Constant returns to scale (i.e., number of cities served)

c) Stage length is an important determinant of productivity,

E. Cost Analysis Methodology

The TFP regression model assumes a single output. It is dual to simple single output Cobb-Douglas total cost functions and thus assumes homogeneous output and constant productivity of input factors over time. Airlines, however, produce several different outputs, including scheduled passenger, scheduled freight, charter passenger and charter freight services. These outputs are produced over routes of varying size and length and within markets of different densities. Input productivities have also changed over time, especially as new technology was adopted. Therefore, a realistic characterization of an industry's cost structure requires not only the incorporation of multiple outputs and multiple inputs but also the special characteristics of the route networks and changes in input productivities.

Cost function estimation, allows one to measure scale, density and interproduct cost relationships. Economies of traffic density measure how total cost changes in response to a 1% increase in all outputs, holding the size of the network (points served), output attributes and input prices constant. Economies of scale measure how the total cost changes in response to a 1% increase in outputs <u>and</u> points served, holding output attributes and input prices constant.

The examination of interproduct ccst relationships allows assessment of the presence or absence of cost complimentarity between a pair of products. In particular, for each pair of outputs, one can evaluate the change in the marginal cost of one output when production of another product is increased.

E.1 Cost function results

A total cost function is estimated in Appendix A. It disaggregates a carrier's total output into three different measures; scheduled passenger, scheduled freight and charter services. Alternative output definitions, such as short, medium and long-haul services, could have been considered. The three outputs above, however, have the largest differential impacts on costs after controlling for the effects of input prices and production technology. Data were not available separately for short, medium and long-haul routes. Furthermore, the differential effects on cost of short, medium and long-haul routes are indirectly captured in the model by average stage length in the (hedonic) output aggregator function.

Examining the cost structure revealed the following important results:

1. With the exceptions of Nordair [which in 1980 exhibited increasing returns to scale (point estimate 1.19, t-statistic 2.0)], and Air Canada [which had weak evidence of decreasing returns to scale (point estimate .85, t-statistic 1.5)], all airlines experienced constant returns to scale (firm size). Unit costs would not fall if Canadian carriers expand output by adding more cities to their networks.

2. There is evidence of significant economies of traffic density for all airlines except, possibly, Air Canada. Unit costs would decrease if carriers expanded output within their existing net-

works. Unit cost could also fall if a carrier dropped a low density point and added a high density point. This cost characteristic is most important for public policy decisions such as the Regional Air Carrier Policy.

3. There is cost complementarity between scheduled passenger services and charter services only if the proportion of charter services is less than 5%. Expansion by a carrier of charter service beyond 5% increases the marginal cost of scheduled passenger service.

4. Of the firm's output characteristics investigated, stage length appears to be the most important in affecting costs. The minimum cost firm size appears to decrease rapidly as stage length decreases.

These results suggest that the Regional Carrier policy of confining the regional carriers to particular geographic regions (and therefore markets), and the emphasis on their role of providing 'feed' to the national carriers, had a significant negative impact on the regional's performance. They were forced to expand their networks within regions and thus could not obtain stage length economies. The failure to allow regionals into a broader domestic market had a number of additional implications. First, the regional carriers were forced into a larger proportion of charter output than was cost efficient. This adversely affected the cost of providing scheduled passenger services - their primary mission under the policy. Second, the regional carriers had limited opportunities for exploiting economies of traffic density. A high density point exterior to or bordering upon the region if substituted for a low density point within the region would have meant a fall in unit costs from density and stage length economies.

Cost differences among carriers are due to both scale and traffic density effects. The scale component is, in turn, affected by output mix and stage length. The findings of a) constant returns to scale, b) strong increasing returns to traffic density and to stage length, and c) lack of complementarity between scheduled passenger and charter services in the existing regional carrier market configurations, leads to the conclusion that any attempt to expand the scale (output and points) of regional carriers without fundamentally altering the nature of their network (for example stage length and participation in denser routes) would not improve their cost efficiency. Therefore, the New Canadian Air policy, announced on May 10, 1984, abolishing the Regional Air Carrier Policy appears to be a step in the right direction.[3]

The findings of constant returns to scale indicate that Air Canada might not have a cost advantage over other Canadian carriers due to its large size. (If anything, the results suggest that Air Canada may have a slight cost disadvantage, ceteris paribus). Its high traffic density, however, may give it an important edge. Air Canada, for example, has an output density of 46 million RTK per point served compared to CP Air's 33. The results suggest that Air Canada is closer to the minimum efficient density than CP Air or the regionals.

A variable cost model was also estimated and confirmed most of the empirical results concerning cost structures obtained from the total cost model. In addition, it revealed that Air Canada's productivity (TFP), or equivalently its cost performance, suffered a great deal due to its high

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[3] There are, however, other problems with the May 10, 1984 policy. See Oum and Tretheway (1984) for a discussion.

excess capital stock. The Regional carriers have suffered from excess capital stock to a lesser extent than Air Canada. Although the point estimate indicated that CP Air also has some excess capital stock, the evidence was not statistically significant. Air Canada's performance was adversely affected by its excess capital stock significantly more than was CP Air's. The fact that Air Canada's efficiency suffers most from excess capacity is consistent with economic theory. The opportunity cost of capital perceived by Air Canada's management is lower than that of the privately-owned carriers because of the Crown carriers access to the federal treasury, less pressure to pay dividends to its shareholder (the federal government), favorable borrowing rates due to its government ownership, etc.[4] Earlier it was mentioned that the regionals suffer from under-utilization of their aircraft because of the lack of compatibility between their scheduled and charter service markets and their [too] heavy concentration on charter services. The results here indicate that even with this disadvantage the regionals have less excess capacity than Air Canada.

The labour demand elasticities estimated from the cost function (-.60) indicate that the industry employment is expected to rise with lower fares, ceteris paribus. However, this assumes no radical changes in the

[4] Some people may argue that the effects of differences in capital costs across carriers are already controlled for in our cost models, and thus dismiss our argument as irrelevant. However, we wish to point out that the capital cost used in our analysis was the economic opportunity cost, not the actual cost incurred by the carriers. For example, in computing the service prices of capital assets we applied the McLeod, Young and Weir 10-year bond rate as the interest cost, and the corporate income tax rate (for dividend payment) uniformly to all carriers including Air Canada.

Therefore, if Air Canada's management perceives its capital cost as lower than the industry's norm, there is an incentive to over-expand its capacity beyond the industry norm.

structure of the industry's production process. Should significant work rule changes that increase the productivity of employees occur, then the increase in industry employment may be attenuated or become negative. However, the lower cost structure that would occur with such changes could lead to yet lower fares which ultimately would increase employment.[5]

E.2 Conclusion

Performance comparisons based on observed TFP and cost levels indicates that the transcontinental carriers have been more productive than the regional carriers. This is the same result other studies using simple productivity measures have reached. However, once these measures are corrected for scale and traffic density economies, and differences in the operating environment, the relationship between trunks and regionals is reversed. The regional carriers have been more economically efficient than Air Canada and to a lesser extent than CP Air. The apparent poor performance of Air Canada is due to overinvestment in capacity to provide services. Once this overinvestment is controlled for, all the Canadian carriers have roughly similar levels of residual productivity. Air Canada was found to have the highest level of excess capital stock, followed by the Regional carriers. CP Air appears to have the least excess capacity.

In general, air transport in Canada is subject to constant returns to scale, indicating that by itself, adding new destinations to a carriers' network will not lower unit cost. In contrast, significant economies of

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[5] Oum and Gillen (1983) find that the demand for air passenger services is price elastic.

traffic density exist (except perhaps for Air Canada). Carriers can lower unit cost by increasing traffic within existing markets. Similarly, adding a new point with high traffic density can lower system average cost. These findings seem to underscore the importance of a network with good traffic feed. Good feed can increase traffic density for a given carrier. A properly designed hub and spoke system, which effectively increases the density on any given network link, could be desirable from a cost point of view.[6]

Charter and scheduled passenger services are compliments in production only for fairly low proportions of charter services. The regionals, with an output mix often consisting of 50% charter services, experience no such complementarity. In fact, for the regionals, the cost of scheduled services are <u>higher</u> because of the presence of such a large portion of charter services. An intuitive explanation for this observation is that a scheduled carrier can make some contribution to overhead by flying the occasional charter in off-peak periods; weekends perhaps, or slow months of the year. Aircraft acquired for scheduled services are paid for in part by charter services which pick up some of the slack time. In contrast, the regionals cannot rely for their charter services on idle time of the aircraft purchased or leased for their scheduled services. There are two reasons for this: (i) their charter services require large long-haul

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[6] Complex type hub and spoke operations, where flights come in and leave the hub in batches could offset this. In such a system labour and sometime capital can be idle for long stretches of time.

oriented aircraft while smaller and short-haul oriented aircraft are required for their scheduled service routes; and (ii) since they produce a very high proportion of their total output in charter markets, they cannot rely on idle time of aircraft used for scheduled services. Therefore, they must acquire aircraft dedicated to the large amount of low-fare charter services they are selling. This will not lower costs of scheduled services. Aircraft are not utilized fully, and overall system costs will rise.

These findings lead to the conclusion that the regional carrier policy has been costly to Canada. The policy restricted carriers to particular geographic regions and thus limited their ability to expand scheduled services and increase stage lengths. There was a clear incentive for the regionals to seek growth in charter markets. They did so with a passion and as a result Canada's industry wide costs of air transport were higher than they need have been.

We therefore feel that the abolition of the Regional Carrier Policy on May 10, 1984 was an important one for both the regional carriers and the industry. The new policy also provided some opportunities for carriers to adjust their networks to find the optimal stage lengths and sets of feeder routes to increase their route densities.

CHAPTER V - EFFECT OF REGULATORY POLICY AND OWNERSHIP ON CARRIER AND INDUSTRY PERFORMANCE

A. Introduction

This, and the following chapters develop measures for and assess the effects of regulation and ownership on carrier and industry economic performance. The results of the economic analysis conducted in Chapter IV and Appendix A are used as relevant experiences of the U.S. and other countries with deregulation and ownership policies. The effect of regulation and ownership on economic performance can be meaningfully decomposed into two components: (i) effect on allocative efficiency and (ii) effect on technical efficiency.

"Allocative inefficiency" results when firms move or are forced to move to an inefficient point on a given production or cost function. Douglas and Miller (1974), for example, illustrate that airline price regulation can create excess capacity and lower load factors by inducing carriers to engage in scheduling competition. Consequently, inefficiency, (caused by the price regulation) is reflected in carriers utilizing the wrong mix of labour, capital and fuel inputs, with a given production technology. Another example is the inefficient mix of scheduled and charter outputs the regional air carrier policy generated by relaxing access to charter markets while constraining access to scheduled domestic services.

"Technical inefficiency" is caused by factors which generate a downward shift in the firm's production function, or equivalently, an upward shift in the cost function. Deregulation, for example, has led to new ways of allocating tasks to employees (perhaps by the elimination of restrictive work rules) such that fewer employees are now needed to provide a given amount of service. Thus technical efficiency has been improved. Regulations which prevented the realization of this gain are said to have created technical inefficiency. Any enhancement in the productive capability of inputs improves technical efficiency.

This chapter deals primarily with the effect of ownership and regulation on "technical efficiency", leaving the effect on "allocative efficiency" for the following chapter. An exception is the issue of excess capacity caused by the government ownership and socially imposed duties which will be discussed in this chapter.

B. Effects of Ownership on Performance

B.1 Expected Effects:

As described in Chapters I and II, a government-owned carrier is likely to be less economically efficient than its private sector counterparts for the following reasons:

1. Over-capitalization induced by a lower perceived cost of capital due to less pressure to pay dividends to the government, and more favorable borrowing conditions than privately owned carriers.

2. Socially imposed duties such as jet service to small and remote communities, and providing a more sensitive response to national objectives such as energy conservation, employment objectives, and bilingualism, for example.

3. Lack of proper incentives for managers and employees to maximize profit or minimize the cost of producing a given output.

Overcapitalization caused by government-ownership:

Crown corporations in Canada are under less pressure from the government to pay dividends than their private counterparts (Tupper and Doern, 1981). In the past CP Limited, which owns both CP Rail and CP Air, regularly paid substantial dividends to its shareholders, whereas both CN and Air Canada do not usually pay dividends to the federal government except as a symbolic gesture (see Holler (1983) for details on dividend payments by CN and CP).

The average yield on CN's long-term bonds has been consistently lower (between 0.5% and 2.5% lower) than CP's during the last 26 years. CN's bond yields have been lower, even in those years for which CN's financial performance was significantly inferior relative to CP's (see Freeman, Oum, Tretheway and Waters, 1985 for details on the bond yields). Although systematic data on the bond yields for each air carrier were not compiled, casual evidence indicates that Air Canada's long-term bond yields are lower than those of CP.

Some industry observers state that Air Canada's recent loan through a Swiss bank has very favorable terms which no other Canadian airline can obtain (Globe and Mail, Business Section, December 17, 1985). Undoubtedly, the Crown corporation's lower bond yields are due to their high credit ratings because the financial market views the government as their eventual financial backer. In the past, the federal government frequently injected equity capital and cancelled large debts to its Crown corporations, and therefore the perceived cost of capital to a Crown corporation's management would probably be lower than that of its private sector counterparts. The lower perceived capital cost is more likely to lead a Crown corporation to invest in [capital] capacity and thus create allocative inefficiency resulting from an inefficient mix of inputs.

Social Services and National Objectives

Prior to the new Air Canada Act of 1977, the government used the Air Canada contract as an instrument to assign to Air Canada the provision of certain air services. Air Canada was requested to serve a broad range of markets and routes, implicitly allowing cross-subsidization from dense routes to the uneconomic services to and from small communities. Even after the new Air Canada Act, which put Air Canada formally under the jurisdiction of the Canadian Transport Commission, Air Canada has been pressured directly or indirectly to maintain jet service to some points perceived to be uneconomic. To the extent that it provides these uneconomic services for social reasons, it is expected to be less efficient than its private sector counterparts.

Immediately after the first oil crisis in 1973-74, Air Canada reduced its fuel consumption sharply relative to privately-owned carriers. Air Canada's fuel consumption fell by about 25% between 1975 and 1978 (Figure 3.12) while at the same time expanding output by about 12% in the same period. It seemed apparent that Air Canada made more of an effort to invest in fuel efficient aircraft and engines than any other carriers. This of course does not necessarily mean the Crown carrier selected an optimal investment in energy conservation. The carrier may have gone beyond the economically efficient solution where marginal cost equals marginal benefit, and to this extent Air Canada may be less efficient than its privately-owned counterparts.

Crown corporations are more likely to cooperate to achieve other national objectives such as employment goals, compliance with equal opportunity employment, selection of an aircraft type supported by the government, and bilingualism. To the extent that Air Canada complies with the non-economic national objectives beyond its own economic reason, Air Canada is expected to be less efficient than its privately-owned counterparts.

Questions of Proper Incentives:

The so-called "property rights" theorists believe that a government-owned firm is less efficient because in part management and employees are not motivated to maximize economic or financial objectives. They cite two major reasons for the lack of proper motivation. First, the government-owned firms have less flexibility for transferring the created economic wealth to its employees than do privately-held firms. An interesting example of this behaviour occured in 1980 when the government blocked Air Canada's attempt to make some bonus payments to its employees. Second, the politicians who control government corporations have diversified objectives, and thus are not likely to reward management solely on the basis of economic performance.

The lack of proper incentives stifles innovations in production and management. Management might also be expected to be more generous in wage settlements with unions than the privately-owned firms. Air Canada's average salary per employee, for example, was about 10% to 20% higher than that of CP Air throughout our study period, 1964-81 (see Figure 3.8).

The average salary for Air Canada's general management personnel was about $78,000 as compared to CP's $50,000 in 1981. Although data on the determinants of salary such as experience, seniority, education, etc. are not available, Air Canada appears more generous toward employee salaries than CP Air.

In sum, government-owned firms are expected to perform less efficiently in an economic sense because: (i) there is a lower perceived cost of capital, (ii) government intervenes in such matters as social services, setting service standards, choice of aircraft, energy conservation, employment objectives, etc., and (iii) there is a lack of proper incentives for innovative production and management.

Although there were occasional exceptions (such as instructing them to move their headquarters from Vancouver to Calgary), the Alberta government gave PWA management nearly complete freedom to run the airline without interference. On the other hand, the federal government frequently inter vened in Air Canada's management, through the Air Canada contract, the government-appointed board, The Minister of Transport, and Cabinet and CTC orders, on such matters as uneconomic services to isolated communities, aircraft purchase, service standards, fuel consumption, union-management contract negotiations, ban on bonus payment to Air Canada's employees, etc. While PWA was generally free from providing social services, Air Canada was not.

A comparison between the respective performances of Air Canada and PWA could reveal the combined effect of social services performed by Air Canada and the greater amount of political interference Air Canada was subjected to. The remainder of this section attempts to test these hypotheses and measure the effect of ownership on technical efficiency and capital investment.

B.2 Measurement of Ownership Effects on Capacity Investment

It was concluded above that Air Canada could be expected to have more excess capacity and a lower technical efficiency than other carriers in Canada. The results of the TFP and cost analysis in Chapter IV confirm this expectation.

Residuals from the log-linear TFP regression (regression (4) in Table A-1 of Appendix A) measures total factor productivity after controlling for the effects of variations in output, output mix, the attributes of the outputs and network size. The results indicate that CP Air, PWA and Nordair are significantly more efficient than Air Canada while the statistical evidence is weak when Air Canada is compared to Quebecair, EPA and Transair. It is noteworthy that PWA is among the top efficiency performers. This confirms our expectation that a Crown carrier run like a private corporation (without social services and facing competition), performs as well as privately-owned carriers. This also confirms our expectation that Air Canada, with social services, a lack of competition and a capital cost advantage, is an inferior performer in terms of economic efficiency. The TFP regression indicates that CP Air's total factor productivity is about 23.5% higher than Air Canada, after controlling for output, output mix, load factor, stage length, and the number of points served, etc.

When capital stock levels are controlled for in the TFP regression, the differences in the productivity performance among the seven carriers become statistically insignificant at any reasonable level of confidence. The statistically significant negative coefficient, -0.132 (see Appendix A), for the capital stock variable indicates the existence of excess capacity on average in the industry, implying that firms cannot adjust their capital inputs to optimal levels within a year.

As indicated in Chapter IV, a log-linear TFP regression is somewhat restrictive, and thus these results cannot be viewed as conclusive. Therefore the ownership effects were also investigated using cost functions. Since the TFP regression results indicate that firms do not typically adjust their capital stock levels within each year, in order to reflect this short-term disequilibrium adjustment in capital stock, a translog variable cost function was estimated (see Appendix A) in which the capital stock levels are controlled for in addition to other economic variables. Air Canada and PWA are likely to have excess capacity because of their lower capital costs, and the other Regional carriers are also likely to be over-capitalized because of the improper mix of scheduled and charter services. In order to capture the differential impacts of excess capacity among these groups of carriers, four separate capital stock variables[1] were incorporated in the variable cost function (presented in Appendix A): one capital stock variable common to all carriers (coefficient H = 0.012), one

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[1] Since we did not have systematic data on the imputed cost of capital unique to Air Canada, the identical series of the capital rental prices were applied to all airlines including Air Canada. Therefore, the effect of lower perceived capital cost is expected to show up in the coefficient for the capital stock variable unique to Air Canada.

unique to Air Canada's capital stock variable (coefficient HAC = 0.041), one unique to CP's capital stock variables (coefficient HCP = -0.090) and one unique to PWA's capital stock variable for those years for which it was owned by the Alberta government (coefficient HPWGOV = 0.021).

The capital stock coefficients estimated in the variable cost function are tested in Appendix A against the value of the coefficient ($\varepsilon_K^* = -0.145$) which would prevail if optimal capital stock conditions were employed. For convenience the test results are reproduced below.

Test Construction	Air Canada	CP Air	(1975-81)	Regionals
$(H + HAC) - \varepsilon_K^*$	0.198 (t=2.45)			
$(H + HCP) - \varepsilon_K^*$		0.067 (t=0.83)		
$(H + HPWGOV) - \varepsilon_K^*$			0.178 (=-1.64)	
$H - \varepsilon_K^*$				0.157 (t=1.91)

The above test statistics confirm the expectation that with the exception of CP Air, all other carriers have excess capacity.

The results indicate that Air Canada has the most excess capital stock, followed by PWA (during the years owned by the Alberta government) and then by other regional carriers. There is no conclusive statistical evidence that CP Air has excessive capital stock.

Although the differences in the capital stock coefficient between carriers are not statistically significant, in the absence of any better procedure it was decided to use their point estimates in computing the effects of ownership and regulations.

If the variable cost index for a carrier using an optimal capital stock is set as 100%, the above results on the statistical tests are translated as follows:

- variable cost index when using optimal capital stock = 100%
- Air Canada's variable cost index = 122% (=exp(0.198))
- PWA's variable cost index = 119% (=exp(0.178))
- Other regional carriers' variable cost index = 117% (=exp(0.157))
- CP Air's variable cost index = 107% (=exp(0.067))

It should be emphasized that the effects of the differences in the level and mix of outputs, network size, stage length, fuel and labour input prices, and the constant rate of change in production technology are controlled for before computing the above variable cost index. This variable cost index therefore, reflects only the effect of the excess capital stock each carrier has employed because of lower capital costs, regulatory constraints and socially imposed services.

The results of the variable cost index reveals the following relationships:

(a) The difference in the variable cost index of 15% between Air Canada and CP Air is a consequence of Air Canada having even more capacity than CP Air. This is the variable cost component of economic inefficiency created by Air Canada's lower capital input cost and social services.

(b) The 12% difference in the variable cost index between PWA and CP Air, is a measure of the economic inefficiency created by PWA's lower capital input cost, occasional social services during the period owned by the Alberta government (1975-81), and by the Regional Carrier Policy which induced carriers to over-expand into charter markets.

(c) The 10% difference in the variable cost index between the other regional carriers and CP Air, is a measure of the economic inefficiency created by the Regional Carrier Policy.

(d) The difference of 7% between CP Air's variable cost index and the optimal variable cost index is a consequence of the excess capacity due to the regulatory effect.

(e) Combining (b) and (c) above, suggests that PWA's lower capital input cost during the period for which it was owned by the Alberta government is responsible for the increase in its variable cost by about 2%.

Except for the effect of PWA's government ownership (1975-81), all other figures reported above are average yearly effects for our study period 1964-81. Since Air Canada enjoyed a capital cost advantage considerably more than PWA, it is impossible for us to decompose Air Canada's 15% inefficiency relative to CP Air into the effects of capital cost advantage and of social services.

B.3 Effect of Ownership on Technical Efficiency:

The discussions on the expected effects of government ownership, indicated that government affects more than the investment in capital. For example, the lack of proper incentives for profit maximization or cost minimization is likely to determine the type of work rules which management and unions agree upon. The less flexible the work rules, the more inefficient an airline becomes in terms of technical efficiency relative to other airlines. However, after incorporating the differential capital stock coefficients in the translog variable cost model, there were no statistically significant firm effects. This implies that there is no difference in technical efficiency between the government-owned and the privately-owned carriers.

An attempt to include a dummy variable for government ownership was also statistically insignificant. The next step was to examine the residual cost index obtained from the translog variable cost model. Since the industry mean of the residual cost index is unity, the residual cost index itself can be used as an indicator of a technical efficiency.[2] There are dangers of using the residual cost index as a relative measures of technical efficiency, since the cost residuals are "catch alls" and include the effect of omitted variables and stochastic errors as well as reflecting ownership and regulatory effects. Although we believe all important variables are included in our cost models, we use the residual cost index as a last resort, and as a suggestive, not conclusive measure.

Comparing the average residual index of Air Canada with that of CP is superior to comparing it with other carriers for determining the effects of Crown ownership of Air Canada, because:

1. The two carriers have operated in similar markets, particularly in transcontinental and international markets, whereas other carriers operated predominantly in regional and charter markets. While the cost functions control for the most important operating factors affecting performance, they cannot control for everything.

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[2] Since cost variables enter in the total and variable cost functions in natural logarithmic values, we obtain the residual cost indexes by exponentiating the logarithmic residuals. Since the latter means zero, the industry norm of the residual cost index is unity.

2. The crown ownership of Air Canada is significantly different from that of PWA in that the federal government used Air Canada as a policy instrument while the Alberta government largely left the operation of PWA to management.

3. Nordair was acquired by Air Canada just prior to a major recession and thus it is difficult to disentangle the ownership effect from the recession effect. The two data points (1980 and 1981) are not sufficient to study the effect.

4. The results of various analysis to date indicate an absence of a public ownership effect, per se. The difference in performance appears to occur because of the social services and the perceived capital cost differentials between privately-owned and publicly-owned firms.

5. A comparison between Air Canada and PWA is further obscured by the fact that PWA was constrained by the regional carrier policy.

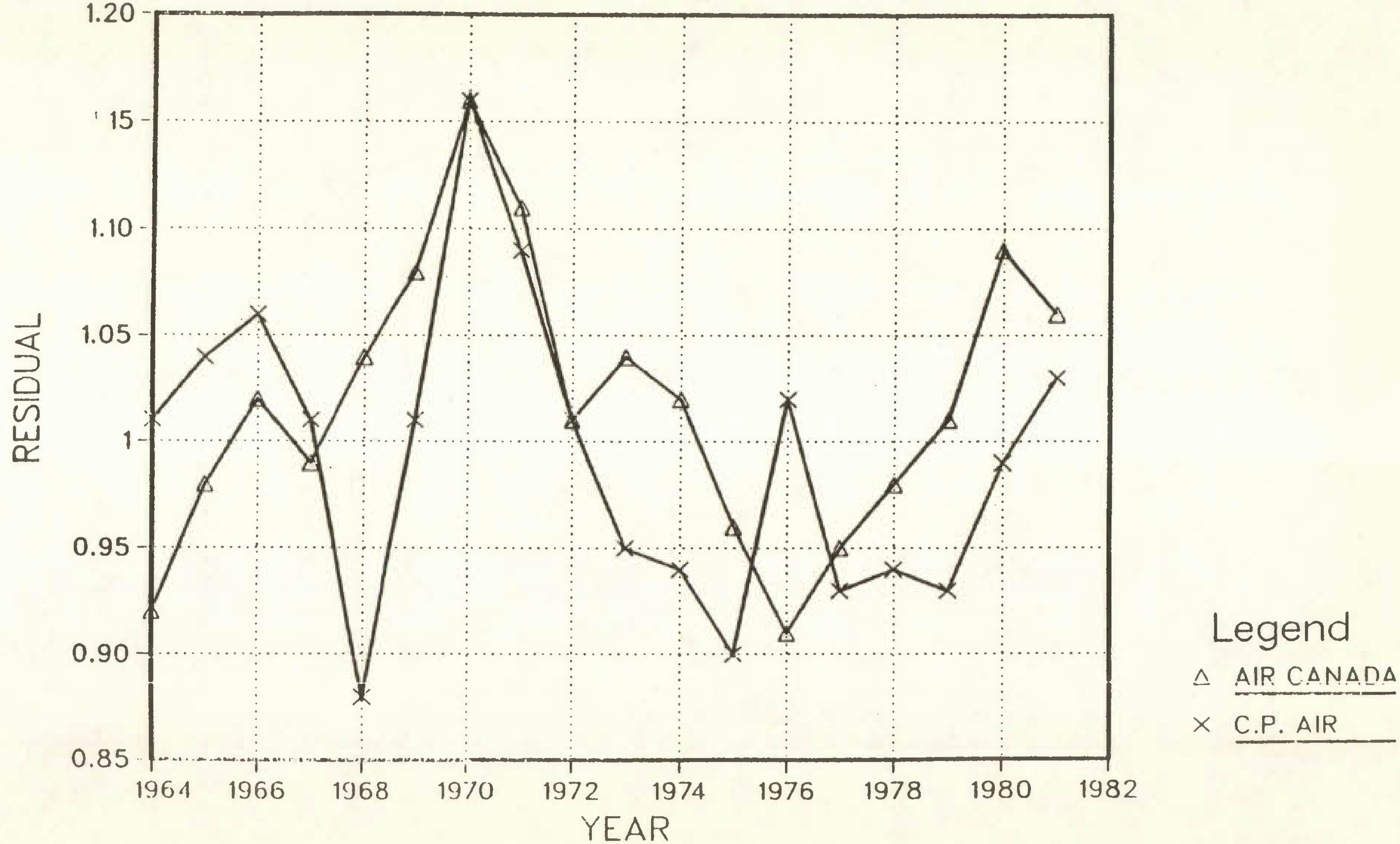
Figure 5-1 illustrates that, for the majority of the 18 years contained in the study period, the residual variable cost index of Air Canada is somewhat higher than that of CP Air. The average difference between the two firms' residual variable cost indexes is as follows:

Air Canada	:	1.016
CP Air	:	0.983
Difference	:	0.033 or 3.3%

It appears that after controlling for outputs, network, technology, input prices and the capital stock level, Air Canada's variable cost is 3.3% higher on average than that of CP Air. Since variable cost is about 87% of total cost (i.e. capital cost is about 13%), this figure translates into an increase in total cost of about 2.9% (=3.3% of 87%) due to Crown ownership. This figure, as cautioned earlier, is not statistically significant and must be viewed as suggestive rather than definitive. Obviously, this figure is small relative to the 15% excess capital stock effect of Air Canada's

FIGURE 5-1

VARIABLE COST FUNCTION RESIDUALS TRANSCONTINENTAL CARRIERS 1964-1981



government ownership. Furthermore, this 2.9% difference is the average annual difference in technical efficiency for the entire period, 1964-81.

C. Evidence on the Effects of Regulatory Relaxation on Performance

The effect of the regulation of entry, pricing, capacity and service conditions can also be categorized into two components: allocative efficiency and technical efficiency. Regulation introduces allocative inefficiency by establishing rules and inducing behaviour which cause cost to deviate from the values which would normally prevail in the deregulated industry; for example, higher labour charges and excess capacity induced by regulatory distortions. Another example is the economically inefficient scheduled vs. charter output mix which was induced by the regional carrier policy.

"Technical inefficiency" is created by a lack of innovative production and management, restrictive work rules, etc. The effect is to shift the production function downward, or equivalently to shift the cost function upward. This section, focuses upon the effects caused by excess capacity and technical inefficiency.

The preceding section measured the effect on cost efficiency of the general regulation-induced excess capital stock as a 7% increase in total cost. The economic inefficiency caused by the regional carrier policy was quantified as 10%. These figures were calculated using the translog variable cost function which allows for differential coefficients for capital stock across the carrier groups. It is important to note that the effects of government ownership is controlled for in measuring these regulation effects. Furthermore, these 7% and 17% (7% plus 10%) allocative cost inefficiencies respectively for the transcontinental and regional carriers are average figures for the entire study period 1964-81. This amounts to about 9% of the total industry cost during the period. As shown below the regulatory relaxation which took place since the mid-1970 have reduced much of these inefficiencies.

Below, the residuals of the total and variable cost functions are used to measure the effects of regulatory relaxation since 1977. Although the effects of technical efficiency are concentrated on, our intention is to measure the extent to which carriers have become more efficient by reducing their excess capital stock since 1977, a point at which greater competition was introduced. Since the construction of the total cost function assumes that firms adjust their capital stocks to their respective optimal levels within the year, the residuals will reflect both the effect of non-optimal capital stock levels as well as the effect of technical efficiency. Therefore, the difference between the effects of the regulatory relaxations on the total and the variable cost residuals (adjusted for the scale of variable cost), are likely to be the effect of the excess capital stock. The year 1977 was selected as the dividing point for the following reasons:

1. U.S. regulatory relaxation (de facto deregulation) had begun by 1977. This created competitive pressures on Canadian carriers both in transborder and transcontinental routes. Supersaver fares were introduced in 1977 in the U.S.

2. The New Air Canada Act (Bill C-33) was tabled in Parliament in 1977, which effectively put Air Canada on equal terms with other carriers.

3. CP Air's capacity restrictions on transcontinental routes began to be relaxed in a major way from 1978; this, of course, increased competitive pressure on Air Canada.

4. Domestic Advance Booking Charters (ABCs) were introduced in 1977.

Again, the danger of using the residual cost index as the measure of technical efficiency must be recognized for the reasons mentioned earlier. The empirical results discussed here should be taken as suggestive, not conclusive. The cost models control for most of the important variables affecting carrier costs, and thus the residuals may be a reasonable approximation of the relative technical efficiency. For example, output levels and input prices included in the cost models are likely to reflect a significant portion of the effect of economic cycle (booms and recession) on cost efficiency. Therefore, although the residual costs are an imperfect measure, they are not necessarily unreliable or unreasonable measure.

The comparison of the residual cost indexes between the pre-1977 and the liberalized (post-1977) periods is likely to give only the lower bound of the effects of the regulatory changes. This is a consequence of the negative impact of the 1980-81 recession (the worst since World War II) on air carrier performance. For a valid comparison between any two periods, the impacts of the economic cycle over and above the impacts of outputs and input prices on cost efficiency should be removed from the residual cost indexes before making comparisons.

Since there is no easy way of doing this, we merely compute the average difference in residual cost indexes between 1964-76 and 1977-79 (excluding the 1980-81 recessionary period), and use it as the upper-bound of the effects of regulatory liberalization since 1977. This is an upper-bound because some recessionary years such as 1974-75 and 1969-70 (although more moderate than 1980-81) are included in the 1964-76 period.

Table 5-1 report the averages of the residual cost indexes for various sub-periods, the entire 18 year period, and the upper and lower bounds of the effects of the regulatory relaxation since 1977 on cost efficiency for each of the seven carriers. The Table indicates that there have been significant improvements in cost efficiency for the five largest carriers (Air Canada, CP Air, PWA, Nordair and Transair, in order). The lower bound of the effect for EPA is slightly negative while its upper bound is 2.2%. Quebecair's residual cost efficiency has decreased by 15.8% (upper bound) and 25.8% (lower bound) since regulatory relaxations.[3]

It is certain that the dramatic decrease in Quebecair's cost efficiency was caused by the abrupt and significant reduction of its total output and changes in output mix without allowing time for an appropriate adjustment in factor inputs (number of employees and type of aircraft).[4] It was therefore decided to regard the change in cost efficiency of Quebecair since 1977 as a significant outlier, and thus exclude it from the computations. Transair is also excluded because it merged with PWA in 1980.

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[3] Quebecair experienced the largest change in efficiency over the 18 years studied. During their most efficient period (1969), the residual total cost index equalled 0.64. By 1981 (their least efficient period), this index reached 1.64. The extreme cost inefficiency in 1981 was caused by the excessively abrupt and drastic reduction in its charter services without an opportunity to expand into appropriate scheduled service markets.

[4] The changes made by Quebecair since 1978 are evident in the following statistics:

	Total output (million RTK)	Charter	Number of Employees	Scheduled Points	Load Factor	Revenue tonnes per Charter Deptarture
1978	128	75%	1019	23	61%	4.6
1979*	109	62%	1003	21	64%	3.7
1980**	57	48%	849	22	58%	1.8
1981	41	39%	933	23	53%	2.1

*Suspended overseas charter flights.

**Sold one B727 and two B707s and bought two B737s.

Table 5-1

Averages of the Residual Cost Indexes for Various Periods

Carrier	Total Cost	Variable Cost
AIR CANADA		
77-79	0.94	0.80
77-81	0.98	1.02
64-76	1.05	1.02
64-81	1.03	1.02
Δ 64-76/77-79	11.1%	3.8%
Δ 64-76/77-81	7.3%	0%
CP		
77-79	0.91	0.93
77-81	0.94	0.96
64-76	0.99	1.01
64-81	0.98	0.99
Δ 64-76/77-79	8.4%	7.3%
Δ 64-76/77-81	5.4%	4.2%
PWA		
77-79	0.93	0.89
77-81	0.95	0.91
64-76	0.99	1.00
64-81	0.98	0.98
Δ 64-76/77-79	6.6%	10.3%
Δ 64-76/77-81	4.1%	8.8%
QUEBECAIR		
77-79	1.14	1.15
77-81	1.24	1.18
64-76	0.98	0.96
64-81	1.05	1.02
Δ 64-76/77-79	-15.8%	-18.6%
Δ 64-76/77-81	-25.8%	-21.9%
EPA		
77-79	0.99	1.03
77-81	1.02	1.05
64-76	1.02	1.02
64-81	1.02	1.03
Δ 64-76/77-79	2.2%	-1.0%
Δ 64-76/77-81	-0.5%	-2.7%
TA		
77-79	0.93	0.93
77-81	-	-
64-76	0.67	0.99
64-79	0.96	0.98
Δ 64-76/77-79	3.6%	6.9%
NORDAIR		
77-79	0.98	0.96
77-81	0.99	0.98
71-76	1.02	0.99
71-81	1.01	0.98
Δ 71-76/77-79	4.1%	2.6%
Δ 71-76/77-81	2.4%	0.6%

Table 5-2 summarizes the effects on cost efficiency of the regulatory relaxations which took place between 1977 and 1981. The upper bound figures are based on the comparisons of the average residual cost index between 1964-76 and 1977-79, while the lower bound figures are obtained by comparing them between 1964-76 and 1977-81. The total cost savings to the transcontinental and regional carrier industry calculated on the basis of the 1981 output are approximately $364 million (10.4% of the total cost) for the upper bound and $222 million (6.4% of the total cost) for a lower bound. Subsequent analysis uses the lower bound effect 6.4% because from 1977 the New Air Canada Act (Bill C-33) has had an impact on the industry's cost efficiency as well.

For each airline, the total cost savings are decomposed into two components; the savings in variable cost and capital input cost. For example, CP Air's lower bound estimate of the total cost saving, 5.4%, is decomposed into a saving of 4.2% (= 3.5% of the 87% of total cost) due to the improved efficiency of variable inputs (labour, fuel and materials) and the remaining 1.8% saving comes from the improved efficiency in using its capital stock.

Most of Air Canada's total cost savings stem from savings in capital input cost (as was the case of ownership effect) while more than two-thirds of CP Air's total cost savings arise from savings achieved by improvements in the way it used variable inputs (labour, fuel and purchased materials). The reduction in PWA's variable cost due to the regulatory relaxations since 1977 was significantly larger than its savings in the total cost. Because of this, despite some increase in the residual capital cost index

Table 5-2

Effects of Regulatory Relaxations on Cost Efficiency

	Decrease in Residual Cost Indexes				Efficiency Change Due to
	(1) Total Cost (total savings in 1981 in $ millions)		(2) Variable Cost* (% in terms of total cost)		(3) Capital Inputs
Air Canada:					
Upper bound	11.1%	($273)	3.8%	(3.2%)	7.9%
Lower bound	7.3%	($156)	0%	(0%)	7.3%
CP Air:					
Upper bound	8.4%	($65)	7.3%	(6.2%)	2.2%
Lower bound	5.4%	($42)	4.2%	(3.5%)	1.8%
PWA:					
Upper bound	6.6%	($19)	10.3%	(8.8%)	-2.2%
Lower bound	4.1%	($12)	8.8%	(7.5%)	-3.4%
EPA:					
Upper bound	2.2%	($1.7)	-1.0%	(-0.9%)	3.1%
Lower bound	-0.5%	($0.4)	-2.7%	(-2.3%)	1.8%
Nordair:					
Upper bound	4.1%	($5)	2.6%	(2.2%)	1.9%
Lower bound	2.4%	($3)	0.6%	(0.5%)	1.9%

Total Cost Savings Of the Industry (based on the 1981 industry's total cost):
Upper bound ($364) or 10.4%
Lower bound ($222) or 6.4%

* The figures in brackets indicate the percentages of total cost savings due to an improvement in the use of variable inputs, i.e., efficiency change due to variable inputs. These figures and the corresponding efficiency changes due to Capital Inputs add up to the percentages of total cost savings reported in column (1).

in the post-1977 period, it experienced a significant reduction (6.6% for upper bound and 4.1% for lower bound) of the residual total cost index. Since PWA had expanded rapidly in the post-1977 period (e.g., merging with Transair etc.), it is likely that they over-expanded their capacity. Low interest loans from the Alberta Heritage Fund may have contributed to this expansion. EPA appears to have had just the opposite of PWA's experience, with an increase in the residual variable cost index while its residual capital cost index fell substantially. As a result, the lower bound of the effect of regulatory relaxation upon EPA's total cost was slightly negative (-0.5%) while the upper bound was positive (+2.2%). For the case of Nordair, the upper and lower bound figures appear to indicate that the savings in total cost is shared almost equally between the capital cost and the variable input costs.

D. Summary

This chapter attempted to measure the effect of government ownership on air carriers by utilizing the results of the total and variable cost functions estimated for Chapter IV in Appendix A. In particular, the total variable cost function was used to identify the effects of excess capital stock (caused by government ownership, and regulatory policies) on cost efficiency. The residuals from the total variable cost function were compared between Air Canada and CP Air to measure the effect of ownership on the technical efficiency; i.e., shifts in the cost function.

During the 18-year period (1964-81), crown ownership reduced the cost efficiency of Air Ca a by about 17.9% of total cost. This is equivalent to about $370 million in additional cost each year (on the basis of Air

Canada's 1981 total cost). Of the 17.9% cost inefficiency caused by crown ownership, 15% is due to inefficient use of capital stock (excess capacity), and the remaining 2.9% is due to inefficient use of the variable inputs such as labour, fuel and other purchased materials. A substantial reduction in cost inefficiency has occurred since tabling of the New Air Canada Act (Bill C-33) in Parliament in 1977. The effect of this is difficult to measure because it happened in the same year in which a series of regulatory relaxations began. For example, the effects of the regulatory relaxations measured in Table 5-4 are likely to include the effects of Bill C-33. Therefore, the effect of privatization of Air Canada, even in 1981, would have improved its cost efficiency substantially less than 17.9%.

Other important effects on excess capacity include:

1. A reduction in cost efficiency of all carriers by about 7%.
2. The Regional Carrier Policy reduced cost efficiency of the regional carriers further by about 10%.
3. PWA had an additional cost inefficiency amounting to about 2% since the Alberta government acquired it in 1974. This was caused by the excess capacity induced by its capital cost advantage.

In the period from 1977-81 all airlines, except for Quebecair, have improved their cost efficiency due to regulatory relaxations and the introduction of competitive market forces. The percentage increase in cost efficiency is positively correlated with the carrier size: the lower bound figures are 7.3% (Air Canada), 5.4% (CP Air), 4.1% (PWA), 2.4% (Nordair) and -0.5% (EPA). The total industry savings per year calculated on the basis of the 1981 costs is between $360 million (or 10.4%: upper bound) and

$220 million (or 6.4%: lower bound). Even if we use the lower bound improvement, 6.4%, this implies that much of the inefficiencies caused by the regulations, 9%, had been removed by 1981. The remaining inefficiency is at most 2.6%.

It is worth restating at this point that the estimated cost functions controlled for the scale and mix of outputs, network variables, input prices and the constant rate of improvement in the industry's production technology. The cost savings measured in this chapter by examining the residuals therefore do not include the effects of changes in the values of the variables which may have been caused by changes in ownership and/or regulations. For example, the effect of reduction in input prices caused by the regulatory relaxations is not included in the figures. In addition, the effect of regulatory policy measured in this chapter include only the regulatory relaxations introduced in the 1977-81 period. In particular, it does not include the effects of the May 10, 1984 Liberalization Policy. These additional effects are treated in other chapters of this report.

CHAPTER VI: - EFFECTS OF REGULATORY POLICY AND OWNERSHIP ON AIRLINE OPERATIONS

A. Introduction

In Canada, economic regulation of the airline industry and crown ownership were viewed as complementary instruments to achieve the aims of government. The perception of the government at the time the crown carrier was created was that the private market would fail to establish and maintain a national air transport network, operate in remote areas and regional centres, assure service continuity, and develop a presence in international markets. Until the late 1970's, Canadian airline regulation was structured to complement the primary instrument, Air Canada. This complementarity was evident in both the transcontinental carrier policy and regional carrier policy. The regional carriers were to essentially provide feed for Air Canada as well as service local markets. Even the allocation of international routes between CP Air and Air Canada was designed to insure the two carriers did not compete. This dual approach has affected both industry performance and managerial decision-making. Some of these effects were beneficial while others were not. Air Canada was, for example, able to realize all available density economies. Average load factors were higher in Canada than in the United States. This was achieved at a cost however, as regional carriers were not able to realize stage length and density economies. Other Canadian carriers were induced to follow Air Canada's lead in establishing uniform high quality service and rate structures.

Chapter V measured the direct effects of regulatory policy and crown ownership on industry and carrier performance. If ignored the indirect effects through input prices, outputs and networks. This chapter attempts to distinguish between and determine the effects of the two instruments (regulation and ownership) on input prices, outputs, networks, and routing patterns.

B. The Effect on Input Prices

B.1 Ownership Effect on Price of Labour Input

For several reasons publicly-owned airlines may be able to pay a higher price for labour input than would privately-owned carriers. The differential may be attributable to:

1. Publicly-owned firms generally have higher credit ratings in long-term bond markets, and thus save interest costs on borrowing. Labour may be able to capture cost savings with respect to other factors.

2. Publicly-owned firms are less concerned with paying dividends to [their] shareholders. Again a capital cost saving that could be captured by labour.

3. Labour in public institutions or firms may be able to affect the elasticity of supply of labour with respect to wages by altering employment rules. They also may be able to reduce the substitution possibilities between labour and other factors by altering rules.

4. Labour unions within public corporations have more power due to opportunity to politicize wage/working condition negotiations. Publicly owned firms are concerned with complying with the government's employment goal.

5. Labour in a public firm is subject to other government policy and may receive a higher wage as compensation. The use of Air Canada to 'demonstrate' the governments bilingualism policy may have had a significant effect upon labour costs for that air carrier.

The multilateral labour price index reported in Chapter III indicates that in 1980 Air Canada and PWA paid respectively about 4% and 6% higher wages than that of CP Air after adjusting for the quality of labour. PWA's rate of increase in its labour price index since the Alberta government's take over in 1974 was significantly higher than those of other carriers [see Figure 3.8]. This may be caused in part by the resource boom which began in western Canada about 1974.

Since the debate on liberalizing economic regulation of the industry accelerated in 1983, carriers and unions have been positioning themselves for the new environment. CP Air and PWA have been somewhat successful in negotiating both wage and work rule concessions from their workers. Air Canada as well as other carriers have attempted similar negotiations but with somewhat less success.

We believe that the minimum effect of privatization (not deregulation) of Air Canada would be about a 5% reduction in its long-run equilibrium wage level. Borcherding et al. (1982) note that in Canada, empirical studies have shown employees of public institutions to have wages approximately 10% above the market, and of this about 6% is rent. A lower cost structure at Air Canada would place pressure upon other carriers to also lower their input costs. Historically Air Canada, because of its dominance, has set the industry standards for wages, and therefore it is highly likely that other airlines would also reduce their wage levels by at least the same factor. This implies that in the long run the industry's total bill for labour compensation could be reduced by 5% with the privatization of Air Canada. Since labour cost accounted for 29% of the airline industry's total cost in 1981, this amounts to a reduction of total cost by about 1.45% (=0.05 × 0.29), a saving of $50 million (=1.45% of $3,493 million) in that year.

B.2 Regulatory Impact on Price of Labour Input

It has been well established [Reschanthaler and Stanbury, 1982, Douglas and Miller, 1974, Jordan, 1981] that regulators of the airline industry are intentionally or unintentionally captured by the industry and firms they are supposed to regulate. Thus, price and entry regulations of the airline industry in various countries have led to regulator-enforced cartels. This is particularly true both in Canada and in the pre-deregulation U.S. Cartels attempt to maximize joint profits. Some of the monopoly rents may have been transferred to suppliers of inputs. Since the airline industry has no major impacts on interest rates or fuel markets, most of the rents are likely to have been transferred to the labour inputs and to a lesser extent to the purchase price of aircraft.

There is evidence [see Jordan, 1979; 1981] that Air Canada's union contracts were closely replicated by other carriers [see for example, Figure 3.9 for the similarity of wage changes for pilots and co-pilots]; even in the case of small regional carriers. The multilateral labour prices index presented in Chapter III indicates that in 1980 the labour input price for Nordair and EPA were only about 20% less than that of Air Canada, while PWA had a slightly higher labour price index than Air Canada.

Deregulation will most likely lead to a reduction in real terms in labour input prices below the current level since there would no longer be a source of rents. Because adjustments are still taking place, it is difficult to measure the full effect of deregulation in the U.S. on its overall labour costs. The long run effect could be substantially larger than what has been observed so far. In the United States, between 1978-1983 output per employee increased approximately 15% for trunk carriers and approximately 40% for local carriers [Bailey et al., 1985, table 8.5]. As a consequence the labour cost index fell [for the years 1978-81] by 7% for trunks and regionals. There have also been significant changes in work rules. New entrants are forcing existing carriers to eliminate any rents captured by labour. One can speculate that labour costs in the long run are likely to decrease in Canada due to both wage and work rule changes by as much as 20% under a U.S.-style deregulation. Since labour costs account for about 30% of total costs, this translates into a savings of 6% of the total cost of the industry or $210 million on the basis of the 1981 total Canadian airline costs (=0.20 x 0.3 x $3.5 billion). A more extensive analysis is available in Gillen, Oum, Tretheway (1985). This 6%, together with the 2.6% production inefficiency remaining as of 1981 (Chapter IV), gives 8.6% as the improvement in the industry's cost efficiency from a U.S. style deregulation.

C. The Effect on Output Mix

Air carriers produce different outputs over different routes in various geographic areas. Air Canada and CP Air both produce freight and scheduled passenger outputs as well as small amounts of charter services. The regional carriers produced scheduled and charter services in varying proportions. The stringency with which entry and fare controls were applied against the two markets differed significantly. In particular, entry into charter markets was significantly easier.

A firm supplying products to both regulated and unregulated markets is motivated to oversupply output to the unregulated or less regulated market. The multiproduct airline would generally expand services up to the point at which marginal revenue equals marginal cost. The oversupply is relative to what would occur in a non-regulated market. The oversupply occurs because firms are operating on a different marginal revenue function, and with entry control on scheduled service markets the opportunity cost of moving capacity into charter markets is lower. Specific examples in the Canadian airline industry are discussed below.

Although all aspects of airline services are regulated in (as well as to and from Canada), the regulatory agencies have maintained flexibility in approving charter services relative to awarding scheduled service routes. This appears to have been the case for the Canadian regional air carriers. As a result the regional carriers have expanded their international charter services at particularly high rates especially in the 1970s. This has resulted in an economically inefficient mix of scheduled and chartered services.[1] Scheduled services have become of almost secondary importance for some regionals (Quebecair and PWA). Moreover, because the nature of their scheduled service markets was incompatible (in terms of route density and distance) with that of many of their international charter markets, the regionals needed to purchase large aircraft for their low-yield charter services, rather than being able to use the excess plane capacity during off-peak times or seasons from their scheduled service markets.

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[1] Economic efficiency is not the same thing as managerial efficiency. Managers responding properly to regulatory incentives will be properly judged by shareholders as being managerially efficient. The resulting use of scarce resources by the efficient managers can be socially undesirable, or economically inefficient. It is the wrong regulatory incentives rather than the manager's response that leads to economic inefficiency.

As reported earlier, the investigation on interproduct cost relationships indicated that charter and scheduled passenger services are compliments only for fairly low proportions of charter services. The regionals, with an output mix often consisting of 50% charter services experience no such complementarity. In fact, for the regionals, the marginal costs of scheduled services have been adversely affected by the presence of such a large portion of charter services.

Furthermore, the Regional Carrier Policy prevented them from realizing the gains from economies of stage length and of traffic density in their scheduled services by denying their access to medium to long-haul dense markets.

C.1 Effects of Other Policies on Output Mix

The effect of ownership upon output mix is straightforward. Since its creation, Air Canada was given the bulk of scheduled passenger services in Canada, particularly in transcontinental routes, most transborder routes and international routes to major European and Caribbean markets. They therefore had and continue to have very little charter output. Their proportion of freight output reflects their extensive scheduled passenger network. The government policy with respect to both transcontinental service and regional carriers were the result of crown ownership. These policies had a significant effect upon output mix. The transcontinental policy of limiting CP Air (a policy which ended in 1979) to a small proportion of transcontinental capacity prevented this carrier from realizing density economies.

The effect of deregulation will be to significantly alter output mix.[2] In the U.S., domestic air travel had always been dominated by scheduled passenger service. Nevertheless, substantial amounts of charter services have been provided. In 1975, the year before ABC charters were allowed, the CAB reported data for seven "Supplemental" (i.e. charter services only) air carriers. Traffic data for these carriers are reported in Table 6-1 for the years before deregulation. Table 6-2 indicates the share of total charter services in total domestic services and the share of the supplemental carriers in total charter services for years before and after deregulation.

Table 6-3 illustrates the decline of domestic charter services by the former supplemental carriers. The total revenue-passenger-miles of charter services offered by these carriers is quite a bit less than it was before deregulation (compare Tables 6-1 and 6-3). Further, for two major carriers, Capitol and World, charter services (which were 100% of total domestic service in 1976) are now insignificant portions of their total domestic output. Both carriers now provide significant amounts of scheduled domestic services. For Transamerica, domestic services (all of which are charter) now account for only 4% of its output.

These figures suggest an important facet of deregulation: charter markets almost disappear. We believe there are theoretical reasons for this. Demand models indicate that passengers, even discretionary travellers, are sensitive to the time when service is offered. Passengers have

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[2] This section draws on materials published in Gillen, Oum and Tretheway (1985a, Appendix A).

Table 6-1

U.S. Supplemental Air Carriers Domestic Revenue Passenger Miles
1975 - 1976
(in millions)

Carrier	1975	1976
Trans International	228	111
Overseas National	219	404
Capitol	191	218
McCulloch	116	84
World	72	76
Modern	52	*
Evergreen	18	27
Total Supplementals	890	920

*Data not reported due to strike

Source: U.S. CAB, Handbook of Airline Statistics

Table 6-2

U.S. Airline Industry Share of Charter Services in RPM
(In Percent)

	Share of Domestic Charter Services in total Domestic Services	Share of Supplemental Carriers in total Domestic Charter Services
1975	3.8%	17.0%
1976	4.6%	13.0%
1981	1.4%	11.9%
1982	1.6%	4.3%

Source: U.S. CAB, Handbook of Airline Statistics, and Air Carrier Traffic Statistics

Table 6-3

Former U.S. Supplemental Carriers
Domestic Charters as a Percent of Domestic Services

	Domestic Charter Service as % of Total Domestic Services		Total Domestic Charter RPM (Millions)	
	1982	1981	1982	1981
Capitol#	2%	3.4%	47	82
Evergreen*	-	100 %	-	45
Overseas**	100%	-	1	-
Transamerica***	100%	100 %	81	172
World	1%	1 %	14	24

Source: U.S. CAB, Air Carrier Traffic Statistics

* In 1982 Evergreen only provided charter freight services in domestic markets.
** In 1981 Overseas only provided international services.
*** Formerly Trans International
\# Capital suspended operations in November, 1984.

preferred departure times, preferred departure dates and preferred destinations. The very nature of charter service reduces the choices a passenger has in all these areas. Some travellers are willing to travel at the convenience of the charter operator in exchange for a reduced fare. The regulated environment in the U.S. prevented scheduled carriers from offering deeply discounted fares to discretionary travellers. This opened up a market niche for charter operators. The regulatory authorities were happy with this arrangement as it provided very high "fences" between the "must go" and discretionary segments of the market. This would allow both segments of the market to receive at least some service, without a substantial revenue erosion from scheduled services.

In a deregulated environment, scheduled operators can attempt to capture some of the revenue from the discretionary traveller. By erecting proper fences around various fares and by strictly limiting the availability of such seats via modern seat management, scheduled carriers can increase total revenue per flight. The discretionary traveller is now faced with chosing between a charter or a scheduled flight, <u>at the same fare</u>. As the latter offers greater choices of destinations, travel dates and times, it is usually chosen.

In our opinion, many charter services are an artificial product of regulation. They disappear in a deregulated environment. The only charter markets that are likely to survive are for special events, very seasonal markets, and for groups which prefer to travel together, such as sport teams, political campaigns, movement of military personnel, etc.

Additional evidence from the U.S. deregulation experience leads to several other observations about changes in output mix in the U.S. since deregulation. First, there seems to be advantages in combining regional routes with transcontinental trunk routes. Bailey, Graham and Kaplan (1985) point out that most of the former local service carriers tied their regional routes together around a hub, and then added transcontinental routes out of the hub. United Airlines, a trunk carrier, dropped local service routes immediately after deregulation but has since added them back. American and TWA have placed substantial orders for DC-9 aircraft, a plane suited to short stage-lower density local service routes. A final observation is the emergence of close links between the large carriers and the small, third level carriers in the U.S. The feed smaller carriers provide seems to be quite important in providing economies of density to the larger jet carriers. The fact that no commuter has been merged into a larger carrier suggests that there are cost advantages to keeping these operations separate (i.e., there are diseconomies of scope between turbo-prop feeder services and large jet services).

D. Network and Routing Patterns Under Regulation and Deregulation

One of the principal aims of government intervention in air transport was to establish and maintain a transcontinental route structure. The government air carrier was to be the principal vehicle to accomplish this task. As a result route structures developed on the basis of Air Canada's priority position and the piecemeal basis by which regulations made route awards (Baldwin, 1975). Under deregulation Canadian carriers can be expected to move toward hub type networks, at least to the extent that it is possible in Canada. This statement is based upon an examination of the

U.S. deregulatory experience and transborder routing effects. The type of network system which will evolve depends very much upon transborder market decisions. Transborder traffic forms a significant market and influences whether networks will have a north-south or east-west orientation. Whether or not cabotage rights will be granted to foreign carriers will also be important since a domination of Canadian markets by U.S. carriers could result in Canadian traffic being routed through U.S. hubs.

D.1 U.S. Evidence[3]

One of the clearest trends of U.S. deregulation is the adoption of the hub and spoke route networks by almost all carriers, new and old. Bailey, Graham and Kaplan (1985, pp. 75-79) document this well. Table 6-4 is taken from their treatise. It indicates the dramatic increase in hubbing by almost all air carriers. Some large carriers, such as United, American and Eastern operate more than one major hub. While others have documented the growth and importance of hubbing, not enough attention has been given to distinguishing two types of hubs: the complexing hub and the point-to-point hub.

Carriers can have two different reasons for hubbing. One is to provide better service to passengers. For example, there may only be sufficient demand for one flight per day from small city A to large city B. However, if traffic from A to C and A to D could be routed through city B, then perhaps three flights per day can be provided from A to B. By adding

[3] This section draws on materials published in Gillen, Oum and Tretheway (1985a, Appendix A).

Table 6-4

U.S. Airlines Growth in Hubbing
(Taken from Bailey, Graham and Kaplan [1985])

Airline	Leading Hub City in 1983	Percent of airline's domestic departures at hub: 1978 (2nd quarter)	Percent of airline's domestic departures at hub: 1983 (2nd quarter)	Percent change in departure at hub
American	Dallas-Fort Worth	11.2	28.6	113.7
U.S. Air	Pittsburgh	16.0	23.2	45.7
Continental[a]	Houston	12.8	22.9	45.8
Delta	Atlanta	18.3	21.4	11.4
Eastern	Atlanta	18.3	21.0	1.0
Frontier	Denver	18.0	33.8	23.8
Northwest[b]	Minneapolis-St Paul	16.1	20.7	18.7
Ozark	St. Louis	15.5	35.6	53.7
Pan American[c]	New York	12.3	35.6	-1.8
Piedmont	Charlotte	3.7	19.6	583.0
Republic[d]	Minneapolis-St. Paul	3.4	7.7	91.1
Trans World	St. Louis	11.9	33.0	81.3
United	Chicago	13.8	18.9	1.5
Western	Salt Lake City	10.3	16.9	129.3

Source: Bailey, Kaplan and Graham (1985).

a. Continental and Texas International departures were combined for 1978.

b. There was a strike at Northwest in the second quarter of 1978. Therefore, in both years data for service during the first quarter are reported.

c. National and Pan American departures were combined for 1978.

d. North Central, Southern, and Hughes Airwest departures were combined for 1978.

more spokes to the hub, service frequency can be increased to each city on the network.

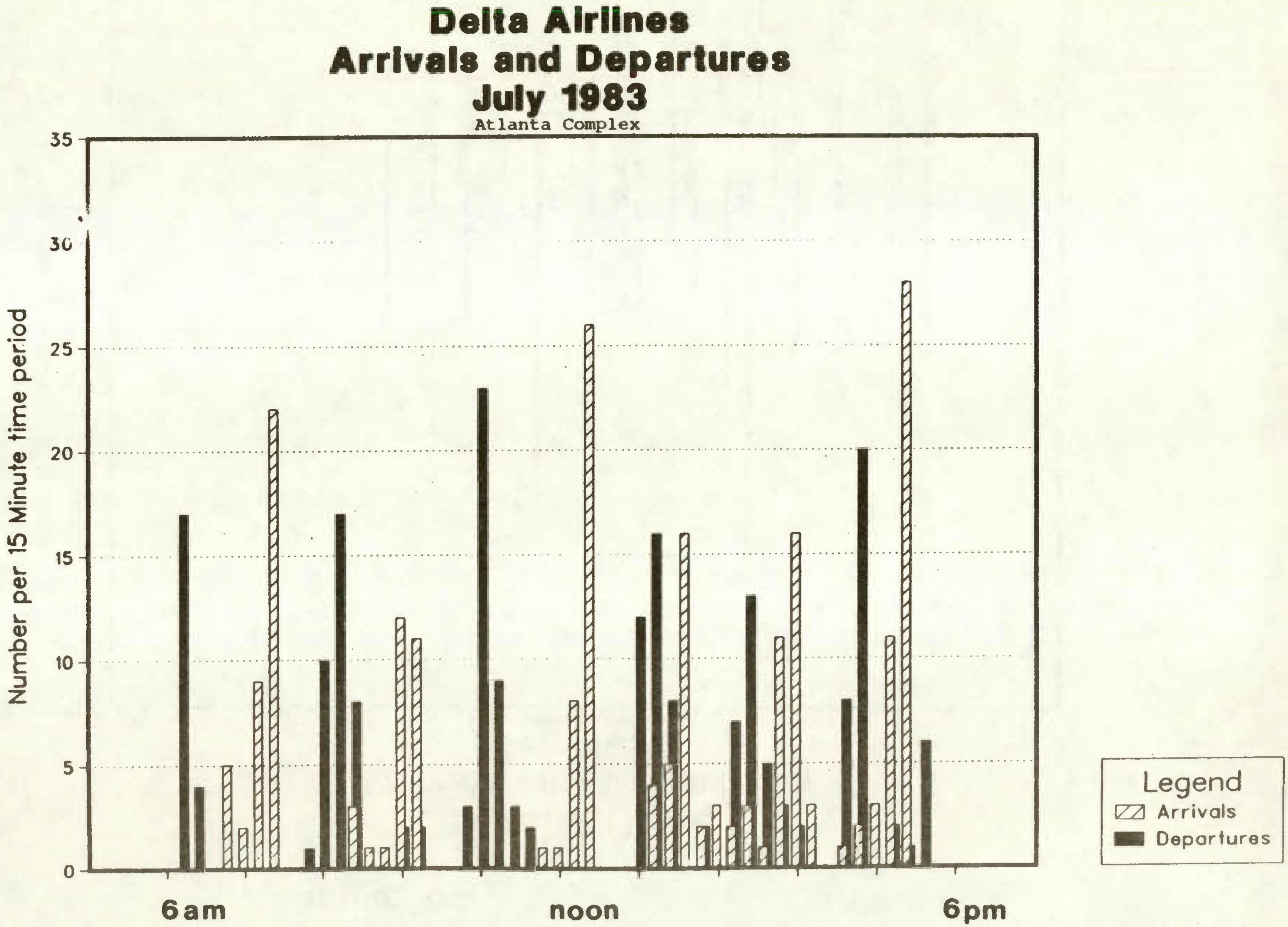
The key to being able to actually capture all this traffic, however, is to be able to provide quick connections between incoming and outgoing flights at the hub. Passengers are generally unwilling to wait two or more hours to make a connection, particularly if nonstop point-to-point service is available.

To provide quick connections, airlines schedule "complexes" of several arriving flights followed by an equivalent complex of departures 30 to 75 minutes later. Delta Airlines operates such a set of complexes at its Atlanta hub. Figures 6-1 and 6-2 illustrate these. Each bar represents the number of arrivals or departures in every 15 minute period. The graphs clearly illustrate batteries of arriving flights followed by a battery of departures. Figure 6-1 shows the pattern more clearly, while Figure 6-2 illustrates the pattern over the whole day.

A second reason for operating a hub is to save costs. Hubbing allows a carrier to realize economies in maintenance facilities. Potentially, aircraft utilization can also be higher. By channeling all aircraft through the hub, it will be easier to find uses for planes in otherwise idle hours. Personnel at the hub can be better utilized, due to the higher volume of traffic.

The complexing type of hub is very expensive to operate in this regard. A look at Figure 6-1 indicates several periods of over an hour with little or no activity. These are times when passengers are busy changing planes. Personnel inside the terminal and outside servicing aircraft are

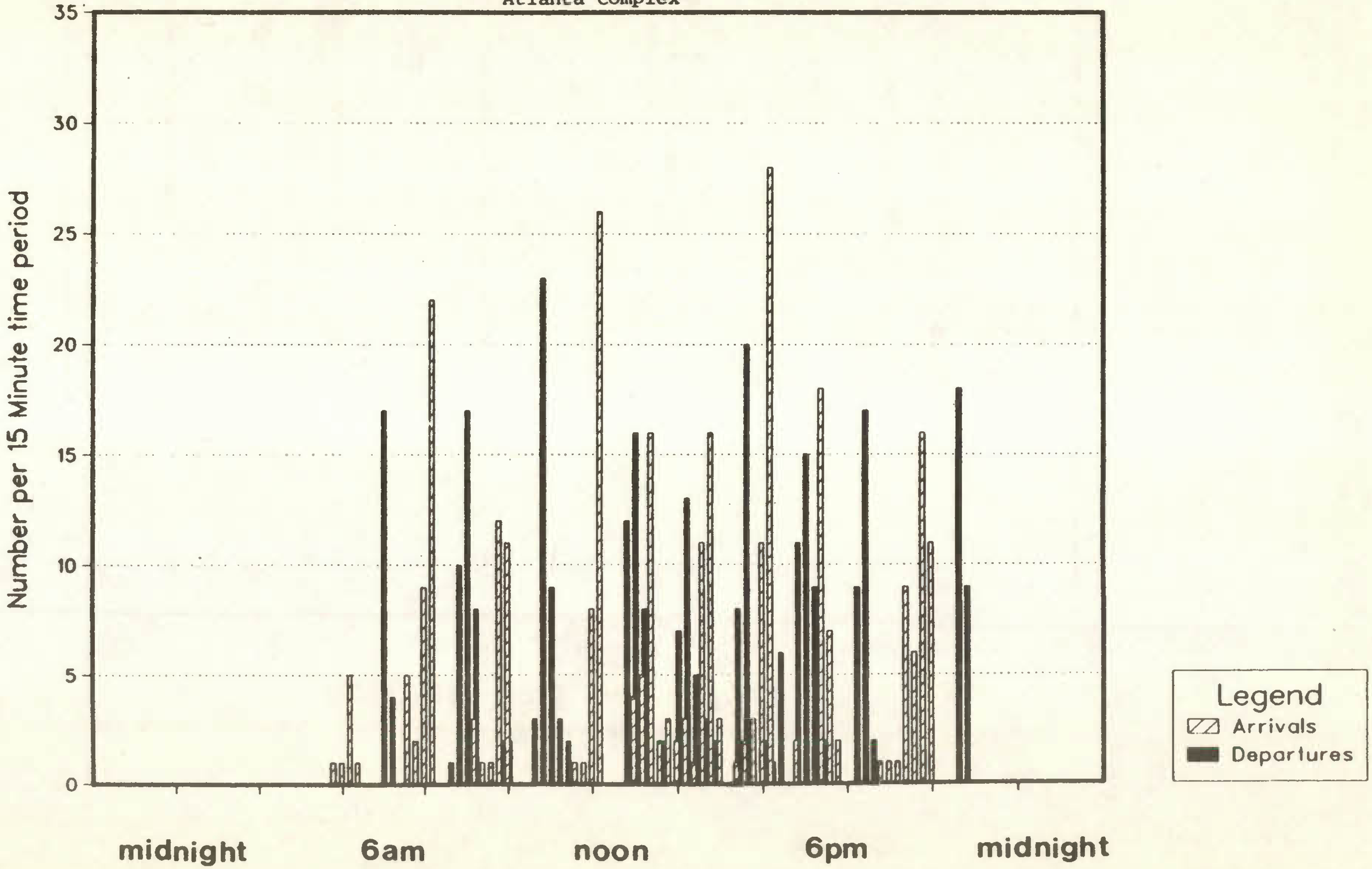
FIGURE 6-1



112.

FIGURE 6-2

Delta Airlines
Arrivals and Departures
July 1983
Atlanta Complex



quite busy. Others, however, whose jobs are related to aircraft movements (e.g., flight personnel) are idle at this time. When the next phase comes, the opposite is true. Further, aircraft can be idle at gates for periods longer than is necessary to service the aircraft. Because large numbers of planes are on the ground during a complex, the airline needs a large number of airport gates and corresponding personnel. In sum, the complex hub is expensive since it idles aircraft, requires many gates and has long periods when personnel are idle. It is an expensive type of network, suitable only if the airline's customers are willing to pay a higher price to obtain convenient connections.

Some carriers chose to operate hubs, but not of the complexing type. We refer to this second type of hub as a "point-to-point" hub. Here, flights arrive in a fairly steady stream throughout the day, resulting in high employee utilization and a need for fewer gates. As soon as an aircraft is serviced, it is 'turned around' and sent out again. Equipment utilization is high. Figures 6-3 and 6-4 demonstrate such a point-to-point hub; that of People Express, a post deregulation entrant carrier, in Newark during 1983. Note also that People's hub has considerable activity late at night and early in the morning relative to Delta's.

In summary, two types of hub operations have emerged since deregulation. The "complex" type of hub is expensive to operate. It provides a high level of service to passengers. As a result it is suitable for a carrier whose customers are somewhat price inelastic, but service elastic. The "point-to-point" hub is less costly and allows high rates of employee and capital utilization (both ground and flight). It is suitable for

FIGURE 6-3

People Express Airlines
Arrivals and Departures
May 1983

Newark Hub

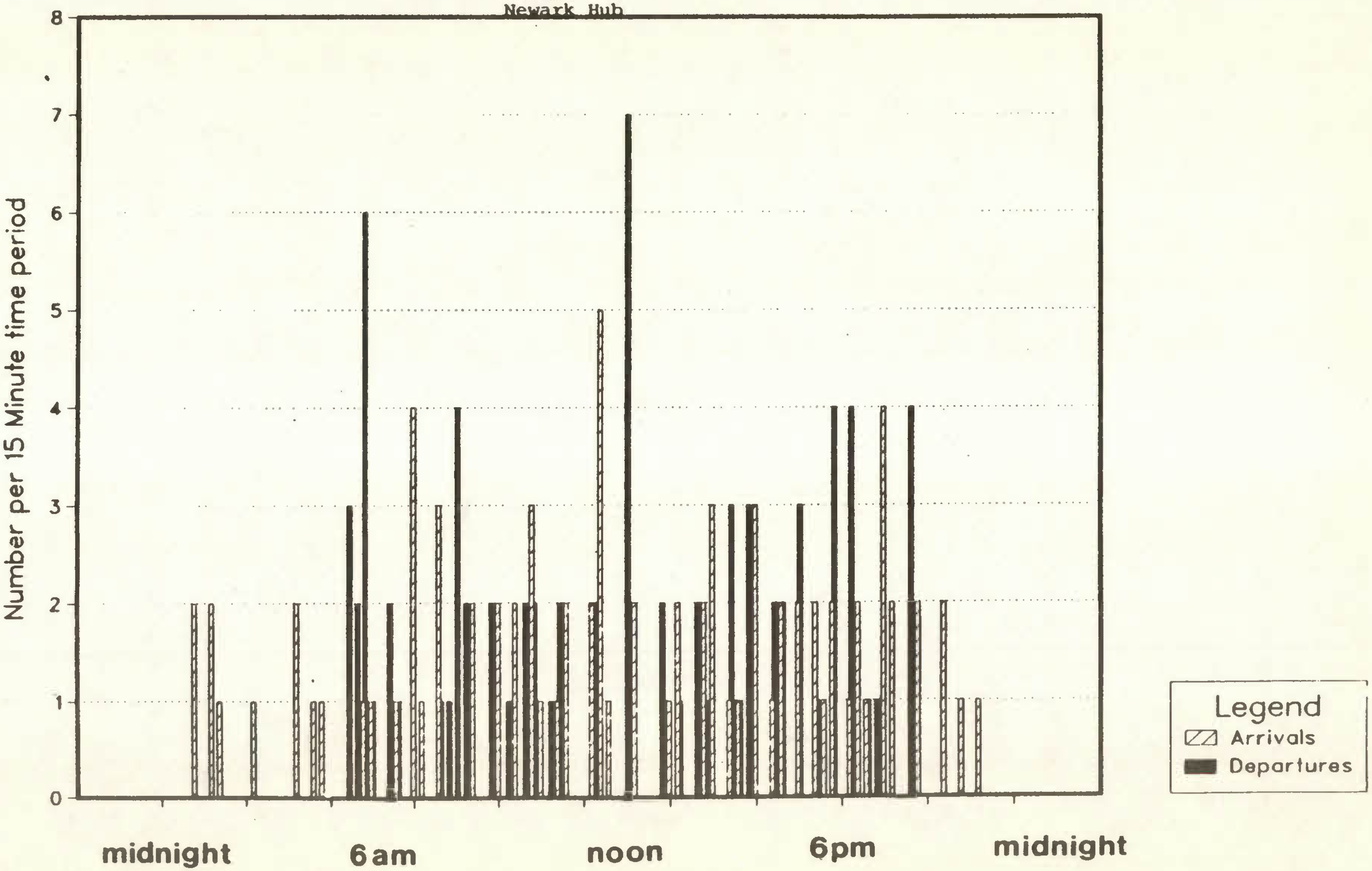
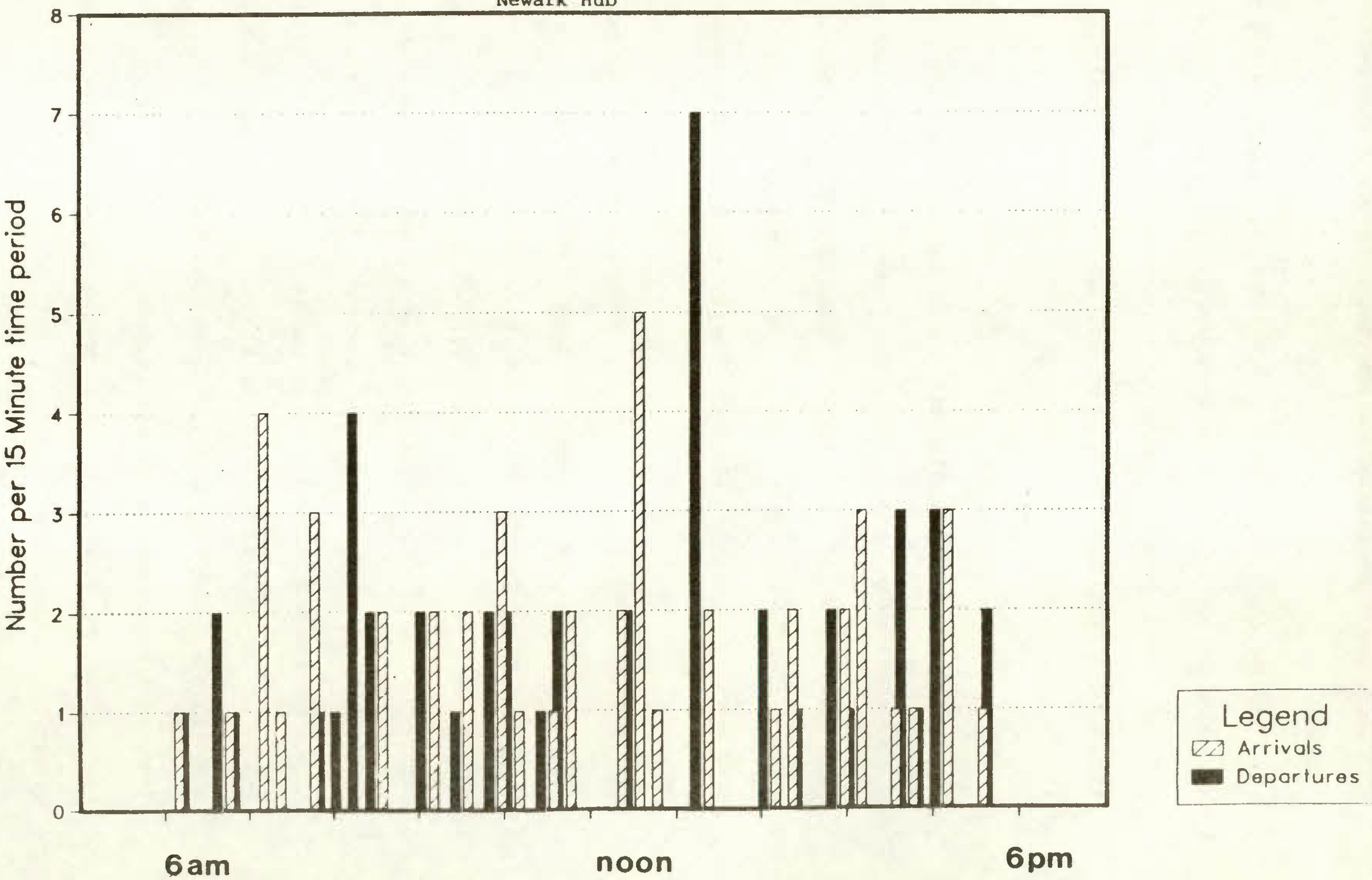


FIGURE 6-4

People Express Airlines
Arrivals and Departures
May 1983
Newark Hub



carriers servicing passengers responsive to price and less responsive to service.

Because of the emergence of hub and spoke networks since deregulation, carriers are apt to now think in terms of adding sets of routes or connections to their network. This is in contrast to the regulated era, when routes were considered on a piecemeal basis as the regulatory agency made them available.

D.2 Transborder Routing Effects of Domestic Regulatory Reform

There are two issues here. The first concerns how domestic deregulation affects traffic flows across the border. The second concerns the consequences of "deregulating" the border, or giving carriers cabotage rights in the other country's markets; an issue the U.S. and Canadian governments have been discussing.

Domestic regulation has strong impacts on cross border traffic. Since U.S. deregulation, many Canadians have travelled south by auto or bus to originate their flights within the U.S. The result is a loss, to U.S. points, of Canadian originating traffic. The low fares (or wider availability of low fares) in the U.S. also attract individuals to choose U.S. destinations over Canadian ones, especially for leisure travel. This will affect both the Canadian living in Toronto contemplating a pleasure trip to Vancouver versus Orlando Florida, or the U.S. citizen considering a trip from Chicago to either Montreal or Washington D.C. The deregulated U.S. carriers also have an advantage in being able to efficiently modify their route structures (at least at one end of the trip) to best serve the true origin-destination flows.

As Canada continues to relax domestic regulation this loss of traffic to the U.S. should halt or reverse. Freedom to enter and exit routes will allow Canadian carriers to modify their route structures. To the extent that domestic fares fall, destinations in Canada will be able to hold their own against destinations in the U.S. If lower costs are achieved in Canada these may be reflected in lower transborder fares. This would attract more Canadians to originate their flights within Canada.

The above discussion took the existing Canada-U.S. route structure as fixed. Such routes are negotiated by a bilateral U.S.-Canada air treaty. Should both countries choose to deregulate their domestic traffic, it seems only natural to raise the question as to whether the bilateral treaty should be liberalized as well. From the consumer's point of view the answer is yes. He or she will be best served if carriers are not constrained in terms of route structure or pricing decisions. The Government of Canada may have objectives other than consumer welfare to consider. In particular, producer surplus or protection of Canadian jobs may also be goals. If Canadian carriers are displaced by U.S. carriers, then there could be a net loss of economic welfare in Canada.[4]

Would Canadian carriers be displaced by U.S. carriers if trans-border markets were significantly liberalized? This is an empirical question

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[4] This can be demonstrated by a diagramatic treatment of consumer and producer surpluses. Suppose the U.S.-Canada market is evenly split so that all Canadian originating traffic is served by Canadian carriers on average. (It is assumed Canadian and U.S. carriers have identical cost or supply abilities in the transborder market.) The figure below illustrates an initial equilibrium at price OP_1. Canadian consumer surplus is area 1. Canadian producer surplus is area 2+3+4. Suppose deregulation of the border allows costs to fall for U.S. (but not Canadian) carriers. This shifts the supply relation right by OQ_3 units. The first Q_3 units will now be supplied by U.S. carriers, the remainder by Canadian carriers. Market equilibrium is now at price OP_2.

beyond the scope of this study. Nevertheless, there is some theoretical evidence that suggests the answer could be yes. Rhagurahm (1984) has developed a model to determine whether traffic will travel nonstop or be channeled through a hub. The objective of the model is to minimize total travel time in the transportation network. (This includes "delay" time at the network nodes, including the hub). Only high density city pairs will justify non-stop direct flights. One can speculate that most Canadian traffic would thus end up travelling through a U.S. hub.

Where would these hubs be located? With a complete open skies policy between Canada and the U.S., much Canadian traffic would hub through a U.S. city. The optimal hub point is located interior to the network in order to minimize total travel time. Canada is on the edge of the North American system. Further, the U.S. has many cities capable of originating much traffic by themselves, and thus have become quite attractive as hub points. It is not too difficult to envision much cross Canada domestic traffic hubbing through U.S. cities such as Minneapolis, Chicago and Detroit under a U.S.-Canada open skies policy.

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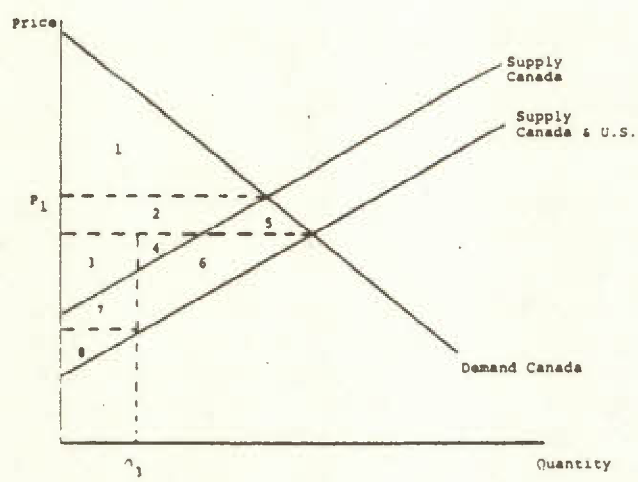
[4] (cont'd)



Canadian consumer surplus is area 1+2+5, an unambiguous increase. Total producer surplus is area 3+4+6+7+8. U.S. carriers, however, reap area 3+7+8 of this; Canadian carriers only area 4+6. The net change in Canadian economic welfare is area 1+2+4+5+6 minus area 1+2+3+4. This nets out to area 5+6 less area 3. Whether this is positive or not depends on demand and supply elasticities.

The main point is that before Canada negotiates an open skies policy with the U.S., it must carefully consider what its objectives are and then empirically investigate the consequences of changes. Some models already exist within the Canadian government for evaluation of U.S. bilateral changes. These models are unsuitable however, for evaluation of an open skies policy. The existing models only look at piecemeal changes in the combined U.S.-Canada air transport network. They cannot consider fundamental network restructuring, the impact of fares on choices of destinations, and the potential for domestic Canadian traffic to hub through U.S. points.

E. Simulated Cost Under U.S. Style Deregulation[5]

The effect of deregulation on efficiency of the carriers and the industry may be broadly categorized into two components: changes in allocative efficiency and in technical efficiency. Allocative efficiency is influenced by, (i) changes in input mix in response to changes in input prices, (ii) reallocation of outputs across the firms in an industry, and (iii) changes in levels and mix of outputs and network configuration for each firm. On the other hand, the technical efficiency is caused by fundamental changes in production technology such as inventions and innovations. This affects efficiency by shifting the whole production function upward, and thus shifting the cost function downward.

The gains in productive efficiency will occur in both domestic and international markets. It is impossible to distinguish the separate effects

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[5] This section draws on material published in Gillen, Oum and Tretheway (1985a).

in these two markets independently. One can, however, examine the pattern of responses in the U.S.

The gain to any particular airline may depend in part upon the proportion of total traffic in international markets. International travel will still be regulated and therefore one might argue that there will be no mechanism to induce carriers to be more efficient. Unless all carriers serving international routes have the same distribution of traffic between [deregulated] domestic and international, it will be in the interests of any carrier to be as efficient in its international market as it is domestically. Furthermore, even international markets can be quite competitive as illustrated in the North Atlantic.

Since Canada has not experienced a complete deregulation of its airline industry it is impossible to use our data base to measure the change in technical efficiency which would be caused by such deregulation. Qualitative conclusions are therefore drawn on the basis of experiences of other countries which deregulated their airline industries.

Since allocative efficiency is determined by levels of the variables included in cost function, the effect of deregulation can be measured from the cost functions of Appendix A, provided that there are reliable forecasts on values of the variables which would prevail under deregulation. This can be done by comparing the simulated costs at values of the variables <u>with</u> and <u>without</u> deregulation. This section merely reproduces results of the simulation (in Table 6-5) conducted in another study (Gillen, Oum and Tretheway, 1985a).

Table 6-5

VARIABLES USED IN THE DEREGULATION POLICY SIMULATION*

	Air Canada	CP Air	Regionals
Total output	15% decrease	10% increase	30% increase
# of points	15% decrease	no change	10% decrease
Output mix:	no change	change	change
Charter		50% reduction	5% of output
Freight		no change	same in absolute
Passenger		balance to make total output grow by 10%	balance to make total output grow by 30%
Stage length	30% increase	10% increase	30% increase
Load factor	no change	no change	no change
Labour price	20% decrease	20% decrease	20% decrease
Captial stock	35% reduction	10% reduction	15% reduction

* All changes are relative to the values actually observed in 1981, and are for the carriers total operations.

The changes presented in the Table are relative to the values actually observed in 1981, the last year of the period for which complete data were available. The total cost for each of the six airlines was simulated using the variable cost function discussed in Chapter 4. The simulation results indicate the industry's cost (adjusted for quantity and quality of outputs) is expected to decrease by 8.8%.[6] This figure is remarkably close to 8.6% obtained by adding up the allocative efficiency effect of eliminating excess capital stock, plus the labour cost saving and subtracting the improvements already made between 1977 and 1981 (see Section C above). The breakdown by carrier group is as follows:

Quantity/Quality-Adjusted Cost Reduction Factor

Air Canada	9.2%
CP Air	5.0%
Regionals	12.5%
Industry	8.8%

The changes in the cost index with deregulation are a consequence of:

1. a reduction in the price of labour input, and the resultant adjustment of input mix,

2. a reduction or elimination in excess capacity,

3. changes in output density, stage length etc. favouring particularly the regional carriers.

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6 Since consumers value more highly the scheduled passenger service (relative to charter or freight) by paying a higher price per RTK, any change in output mix should be viewed as a change in quality of output. Thus, the quality index was computed on the basis of the weighted average prices of the three outputs per RTK.

F. Shifts in the U.S. Cost Function After Deregulation[7]

Regulatory reform can lead to two economic changes. First, firms can move to more efficient points on the production or cost function. Second, the function itself can shift. An example of the former type of change would be a movement under deregulation to a higher proportion of scheduled passenger services if the previous regulatory regime had put limits on the amount of scheduled services a carrier could offer. An example of a cost function shift would be if deregulation led to new ways of allocating tasks to employees (perhaps by elimination of restrictive work rules) such that fewer employees are now needed (at the same wage rate) to provide a given amount of service. Whether the second, "production shift", type of change is likely to occur in a deregulated Canadian environment is now assessed. Rather than simply speculate about this hypothetical question, the U.S. experience with deregulation is examined for evidence as to what has actually happened there.

With the limited amount of data available, the evidence is weak, at best, that cost shifts have occured. There is evidence that changes in technology have been "labour saving" in the U.S. since deregulation.

Caves, Christensen and Tretheway (1983) describe the productivity shifts and their sources that occurred for U.S. air carriers after deregulation. Measured productivity jumped by 2.3% after deregulation from an annual growth rate of 2.8% per year to 5.1%. The proportion of this growth that was unexplained increased by .3% to 2.3% per year. Thus, 2.1% per

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[7] This section draws on material published in Gillen, Oum and Tretheway (1985a).

year of the total 2.3% increase in productivity growth is due to movements to a different point on a simple specification of a production function, while .3% of it is due to a shift of the function.[8] This evidence suggests that while shift or innovative type productivity gains occurred in the U.S. after deregulation, they were small (.3%) relative to the allocative efficiency movement type of gains that occurred (2.1%). From 1977 to 1979 large cost shifts were observed (4.3%, 4.3%, 4.0%). At the end of that year, the U.S. slid into its largest post-war recession. In addition, in 1979/80 airline fuel prices increased 250%, and the air traffic control system was disrupted in 1981 (and thereafter) due to a strike by PATCO.

Table 6-6 compares growth rates of unexplained airline productivity (i.e. production function shifts) and U.S. real GNP. An examination of the figure reveals a clear correlation of unexplained TFP with the business cycle, and that in 1981, as the U.S. was (temporarily) pulling out of the first phase of the 1980-82 recession, unexplained airline TFP during a recovery was, for the first time in the 1955-81 period, as strong as real GNP growth.

From these results we feel that present evidence is weak, at best, of a shift in the production function since deregulation. Accordingly, no such shift was predicted in our simulation of cost in the Canadian airline industry under deregulation. Some observers feel that as more information becomes available eventually a strong increase in unexplained airline TFP will be observed. They cite the fact that in 1981, new entrant air carriers were only starting to appear and had not yet put any pressure on

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[8] The numbers do not sum due to rounding of figures to one decimal.

Table 6-6

Unexplained Airline TFP and U.S. Real GNP
Year-to-Year Growth Rates
1955 -1981

	U.S. Real GNP	Unexplained Airline TFP	3 Year Moving Average of Column 2
1955/56	1.8%	- 3.1	- 1.6
1956/57	1.4	- 2.5	- 2.0
1957/58	-1.1	- 1.8	- 2.5
1958/59	6.4	- 3.6	- 2.6
1959/60	2.5	- 6.9	- 4.1
1960/61	1.9	- 2.3	- 4.3
1961/62	6.6	- .7	- 3.3
1962/63	4.0	2.0	- .3
1963/64	5.5	- 1.0	.1
1964/65	6.0	2.8	1.3
1965/66	6.0	- .7	.3
1966/67	2.7	.2	.7
1967/68	4.6	.4	.0
1968/69	2.8	- 1.7	- .4
1969/70	- .2	- 1.6	- 1.0
1970/71	3.4	2.1	- .4
1971/72	5.7	.2	.2
1972/73	5.8	- .5	.6
1973/74	- .6	.1	- .1
1974/75	-1.2	.4	.0
1975/76	5.4	1.5	.6
1976/77	5.5	1.8	1.2
1977/78	5.0	2.0	1.8
1978/79	2.8	.6	1.5
1979/80	- .3	- .9	.6
1980/81	2.6	2.3	.7
1981/82	-1.9	N/A	N/A

Sources: Federal Reserve Bank of St. Louis, Annual Economic Statistics, and currently unpublished work by Tretheway on U.S. Airline TFP, 1947-1981. Moving average is a trailing moving average.

incumbent carriers. Several work rule concessions were made by unions after 1981, and those made before 1981 had not yet made themselves felt in the data.

G. Summary of the Effects of Ownership and Regulation on Performance

It was noted that the privatization of Air Canada would improve its use of inputs and input mix, and thereby reduce its total cost of producing the same outputs by 17.9% (15% from savings in capital cost and the rest, 2.9% from savings due to technical efficiency). It was also noted that this 17.9% cost saving is the average for the entire study period, 1964-81. Thus the actual cost savings from privatization, will be much smaller than this. If this 17.9% is translated in terms of Air Canada's 1981 total cost level, the cost saving amounts to $370 million (17.9% of $2,067 million). This, in turn, is equivalent to about 10.5% of the industry's total cost. Chapter V, section B, indicated that an industry-wide reduction of labour input prices induced by privatization would have saved the industry an additional $50 million in 1981. These two elements together amount to an average annual saving of about 12.0% of the total industry's cost [i.e., ($370 + $50)/$3,493 (in 1981) = 12.0%].

On the other hand, as noted earlier, the New Air Canada Act of 1977 made Air Canada substantially more market oriented. Therefore, the cost inefficiency due to Crown ownership is likely to be much smaller in 1981 than 12% of total industry cost. In fact, in another work we estimated the efficiency gain from privatization to be 6.7% of the total industry cost if Air Canada had been privatized in 1981. This latter figure was based on a short run adjustment by Air Canada toward an optimal route structure and fleet size. Therefore, the 6.7% might be viewed as the efficiency gain achievable in the short run, while the long-run gain in efficiency lies somewhere between 6.7% and 12.0% of the total industry case.

Since Air Canada has become even more market oriented since 1981 (the last year of our study period), the effect of privatizing Air Canada today may be smaller than even the 6.7%. In order to avoid speculation on where the long-run true value of the privatization effect lies, the 12% figure issued in subsequent analysis because this value is obtained objectively from our analysis in Chapter V and because this study focusses on the historical impact of ownership on performance rather than to speculate change that may occur in the future.

The regulatory relaxations which took place between 1977 and 1981 helped the airline industry improve cost efficiency between 6.4% (lower-bound) and 10.4% (upper-bound). It was decided to use the lower-bound effect, 6.4%. This is the more conservative figure, and it prevents over-statement due to any overlap in the ownership and regulation effects. It was also concluded that under a U.S. style deregulation, labour costs are likely to decrease by about 20% compared to the level which would prevail with regulation. This translates into a 6% saving in the industry's total cost.

The following summarizes the effects of regulations as of 1981:

a) Allocative inefficiency (averaged 1964-1981):	9%
b) Higher labour input prices:	6%
c) Improved cost efficiency between 1977 and 1981:	-6.4%
d) Net remaining cost inefficiency as of 1981:	8.6%

This figure is remarkably close to the 8.8% measured by the simulation of the cost function in Gillen, Oum and Tretheway (1985) which reflects substitutability among inputs and changes in network configurations, in addition to the reduced labour prices and excess capital stock. It is important to recall that this efficiency gain of 8.8% cost reduction is realtive to 1981 actual costs, a saving of $307 million (8.8% of $3,493 million). The May 10, 1984 "New Canadian Air Policy" is likely to have already improved the industry's efficiency somewhat. This indicates that additional gains in cost efficiency from further moves toward deregulation is likely to be somewhat less than 8.8%.

The U.S. experience indicates no visible evidence of improved technical efficiency since the 1978 deregulation. There is some partial evidence on efficiency gains due to improved work rules. This claim has not yet been substantiated by any systematic analysis of the carrier or industry data.

CHAPTER VII: - EFFECTS ON TRAFFIC VOLUME AND CONSUMER SURPLUS

Chapters IV, V and VI measured and discussed the effects of deregulation and privatization on the cost efficiency of the carriers and industry. This chapter evaluates the gain in consumer surplus caused by the improved cost efficiency and increased competition. In order to evaluate the consumer surplus, information on the price-elasticity of the demand for air transport services is essential. Most demand studies on air travel, including Oum and Gillen (1983), and Oum, Gillen and Noble (1984) suggest the lower bound figure for the price elasticity as being about -1.1. To provide conservative estimates, this figure is used in subsequent analysis.

Table 7-1 indicates the increases in total industry demands which would be induced by the privatization of Air Canada and by deregulation. First, the expected reduction in cost is listed. Next, the assumption that these cost reductions would be fully passed on to the consumer in the form of fare reductions is made. Implicit in this is that the regulatory and/or ownership changes do not lead to higher rates of returns for carriers and that carriers will not fundamentally change the quality of the services they offer. Next, the demand elasticity is applied to the fare reductions to obtain total industry traffic changes. These conservative estimates indicate that deregulation and privatization are likely to increase the demand for air travel by 9.7% and 5.0% respectively. Since under deregulation the total market size for Air Canada is not likely to expand, there is a large amount of growth potential for the other existing carriers and upstart carriers.

Utilizing the information on the cost savings for the industry (and thus fare reductions) and the volume increases, it is possible to compute

Table 7-1

Impacts on Industry Traffic Levels

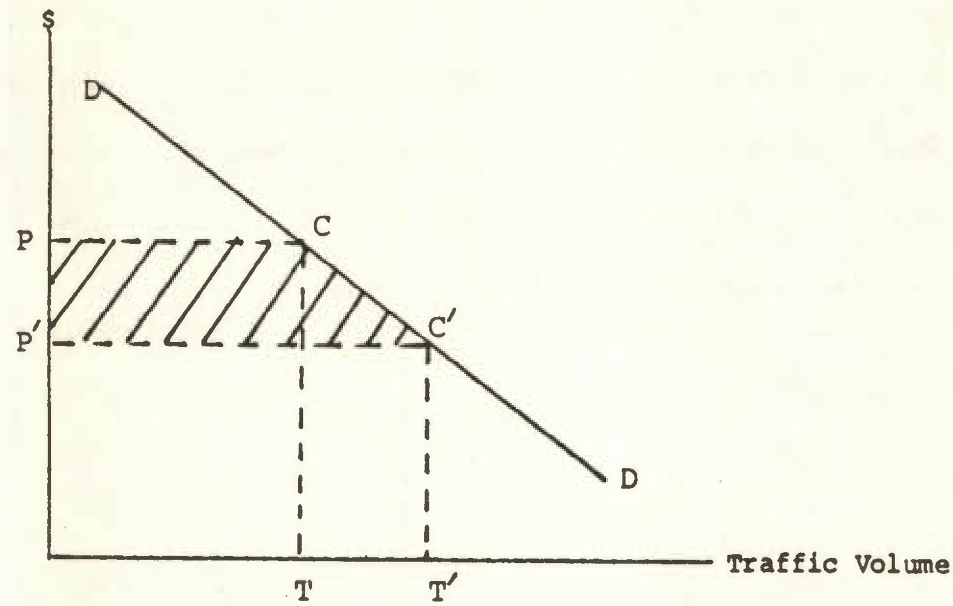
		Deregulation	Ownership
1.	Industry Cost Reduction	8.8%	4.6%
2.	Fare reduction	8.8%	4.6%
3.	Fare elasticity	-1.1	-1.1
4.	Change in industry traffic	9.7%	5.0%

gains in consumer surplus which would have resulted in 1981 if those changes had occurred earlier. The gain in consumer surplus is illustrated as the area bound by PP/CC/ in Figure 7-1.[1] The computation is carried out in Table 7-2. The increase in consumer surplus due to deregulation would have been roughly $318 million in 1981 while the figure for privatization of Air Canada would have been $161 million. These figures are substantially larger than the labour cost reduction of $190 million and $50 million respectively for deregulation and privatization.

[1] Strictly speaking, the income compensated demand curve should be used for computation of consumer surplus. We believe the difference with our calculation is small.

Figure 7-1

GAIN IN CONSUMER SURPLUS
(in 1981)



P = price per RTK ($80/RTK in 1981)
P′ = price/RTK with deregulation or privatization of Air Canada
T = total output of the industry (4360 million RTK in 1981)
T′ = total output of the industry with deregulation or privatization

Net gain in consumer surplus = area bound by PP′C′C

Table 7-2

Calculation of Welfare Gains

	1981 actual	1981 with deregulation	1981 with privatized Air Canada
Total output (in million RTK)	4360	4783 (9.7% increase)	4578 (5% increase)
Price per RTK	$0.80	$0.73 (8.8% decrease)	$0.763
Gain in consumer surplus (in million $)	-	$318*	$161**

* calculation 4360 (0.07) + (4738-4360)(0.07)/2

** calculation 4360 (0.037) + (4578-4360)(0.037)/2
= $161 million

CHAPTER VIII - THE ROLE OF OWNERSHIP VERSUS OTHER INSTRUMENTS

A. Introduction

This chapter asks whether government ownership is unique in its ability to achieve certain goals. Section B investigates whether there have been differences between government-owned and privately-owned firms in their response to changes in the market environment. Section C looks for evidence as to whether privately-owned firms are unable to meet certain social goals. Finally, Section D looks at alternatives to changes in ownership.

B. Response to Changes in the Operating Environment: Government-Owned versus Privately-Owned Firms

Caves, Christensen, Swanson and Tretheway (1983) conducted a study of U.S. and Canadian railroads.[1] This study covered the years 1956-1979. The major event during this time period was the increase in competitiveness in Canadian rail markets brought on by the intermodal competition encouraged in the National Transportation Act and various other measures. Prior to these changes in the mid 1960's, both U.S. and Canadian railroads achieved similar rates of productivity growth. After the reforms, the U.S. continued with the previous average growth rate. In contrast, the two Canadian railroads roughly doubled productivity growth.[2]

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[1] The Canadian figures have been updated and refined in Freeman, Oum, Tretheway and Waters (1985).

[2] Although the National Transportation Act of 1967 increased intermodal competition, it did not encourage intra-modal competition. In fact, the Railway Act not only permitted price collusion between the two railways, but also exempted the two railways from the anticombines investigation. Therefore, the effect of the NTA on Canadian railway performance is expected to be less than the effect of a complete deregulation.

What the authors found interesting was that the two Canadian railroads, one privately owned, the other government owned, responded in similar ways to the regulatory reform. They concluded that it is the competitive environment rather than the form of ownership that had the major effect on carrier performance.

The same result has also been obtained in studies of air transport. Jordan (1983) conducted a study comparing U.S., Canadian and Australian airlines. He found that airlines operating in highly regulated markets were consistently inefficient regardless of which country they operate in, whereas the U.S. intrastate carriers, operating in much less regulated markets, performed significantly better. Although studies of the two national Australian airlines found the private carrier to be slightly more efficient than the government owned one, the differences between the two were judged to be small compared with the effect of regulation on airline performance.

The conclusion reached in the aforementioned studies, that the regulatory constraint is a more important contributor to inefficiency than government ownership, has also been borne out in Canada. Chapter IV showed that the unexplained productivity growth rates of Air Canada and CP Air were quite similar over the 1964-1981 period. Most of Air Canada's inefficiency is caused by the excess capital stock which is in turn a result of the lower capital cost and required social services. Once these effects are removed, the difference in technical efficiency between Air Canada and CP Air became negligible. The performance response of both to the gradual easing of capacity and pricing restrictions since the mid 1970's was also very similar. In a 1984 report on air fares, the CTC noted that since U.S.

deregulation, fares in many city pairs in Canada were as low or lower than comparable fares in the U.S. (CTC, 1984). The individual Canadian carriers, of course, charge similar fares. As the operating environment in Canada changed (due to the U.S. deregulation, competition from charter carriers, regulatory relaxations, etc.) the public and privately owned air carriers have responded in similar ways. For example, as competition builds up in response to regulatory relaxations in Canada, both Air Canada and CP Air responded similarly by establishing a variety of discount fares, adopting a frequent flyer program, forming alliances with other carriers (e.g., Air Canada, PWA and Air Ontario alliance, and CP Air, Air BC, EPA, Nordair alliance), and getting tough with unions for wage and work rule concessions.

C. Evidence on Private Firm Failure to Meet Social Goals

One reason for maintaining government ownership of an air carrier is to meet various noneconomic social goals. Canada might have goals such as provision of service to small and isolated communities, and maintenance of high employment levels and wages in air transport. Is it necessary to use ownership as the instrument to achieve such goals?

In testimony before the 1984 air fare hearings, CP Air indicated that it perceived that government policy wanted it to both maintain high wages and high employment levels. To this end, CP Air took actions (within the context of a regulated environment) to maintain its own planes when it would have been cheaper to contract for maintenance with U.S. carriers, and to roughly match the wage rates of Air Canada. This suggests that government ownership might not be necessary for achieving some noneconomic goals. Regulation seems to be sufficient.

Table 8-1 shows that CP Air has dropped 40% of its points versus 25% for Air Canada. In the U.S., many large carriers dropped service to small communities.[3] This raises the question of service to small communities. Would privately owned carriers provide such uneconomic services under deregulation? The most likely answer is no. However, it is also likely that publicly owned carriers would respond in similar ways, unless they receive government subsidies. Without subsidy, they would be driven from the highly competitive airline business if they maintained uneconomic services.

On the other hand, the use of direct subsidy has preserved service at small communities in the U.S. (including remote communities in Alaska). Further, direct subsidy or wage regulation (e.g. minimum wages) could have maintained employment and wages (another social goal), although at a cost to society.

The main point is that with regulation, publicly owned firms are not necessary for achieving noneconomic goals. Without regulation, publicly owned firms are not sufficient (except with large subsidy) to ensure that such goals are achieved. Either regulation or some form of subsidy is needed in order to get a carrier, regardless of its ownership form, to continue an uneconomic service.

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[3] In the U.S., many small communities lost scheduled jet service after deregulation. However, many of these communities and many communities which did not have scheduled air service before deregulation were picked up by commuter carriers. A study conducted by Don Allan & Associates, for deHavilland Aircraft Co., suggests that regulation has in fact thwarted the growth of air service to small communities and that if deregulated, there would be a growth of services using non-jet aircraft.

Table 8-1

Domestic Points Suspended
By Canadian and U.S. Airlines Under Regulation

United States, 1946-78

Number of points suspended by

Trunk Carriers	343
Local Service Carriers	362
Total	705

Canada, 1960-83

Number of points where service was terminated by

Air Canada	10	(out of 41 points served	- 24.4%)
C.P. Air	12	(" " 29 " "	- 41.4%)
Eastern Provincial	8	(" " 25 " "	- 32.0%)
Nordair	5	(" " 23 " "	- 21.7%)
Pacific Western/Transair	28	(" " 73 " "	- 38.4%)
Quebecair	9	(" " 30 " "	- 30.0%)
Total	72	221	32.6%

Source: Prof. William Jordan, York University, March 1984.

D. Conclusion: Alternatives to Changes in Ownership and Regulation

Ownership and regulation were policy instruments used to meet the goals of air transport in the early days of Canadian aviation. Those goals primarily included economic efficiency, and to a lesser extent provision of service to small or isolated communities. Over time, airline markets changed. Neither regulation or ownership are now needed to achieve economic efficiency. Indeed there is evidence that regulations such as those constituting the Regional Carrier Policy have significantly lowered efficiency.

This leaves the question as to whether Canada needs to continue to use Crown ownership and regulation to meet other goals. In the previous section it was argued that ownership is neither necessary nor sufficient to achieve such goals. Regulation is sufficient, but we may pay a high price to use it in terms of economic efficiency. An alternative exists to regulation. That is, direct subsidy. This policy instrument has been used successfully to maintain small community service in the U.S., while simultaneously achieving the economic efficiency benefits of deregulation. Direct or indirect subsidy could also be used to achieve employment goals should Canada choose to continue their pursuit.

CHAPTER IX - ALTERNATIVE METHODS OF CHANGING OWNERSHIP IN CANADA[1]

A. Introduction

The previous chapters have focused on the efficiency costs of regulation and government ownership. They have also assessed the consequences of deregulation as well as privatization. In the analysis of privatization it was implicitly assumed that all methods of privatization are homogeneous; meaning the consequences are independent of method. This may not be the case, and therefore the effects of different privatization methods are now investigated.

In developing the various scenarios the issue of efficiency and the matters which effect it are focused upon. Privatization is treated as complete and intermediate alternatives, such as mixed enterprises are not considered. The assessments are also made with an understanding that it is the domestic market which is being deregulated. What happens in the future to transborder on international markets is not considered here. It is recognized that these international issues are important; indeed discussion of bilaterals and the exchange of cabotage rights are on the agenda. But these issues are beyond the scope of this study.

Financial issues and factors dealing with the process of privatization are also not addressed. In particular, the possibility of foreign ownership and the price Air Canada is sold for are not considered. The purpose of this chapter is to point out that there are efficiency implications associated with the method of privatization.

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[1] This chapter draws on materials previously published in Gillen, Oum and Tretheway (1985a).

Alternate A: Privatization Without Breakup - Under this policy Air Canada is sold to the private sector in its entirety. There is no breakup of Air Canada. None of its divisions are spun off. None of its routes are spun off.

There are four different methods for selling Air Canada. The first of these is sale of Air Canada to the highest bidder. Under this alternative, Air Canada is most likely to be sold to a single entity. The new owner is likely to exercise complete control over Air Canada. Because of this, Air Canada could rapidly become a very effective competitor, especially in a deregulated environment.

A second method for the sale of Air Canada would be a general sale or placement of stock. This, for example, is the method used for the recent sale of British Telecom. It is also the method that was used for the sale of Pacific Western Airlines in late 1983. Under this scenario the ownership of Air Canada is likely (but not necessarily), to be dispersed among a fairly large number of investors. In this case it is not assured that the new owners of Air Canada will exercise effective control over the carrier.

A third alternative for the privatization of Air Canada is to sell shares to the company's employees. Air Canada's management has actually recommended this option, at least in part. The management of Conrail in the U.S. has also advocated this in its privatization. There is quite a bit of precedent for the sale of company stock to employees. Several airlines in the United States have sold stock to their employees as a means to provide productivity incentives and to achieve wage and work rule concessions from labour. Examples are Eastern Airlines and Pan American. Some of the new airlines in the United States also have employee stock ownership. People Express requires a substantial ownership of its stock before one can become an employee of the airline.

It has been suggested that employee ownership of an air carrier can be a very effective means to achieve efficiency gains. Employees identify with management's goals and the activities of the company and strive to achieve excellence. In such an environment it is perhaps easier to obtain necessary work rule concessions. Furthermore, in many other high technology industries, such as electronics and computers, companies have substantial employee participation in the ownership of the company. It has been suggested that this leads to a stable work force and a highly motivated group of employees.

One major problem with sale of stock to employees is that such proposals often have at their core a share price significantly below the worth of the company. Further, in some proposals, such as a proposed employee takeover of Conrail, employee groups typically will pledge significant portions of the assets of the company as collateral to obtain the funds to purchase the stock. This can leave the carrier with a very high debt to equity ratio, which in turn could adversely affect operations and planning for many years.

A final method for privatization of the Crown air carrier involves various combinations of the above. We believe both sale to the highest single bidder, and sale of assets to employees offer the greatest potential for achieving efficiency gains. In the case of sale to the highest bidder, stockholders exercise effective control over the carrier and can quickly redirect its policy, if necessary. In the case of sale to employees, one is likely to obtain a very cooperative attitude with the work force in order to achieve gains such as innovation and changes in work rules.

The alternative of giving a share of Air Canada to all Canadians is very undesirable, given the impact this would have on the dominance of Air Canada in domestic markets. All Canadians would have an incentive, ceteris paribus, to ticket on <u>their</u> airline, Air Canada. A general placement of Air Canada stock to a wide group of investors would not increase the carrier's dominance, but it may be some time, if ever, before stockholders can take effective control of the carrier from management. A combination, such as a partial sale of stock to employees with the balance being placed with the highest bidder, seems attractive. In the absence of historical evidence, it is difficult to make definitive statements of the impacts various methods of privatization will have on the performance of the carrier.

<u>Alternate B: Privatization With Breakup</u> - In addition to privatizing Air Canada there have been arguments made regarding a breakup of the carrier with the pieces in turn being sold off. If the carrier were dismembered it would in turn require spinning off some of its important components, such as the maintenance base and the computer reservation system, RESERVEC so they would be available to all.

There are a number of arguments for breaking up Air Canada and they are wholly to do with the domestic market. First, in a recent article in the <u>Yale Journal on Regulation</u>, Elizabeth Bailey and John Panzar (1984) examined the effect of competition in U.S. airline markets since deregulation. Using evidence obtained from the United States Civil Aeronautics Board, they find that markets with actual competition achieved somewhat greater gains from deregulation than markets with only potential competition. This is in contrast with the economic theory of contestable markets, a theory which played an important role in the airline deregulation debate in the U.S., which suggests that actual competition in markets is not necessary. The threat of competition is sufficient to cause an incumbent carrier to behave in an economically efficient manner. Bailey and Panzar (1984) do not refute the contestable market theory as they indicate that even in markets with only one carrier, fares (and service offerings) do not exhibit monopoly levels, but rather, are only somewhat higher than comparable markets with actual competition. Hence the argument that with actual competition on all routes the benefits of deregulation will be increased.

A second argument for breakup is the effect that Air Canada's dominance of the market would have on the performance of a deregulated airline industry. Air Canada roughly has a 50% share of the domestic Canadian market. This large market share is a concern if it represents a substantial number of markets in which the carrier is a monopoly. It can also be a concern if it indicates that Air Canada has deeper financial pockets than its competitors and thus would be able to survive a long and protracted battle to achieve monopoly power.

Some observers of the Canadian airline industry suggest that Air Canada's dominance of the domestic market per se is no need for concern. Some will cite the contestable markets theory from economics claiming that the threat of entry into markets will force Air Canada to behave properly.

Others, such as former Minister of Transport Lloyd Axworthy, suggest that Air Canada's relatively high cost structure will give it a disadvantage in markets. He claimed that potential competitors could quickly drive Air Canada out from a market due to its high fares. This of course is premised on Air Canada not being able to draw on the Public Treasury to finance ongoing losses, assumes the airline is effectively prevented from engaging in predatory practices, and implicitly assumes Air Canada does not have lower costs.

The results of this study indicate there is some evidence that Air Canada's historical cost structure has been greater than that of other carriers. Simple measures of Air Canada's productivity are below those of CP Air. But, by controlling productivity for differences in the operating environment, particularly after controlling for CP Air's long stage length, Air Canada's productivity disadvantage, approximately 5%, is not as great as it might seem (see Gillen, Oum and Tretheway, 1985b). In particular, in the late 1970's Air Canada's performance has improved considerably.

There are a number of different ways in which Air Canada could be broken up. Some of the most commonly mentioned of these are briefly considered.

One potential breakup is to divide Air Canada into a domestic airline and an international airline.[2] While this would significantly reduce the size of Air Canada in an absolute sense, it does little to reduce the dominance of Air Canada in domestic markets. The only way there would be

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[2] ICAO reports that in 1983 Air Canada carried 7.1M passengers in domestic service versus 3 3 million in intercontinental services (including transborder). CP Air carried 2.3 million domestic passengers and 1.3 million intercontinental passengers.

such an effect is if there would be a greater tendency for passengers connecting from domestic to international flights to consider competitors for the domestic leg.

A second alternative would be to break Air Canada into perhaps two or three pieces. Each of these smaller carriers would have a set of regional routes. Each of these regional carriers in turn would receive rights, the necessary equipment and personnel to operate in transcontinental markets. This would give each of the regional carriers a competitive and efficient route structure in the sense that the regional carrier would be able to gather feed and take it on the long hauls. The two (or three) carriers would compete with each other and with CP Air and Wardair on transcontinental routes. Each of the new regional carriers would also be in competition with one or more of the existing regional carriers, and this seems to offer the greatest potential for reducing the dominance of Air Canada.

Gillen, Oum and Tretheway (1985a) undertook simulations of the efficiency consequences of altering the structure and status of Air Canada. Under a set of reasonable assumptions set out in Table 9-1, the costing model was simulated to determine the consequences of both privatizing and breaking up Air Canada. The changes for the industry, Air Canada, CP Air and the Regionals are set out in Table 9-2. Privatization without breakup leads to a direct efficiency gain for Air Canada of about 10% or $219 million, and gains from spillovers onto other sectors of the industry for an additional $20 million. If the carrier were broken up into two or three pieces the efficiency gains are less, approximately $181 million. The

Table 9-1

Variables Used in Air Canada Policy Simulations

	Privatization w/o Breakup	Privatization in Two Pieces (each piece)	Privatization in Three Pieces (each piece)
Output	no change	1/2	1/3
Output mix	no change	no change	no change
Points	10% reduction	60% of total	46% of total
Stage length	10% increase	no change	no change
Load factor	no change	no change	no change
Input prices (labour)	5% reduction*	5% reduction*	5% reduction*
Capital	25% reduction	37.5% of total	25% of total

*Other carriers also reduce labour input price by 5%.

Table 9-2

Cost Simulation Results for Alternative Air Canada Policies
(Regulatory Policy fixed at the May 10th, 1984 Policy)

	Industry	Air Canada	CP Air	Regionals
(a) Pre May 10th Air Canada Policy (status quo)				
Output	4443	2680	1236	527
passenger	74.3%	76.2%	73.3%	66.4%
freight	19.2%	21.2%	18.7%	10.6%
charter	6.5%	2.6%	8%	23%
capital cost	$445	$280	$110	$55
total cost	$3468	$2069	$783	$616
(b) May 10th Air Canada Policy				
Changes:				
capital stock		10% reduction	no change	no change
Results:				
total cost	$3404	$2004	$783	$616
(% change)	-1.8%	-3.1%	0%	0%
(c) Privatization without breakup				
Changes:				
output	no change	no change	no change	no change
points	-	10% reduction	-	-
stage length	-	10% increase	-	-
labour prices	5% reduction	5% reduction	5% reduction	5% reduction
capital stock		25% reduction	no change	no change
Results:				
total cost	$3229	$1850	$773	$606
(% change)	-6.9%	-10.6%	-1.3%	-1.6%

Table 9-2 (continued)

	Industry	Air Canada	CP Air	Regionals
(d.1) Privatization in two pieces				
Changes:				
output	no change	1/2 each piece	no change	no change
points		60% each piece	no change	no change
stage length	no change	no change	no change	no change
labour prices	5% reduction	5% reduction	5% reduction	5% reduction
capital stock		37.5% of total	no change	no change
Results:				
total cost	$3299	$1920	$773	$606
(% change)	-4.9%	-7.2%	-1.3%	-1.6%
(d.2) Privatization in three pieces				
Changes:				
output	no change	1/3 each piece	no change	no change
points		46% each piece	no change	no change
stage length	no change	no change	no change	no change
labour prices	5% reduction	5% reduction	5% reduction	5% reduction
capital stock		25% each piece	no change	no change
Results:				
total cost	$3287	$1908	$773	$606
(% change)	-5.3%	-7.8%	-1.3%	-1.6%

reason for a reduction in the efficiency gains is that the greater number of carriers cannot achieve the traffic density economies available.

Before closing this section it seems appropriate to ask whether Air Canada should be broken up if in the future it (as well as other Canadian carriers) will be flying in a North American market. If one believes Air Canada must remain intact if it is to survive in a free trade North American market, the implication is that the rest of the industry will not survive. If this is the case, serious and careful analysis should be done on the transborder issue.

In closing this section on potential breakups of Air Canada, it should be noted that there are in fact very few routes on which Air Canada enjoys a true monopoly. If one is concerned only with the monopoly power of the carrier in specific domestic markets (rather than the size of the carrier per se) then a breakup of Air Canada might be unnecessary. Perhaps a more effective solution would be to selectively spin off Air Canada's monopoly routes to existing or new air carriers. This of course simply transfers the monopoly on these routes from a large carrier, Air Canada, to a smaller air carrier. To alleviate this Air Canada could be given the option to reenter the routes (perhaps with a nine month lag) in competition with the carrier who had received the original award of the routes.

A variant of this was recently undertaken by the U.K. with respect to British Airways. After a lengthy review of air transport policy, the British decided to keep British Airways intact as a dominant air carrier. However, prior to doing this, they chose to transfer some routes between British Airways and a private competitor, British Caledonian. British

Caledonian received British Airways' profitible routes in the Middle East. British Airways acquired some unprofitable South American routes of British Caledonian. The intent of this was to strengthen British Airways' main competitor, British Caledonian, prior to privatization of British Airways.

CHAPTER X - CONCLUSIONS

This study set out to distinguish and measure the separate effects of government ownership and economic regulation upon the performance of the Canadian airline industry and the carriers within it. The results are due to an extensive two phase analytical modelling effort. Statistical work is supplemented with qualitative data to assess the impact of both direct and indirect ownership and regulatory effects. This approach, we believe, provides a set of quantitative results which are reasonably accurate.

The main findings are now summarized in point form.

A. Effect of Ownership on Economic Performance

- Allocative Efficiency. The analysis of allocative efficiency illustrates that during the study period, 1964-81, Air Canada's cost efficiency was lower than that of CP Air on average by about 15%. This occurred as a result of Air Canada carrying proportionally more excess capital stock than CP Air. This was in turn caused by the combination of Air Canada's lower capital input cost and imposed social services.

- Technical Efficiency. The analysis of technical efficiency compared the average residual cost indexes of the study period, 1964-81, between CP Air and Air Canada. The results indicate that inefficient use of the variable inputs (fuel, labour, and other purchased materials) was responsible for raising Air Canada's total cost further by approximately 2.9%.

- Wages. In section B of Chapter VII, after reviewing the historical facts on wage levels for Air Canada and PWA, it was concluded that privatization of Air Canada would reduce the industry's total long-run equilibrium wages by about 5%. This is equivalent to a saving of about 1.5% of the industry's total cost.

- Total Inefficiency. The combined effect of allocative and technical inefficiencies caused by Air Canada's Crown ownership is to raise Air Canada's total cost by about 17.9%. This is equivalent to about 10.5% of the industry's total cost. Adding the effect of wage rate reductions, crown ownership of Air Canada has increased the Canadian airline industry's total cost by about 12%, or equivalently $420 million based on the 1981 industry size (12% of the industry's total cost of $3.493 billion).

- Consumer Surplus. It is believed that the cost savings would be passed on to consumers, and thus the $420 million cost saving increases consumer welfare by the same amount. Because of the negatively sloped demand curve, an additional $26 million (the "triangular" area of consumer surplus changes) is added to the nation's welfare in the form of consumer surplus, making the total increase in consumer surplus $446 million. This assumes that all of the cost savings are passed on to consumers (see Chapter VII).

- Potential Gains. The previous findings are based on crown ownership inefficiencies averaged over 1964-81. The actual gains in the industry's cost efficiency are now likely to be less than 12%, because Air Canada has gradually adjusted toward deregulation and possible privatization since the New Air Canada Act of 1977. Cost simulation results in Gillen, Oum and Tretheway (1985a) indicate that the short-run effect of privatization would have been to improve the cost efficiency by 6.7% if Air Canada were privatized in 1981. Therefore, the long-run effect of Air Canada's privatization would have been to improve the cost efficiency in 1981 anywhere between 6.7% and 12%.

B. Effect of Regulation on Performance

(a) Effect of Regulatory Relaxation, 1977-81

- Total Gains 1977-81. In Chapter VI, section D, residual (or unexplained) cost analysis was employed to measure the effect of regulatory relaxations (which took place between 1977 and 1981) on the economic efficiency of the industry. The upper bound of the efficiency gain was 10.4% of the industry's total cost, or $364 million per year (based on 1981 industry costs) while the lower bound was 6.4%, or $222 million. The lower bound of 6.4% was used as the effect of regulatory relaxation between 1977 and 1981.

- Carrier Gains. The regulatory relaxation improved the economic efficiency of each carrier as follows:

Carrier	Upper Bound	Lower Bound
Air Canada	11.4%	7.3%
CP Air	8.4%	5.4%
PWA	6.6%	4.1%
Nordair	4.1%	2.4%
EPA	2.2%	-0.5%

The magnitude of the efficiency improvement is related roughly to the size of the carrier. This is because regulatory relaxation without entry freedom for new carriers exerts greater pressure on routes with multiple carriers. These are served, by and large, by the larger carriers. Much of Air Canada's efficiency gain came in the form of a reduction of excess capacity (i.e. capital input) while the major portion of CP Air's efficiency gain resulted from more efficient use of its variable inputs (see Table 6-2 for details).

(b) Effect of a U.S. Style Deregulation

- Labour Price. The study was unable to detect any significant reduction in labour input price arising from the regulatory reforms which took place between 1977 and 1981. However, we speculate that under a U.S. style deregulation, where entry into industry and city pair markets is completely free, the long run equilibrium price of labour input could decrease as much as 20% (see Chapter VIII, Section B). This amounts to about 6% of total industry cost.

- Total Inefficiency 1964-81. Chapter VI, Section B identifies the effect of regulation is to increase total cost by about 7% for Air Canada and CP Air and by about 17% for the regional carriers (the extra 10% was caused by the Regional Carrier Policy). The weighted average is about 9% of the industry's total cost. Again this 9% cost inefficiency was caused mainly by the excess capital stock the carriers were induced to use in a regulated environment. This and the reduction in labour input price together puts the cost inefficiency caused by regulation at about 15%. This 15% is the average figure for the entire study period 1964-81.

- Regional Carrier Policy. The Regional Carrier Policy has led the regional carriers to produce an economically inefficient mix of scheduled and charter services, and also prevented them from taking advantage of the unexploited economies of density and of stage length. As a result, the policy led to a significant loss in the industry's cost efficiency.

- 1981 Inefficiency. Therefore, the cost inefficiency caused by the regulations existing as of 1981 is about 8.6% of the total cost. Although this does not include the further efficiency gains by input substitutions, adjustments of network configurations, etc., it is very close to the cost simulation results of 8.8% obtained in Gillen, Oum and Tretheway (1985a). The simulation exercise reported in Chapter VII, Section E illustrates that a U.S. style deregulation would have resulted in about 8.8% savings in the industry's total cost. This is equivalent to a saving of $307 million based on the 1981 total cost of the industry. An additional welfare gain of $11 million is expected if cost savings lead to price reductions (see Chapter VIII). This total saving includes the effects of a reduction in labour input prices by 20%, elimination of excess capital stocks, network readjustment and rationalization of output mix (especially scheduled - charter service mix).

- Potential Gains. Since 1981 the carriers have moved to improve cost efficiency. Therefore, additional gains in cost efficiency from further moves toward deregulation are likely to be somewhat less than 8.8%.

C. Effect of Ownership on Regulation

Section E of Chapter II, concluded that because the Crown carrier was used in a significant way as a policy instrument by the federal government, economic regulation had to be designed to complement it. Hence, regulations would have been different had there not been a publicly owned Air Canada. Evidence which illustrate the Crown carrier's effects on regulation include:

- Automatic route awards for Air Canada under the Air Canada contracts until the 1977 New Air Canada Act.
- Capacity restrictions on CP Air's transcontinental routes until 1979.
- Regional Carrier Policy until May 10, 1984.
- The reluctance to expand discount fares in the late 1970's.

Crown ownership of Air Canada has influenced in a significant way the regulatory structure and practices in Canada, and thus contributed to an increase in concentration of the industry and of specific markets.

D. Effects of Regulatory Policy and Ownership on Industry and Markets

- Since charter services are a by-product of regulation, most of them are likely to be replaced by low fare scheduled services. A wider spectrum of price-quality choices would be available in the market place.

- As the Regional carriers s participate more vigorously in dense medium-distance routes, they are likely to reduce charter services, moving their traffic mix closer to the economically efficient mix between scheduled and charter.

- Carriers are expected to restructure their network and operations towards a hub-and-spoke configuration as they attempt to increase frequency of service for business travellers.

- Close links between large carriers and third level carriers are likely to emerge as carriers try to establish traffic feeds or connecting traffic as they hand over routes not suited to jets.

E. Ownership vs. Other Instruments

- From a review of Canadian railroads, and the air carriers in Canada, U.S., and Australia, it was concluded in Chapter VIII, Section B that the public and privately owned transportation carriers have responded to the changes in operating and competitive environments in a remarkably similar manner. This implies that what is important for inducing an industry to be efficient is its competitive environment (i.e. regulatory relaxation or deregulation). The form of ownership has less impact on economic efficiency than the competitive environment.

- Through an examination of the historical records of Air Canada and CP Air in fulfilling non-economic social goals such as service to isolated communities, maintenance of employment etc., we were generally unable to detect a sufficient difference between the crown owned Air Canada and the privately owned CP Air. This implies that non-economic goals can be achieved by private carriers as well as by the crown owned Air Canada. Regulation (perhaps with subsidy) appears to be sufficient to achieve any non-economic goals while public ownership is neither necessary nor sufficient to guarantee fulfillment of non-economic social goals.

- Although regulation is sufficient to achieve non-economic social goals, it comes with a high price in terms of economic efficiency as discussed throughout this report. A more efficient but less politically palatable alternative is to use the instrument of direct subsidy.

F. Alternative Methods of Changing Ownership

Chapter IX reviewed two alternatives to the Air Canada question: Privatization Without Breakup, and Privatization With Breakup. It also discussed alternative methods of privatization and of breakup. Conclusions are:

- The form of ownership is not as important as regulation in inducing the industry to become economically efficient.

- The most attractive method of privatization appears to be a combination of sale to the highest single bidder with a partial sale of stock to employees. This method is preferred to all other methods reviewed in Chapter VIII, because a single bidder would be able to exert control over the carrier's management to make effective adjustments to the changing regulatory and market conditions while some employee ownership would increase the cooperative spirit of the owner-employees and boost employee morale.

- Various methods of breaking up Air Canada were considered in Chapter IX, Section B. If a break up is considered necessary to reduce Air Canada's market dominance, and thus reduce the perceived barrier to potential entrants, it appears Air Canada can effectively be broken up into two or three pieces, each of which has a set of regional routes connected by transcontinental routes.

Appendix A

Analytical Methodology: Productivity and Cost Analysis

This appendix gives technical details of the Total Factor Productivity and Cost Function Analysis. This discussion is confined to the salient points for this study. A more complete description is found in Gillen, Oum and Tretheway (1985b).

A. Total Factor Productivity

In measuring the total factor productivity (TFP), we adopted the following methodology proposed by Caves, Christensen and Diewert (1982) (henceforth CCD).[1] This method is designed to compute TFP using a panel data (time-series data for cross-sections of firms) such as ours.

$$\begin{aligned} \ln (TFP_k/TFP_m) = & \frac{1}{2} \Sigma(R_i^k + \bar{R}_i)(\ln Y_i^k - \overline{\ln Y_i}) \\ & - \frac{1}{2} \Sigma(R_i^m + \bar{R}_i)(\ln Y_i^m - \overline{\ln Y_i}) \\ & - \frac{1}{2} \Sigma(S_n^k + \bar{S}_n)(\ln X_n^k - \overline{\ln X_n}) \\ & + \frac{1}{2} \Sigma(S_n^m + \bar{S}_n)(\ln X_n^m - \overline{\ln X_n}) \end{aligned} \quad (A.1)$$

where $\bar{R}$ is the revenue share for output i averaged over all firms and time periods, $\overline{S_n}$ is the average cost share for input n, $\overline{\ln Y_i}$ is the average of the log of output i, and $\overline{\ln X_n}$ is the average of the log of input n. Equa-

[1] The advantages of this procedure over other methods are available in Gillen, Oum and Tretheway (1985b), pp. 63-65.

tion (A.1) uses revenue shares in the construction of the TFP index. All bilateral comparisons based on equation (A.1) are both base-firm and base-year invariant.

Equation (A.1) can be derived directly from a translog transformation structure by taking the difference between each firm's transformation function and the function resulting from averaging arithmetically the transformation functions across all observations. This procedure, in effect, uses the geometric average level of productivity as the norm.

The alternative approach is to define growth in TFP as a total increase in productivity. This will include the pure cost function shift effect of the CCS study, as well as efficiencies due to exploitation of economies of scale and from changes in deviations from marginal cost pricing principles. This is the "revenue share" concept of TFP employed by Denny, Fuss and Waverman (1981). The latter authors decompose changes in this concept of TFP into three components: pure shifts, scale effects and pricing effects. We could generalize this to include effects from differences in network or operating factors, such as stage length. In order to perform such decompositions one must, of course, obtain appropriate cost elasticities.

In our approach to TFP measurement, we did not want to presuppose cost elasticities. Thus, we have measured TFP using revenue shares; i.e., using the Denny, Fuss and Waverman concept of TFP. One can use the estimated cost elasticities to decompose total TFP into its components, including pure cost function shifts.

B. Analysis of Differences in TFP Among Air Carriers

In order to analyze the differences in TFP among carriers we adopted an approach of Caves, Christensen and Tretheway (1981) (henceforth CCT) to TFP decomposition. They regressed using a log-linear function, TFP on a number of factors, including output and network variables, to decompose TFP differences into a number of sources. However. a log-linear TFP function is dual to a log-linear neoclassical cost function which is very restrictive in that it imbeds the condition of homothetic weak separability in substitution possibilities between inputs. This implies straight-line expansion paths. and thus input cost shares remain constant when outputs are changed while keeping input prices unchanged.

In Table A-1 we present several TFP regressions. Column 1 regresses the natural log of TFP on a constant and a set of annual dummy variables. The dummy variable coefficients represent average levels of TFP in each year.[2] From this we see that TFP grew at an average rate of 4.1% per year during the 1964-1981 time period.[3] We also observe the negative rates of growth of TFP in each of 1979, 1980, and 1981. In column 3 we regressed the log of TFP on firm dummies to reveal an average 1964-1981 TFP level for each firm. These dummies reveal deviations of each firm's TFP level relative to that of Air Canada.

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[2] The dummy coefficients represent deviations of TFP, averaged over all carriers. from the 1971 level of TFP. Note that this cannot be construed as a measure of industry TFP. The latter would be constructed by weighting TFP for each carrier by its shares in industry total cost. In contrast, the dummy variables are formed by unweighted averages of firm's TFP levels.

[3] 4.1% = 100*[.226 - (-.467)]/17 years.

Table A-1

LOG-LINEAR REGRESSION EQUATIONS OF TFP INDEX
(T-statistics in parenthesis)

Variable	(1)	(2)	(3)	(4)	(5)
Constant	-.392	-1.713	-.09	-.709	-1.102
	(3.37)	(2.06)	(-1.30)	(.410)	(.64)
Output Index	-	.1411	-	.259	.321
	-	(7.29)	-	(3.30)	(4.38)
Points Served	-	-.0919	-	- .139	- 223
	-	(2.39)	-	(2.10)	(3.48)
Load Factor	-	-.0460	-	-.0308	.0131
	-	(1.32)	-	(.66)	(.28)
Average Stage Length	-	.262	-	.183	.1197
	-	(10.27)	-	(2.22)	1.55)
Freight Share	-	-.063	-	-.0402	.0045
	-	(2.07)	-	(.63)	(.08)
Charter Share	-	.080	-	.0316	.0349
	-	(7.93)	-	(2.01)	(2.30)
Capital Stock	-	-	-	-	-.132
	-	-	-	-	(3.42)
Dummy-CP	-	-	.108	.211	.0114
	-	-	(1.06)	(1.98)	(.114)
Dummy-PW	-	-	-.271	.467	.137
	-	-	(-2.65)	(1.79)	(.61)
Dummy-QA	-	-	-.541	.472	.0238
	-	-	(-5.31)	(1.28)	(.07)
Dummy-EP	-	-	-.649	.389	-.0485
	-	-	(-6.37)	(1.20)	(.17)
Dummy-TA	-	-	-.407	.507	.131
	-	-	(-3.87)	(1.38)	(.41)
Dummy-NA	-	-	.009	.523	.157
	-	-	(.078)	(1.96)	(.69)

Dependent Variable: Natural log of TFP level.

Freight and charter shares are in terms of revenue-tonne-kilometers (RTK).

Capital Stock is beginning balance of the capital stock.

Table A-1 (cont'd)

Variable	(1)	(2)	(3)	(4)	(5)
Dummy 1964	-.467 (2.72)	-.172 (3.55)		-.0604 (.61)	-.129 (1.45)
Dummy 1965	-.421 (2.45)	-.150 (2.15)		-.0523 (.52)	-.153 (1.60)
Dummy 1966	-.410 (2.39)	-.140 (3.0)		-.0615 (.79)	-.166 (2.26)
Dummy 1967	-.396 (2.31)	-.0942 (1.53)		.0482 (.54)	-.156 (1.86)
Dummy 1968	-.306 (1.78)	- 0745 (2.03)		-.0284 (.49)	-.126 (1.89)
Dummy 1969	-.108 (.63)	- 0353 (.75)		.162 (.34)	-.0541 (1.20)
Dummy 1970	-.0892 (.52)	-.0564 (2.14)		-.0443 (1.76)	-.0640 (1.71)
Dummy 1971	- -	- -		- -	- -
Dummy 1972	.0808 (.49)	.0686 (2.88)		.0497 (2.33)	.0102 (.34)
Dummy 1973	.182 (1.10)	.143 (3.97)		.103 (2.52)	.0691 (1.73)
Dummy 1974	.175 (1.06)	.0858 (3.31)		.0381 (1.17)	.0458 (1.05)
Dummy 1975	.226 (1.37)	.105 (1.71)		.0471 (1.08)	.0834 (1.96)
Dummy 1976	.268 (1.63)	.1179 (3.97)		.0683 (1.67)	.1054 (2.50)
Dummy 1977	.339 (2.06)	.166 (4.73)		.1068 (2.27)	.128 (2.80)
Dummy 1978	.376 (2.28)	.199 (6.62)		.131 (2.53)	.145 (2.92)
Dummy 1979	.351 (2.31)	.188 (4.00)		.111 (1.86)	.123 (2.31)
Dummy 1980	.334 (1.95)	.168 (4.48)		.0737 (1.20)	.0985 (1.71)
Dummy 1981	.226 (1.32)	.0716 (.90)		-.0199 (.22)	.0483 (.66)

In column 2 we regress the log of TFP on annual dummies and 6 other regressors representing various attributes of output and network. The coefficient on aggregate output is positive and significant indicating the presence of economies of density of 1.16.[4] The coefficient on points is of the correct sign, negative, and is significant, i.e., TFP is lower when the same level of output is served in a larger network of cities. Combining coefficients on output and points reveals very small economies of scale, 1.05. Stage length and share of charter services are both correct in sign and significant. Load factor is insignificant, small, and has the wrong sign. Freight share is small, has an incorrect sign and is borderline significant.

The coefficients in column 2 may be biased if there are omitted variables, perhaps representing some unmeasured aspect of output quality or service network. Mundlak (1961, 1978) has shown that if the omitted variables are constant over time for a given firm, then unbiased estimates can be obtained by adding a set of air carrier dummy variables to the regression. In column 4 we report such a regression. Three of the six dummy variables are borderline significant; the others insignificant. Interestingly, all dummies are positive. This indicates that after controlling for the effects of stage length, output, load factor, etc., all air carriers

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[4] We distinguish between economies of density and scale. The latter occurs when output growth is due to expansion of the network, as represented by number of points served by an air carrier. Density economies result if unit cost falls when output growth is within a network - the number of points being held constant. Returns to density are measured as $1/\varepsilon_y$, where ε_y is elasticity of cost with respect to output: $\varepsilon_y = 1-\beta_y$, β_y is TFP regression coefficient on out- put. Economies of scale are $1/(\varepsilon_y + \varepsilon_p)$; $\varepsilon_p = -\beta_p$ where . epresents points served.

have a higher level of productivity, on average, than Air Canada. Addition of the firm dummies has not corrected the signs on load factor or freight share. Economies of density are 1.35 (= 1/(1-.259) while the economies of scale are 1.136 (= 1/(1-.259 + .139).

The regressions in columns 2 and 4 correspond to log-linear neo-classical total cost functions.[5] Such functions assume that firms are employing optimal levels of all inputs. We investigated the possibility that air carriers may be out of equilibrium with respect to the two capital inputs by adding the level of capital stock to the regression in column 5. Capital has a negative (and significant) sign indicating carriers, on average, had excess capital. Since the regression in column 5 does not

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[5] Note that a log linear single output neo-classical total cost function can be written as

$$\ln C = \alpha_0 + \sum_t \alpha_t + \sum_i^n \varepsilon_i^W \ln W_i + \varepsilon^Y \ln Y + \sum_i^q \varepsilon_i^q \ln q_i$$

where ln represents natural logs, C is total cost, α_t are time shifts, ε_i are elasticities of cost with respect to input prices (W_i), output (Y) or network variables (q_i), as appropriate. If firms are profit maximizers and price takers in input markets, then ε_i^W will equal the input cost share. Moving $\sum_i^n \varepsilon_i^W \ln W_i$ to the left hand side of the above equation and using cost shares for ε_i^W gives us the log of total cost minus the log of an index of input prices. This is the log of an index of real input. By subtracting the log of output from each side of the equation above, we obtain

$$\ln C - \sum_i^n \varepsilon_i^W \ln W_i - \ln Y = \ln I - \ln Y$$

$$= - \ln TFP$$

$$= \alpha_0 + \sum_t \alpha_T + \sum_i^q \varepsilon_i^q \ln q_i + (\varepsilon^Y - 1) \ln Y$$

exactly correspond to a neo-classical variable cost function, we are unable to properly measure returns to scale and density from it.[6] Nevertheless, all coefficients are of the correct sign and of reasonable magnitudes. Interestingly, all of the firm dummies are insignificant and much smaller in magnitude; EPA's is negative. This indicates that after controlling for the operating factors such as output, stage length, etc., and also for excess capacity, Air Canada's TFP level is not significantly different from those of the other carriers. This suggests that the crown carrier's poor productivity, as revealed in column 4, is largely explained by excess capacity. Examining the annual dummies in column 3, we observe an average of 1.4% per year (1964-1981) TFP growth that is not explained by density economies, stage length, etc.

C. Cost Analysis Methodology[7]

The starting point of our specification of a multiple-output total cost function is as follows:

$$C = C\ (Y_1,\ Y_2,\ \ldots\ Y_m,\ W^*) \qquad (A.2)$$

where

C = total input costs,

Y_i = output of class i, $i=1,2,\ldots,m$,

W^* = $[W^*_1,\ W^*_2,\ldots,W^*_n]$

W^*_i = $W_i \exp(\alpha_i t)$ (price of input i adjusted for technological changes over time),

[6] See Mundlak (1961) for a discussion of this potential bias. Mundlak (1978) discusses alternative estimators that might be used.

[7] Readers are directed to Gillen, Oum and Tretheway (1985b) for a complete discussion of the cost analysis.

W_i = observed price of input $\underline{i}$,

t = time variable indicating the year.

We must modify this general specification to account for the impact on cost of technological and market conditions, conditions which vary over time and between carriers. We do this by replacing the Y_i's in equation (A.2) by "hedonic output functions", $\phi_i(Y_i, q_i)$ where q_i is a vector of network and market variables or "attributes" describing the nature of the i^{th} output class. Our cost function specification thus takes the following form:

$$C = C\ [\ \phi_1\ (Y_1, q_1), \phi_2\ (Y_2, q_2)\ \ldots, \phi_m\ (Y_m, q_m), W^*] \qquad (A.3)$$

In addition to hedonic output functions we explicitly introduce a measure of the size of the network a carrier provides services in. Caves, Christensen and Tretheway (1983) discuss the need of a model with two measures of an airline's size--the magnitude of passenger and freight transportation services provided and the size of the carrier's service network. This allows one to make the crucial distinction between returns to density (the variation in unit costs for a network of given size) and returns to scale (the variation in unit costs with respect to proportional changes in both network size and the provision of transportation services). As our measure of network size we follow the convention of Caves, Christensen and Tretheway (1983) and use the number of points (airports) served.[8]

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[8] We recognize that a carrier's network cannot be completely described by the number of airports it serves. It requires a number of variables to accurately describe the network as it relates to the carrier's cost. However, we believe that the number of airports served is the single most important variable for explaining the effect of network on cost. For this reason, we used this variable as a proxy to identify network effect on cost. given the need to conserve number of parameter estimates.

To estimate the airline cost function we will be using a panel data set, i.e., a cross section of airlines tracked through several time periods. The use of a panel allows one to specify intercept shifts for each firm. The inclusion of such shift factors (binary or dummy variables) precludes bias in the coefficients of included explanatory variables that might arise due to ommission of unmeasurable variables that vary by firm but are constant over time for a given firm.[9] We refer to such firm shift factors as "firm effects". Thus, the general form of the cost function, including firm effects (F), number of points served (P), and hedonic output functions is:

$$C = C\,[F,\ P,\ \phi_1\ (Y_1,\ q_1)\ \ldots\ \phi_m\ (Y_m,\ q_m),\ W^*]. \qquad \text{(A.4)}$$

For estimation purposes the cost function (A.4) and embedded hedonic output functions must be given specific forms. We have chosen the translog form for the cost function.

$$\begin{aligned} \ln C(F,P,\phi,W,t) = {} & a_o + \sum_k f_k D_k + a_p \ln P + \sum_i^m a_i \ln \phi_i \qquad \text{(A.5)} \\ & + \sum_i^n b_i \ln W_i^* + \frac{1}{2} \sum_i^m \sum_j^m a_{ij} \ln \phi_i \ln \phi_j \\ & + \frac{1}{2} \sum_i^n \sum_j^n b_{ij} \ln W_i^* \ln W_j^* + \frac{1}{2} c_{pp} (\ln P)^2 \\ & + \sum_i^m d_i \ln \phi_i \ln P \\ & + \sum_j^n e_j \ln W_j^* \ln P + \sum_i^n \sum_j^m g_{ij} \ln W_i^* \ln \phi_j \end{aligned}$$

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[9] See Caves, Christensen and Tretheway (1980) for arguments as to its attractive qualities.

where

C is total costs

P is the number of points served

D_k is the dummy variable for firm k

W_i^* is the adjusted price of input i

t is the time trend variable

f_k is a the "firm effect" coefficient associated with firm dummy variable D_k

a_o,a_i's, a_{ij}'s, b_i's, b_{ij}'s, c_{pp}, d_i's, e's and g_{ij}'s are the parameters of the translog function, and

$a_{ij} = a_{ji}$, $b_{ij} = b_{ji}$ for all i and j.

We believe the airline production technology has changed over time in such a way as to affect productivity of each input differently from those of other inputs. For example, the introduction of fuel efficient aircraft from the mid 1970s has increased fuel productivity at the expense of capital productivity. Airline employees worked progressively fewer number of hours per year while our data captures only average number of employees and its average annual compensation. Since airlines derive progressively lesser number of hours per employee, ceteris paribus, an employee's service in an earlier year is worth more than that in a later year. In order to reflect these differential impacts on the inputs and in the interest of reducing the number of parameters to estimate, therefore, we specify technical change in the following non-neutrally input-augmenting form:

$$W_i^* = W_i e^{\alpha_i t} \quad \text{(A.6)}$$

where W_i is the price of input i, and the α_i's are the parameters of factor price adjustment function representing non-neutral technical change over time, t.

A log-linear specification of the hedonic output functions is used:

$$\phi_i = Y_i^{\gamma_i} \cdot \prod_{\ell=1} q_{i\ell}^{\beta_{i\ell}} \tag{A.7}$$

where $q_{i\ell}$ is the ℓ^{th} attribute of output i, Y_i is the observed output i, and the $\beta_{i\ell}$'s are the parameters of the hedonic output function for output class i. This log-linear specification is consistent with the exact interpretation of the translog function as the multi-product cost function. Blackorby, Primont and Russell (1977) and Denny and Fuss (1977) have shown that if the overall cost or production function has a translog form, then the micro-aggregators imbedded in the translog function must be log-linear.[10] Since the parameters of the ϕ_i's are unknown, we imbed the hedonic functions themselves into the macro translog function and estimate the parameters of both the cost function and the hedonic functions simultaneously.

A cost function must be linearly homogeneous in the input prices, implying the following restrictions which we impose on the translog cost function:

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[10] Blackorby, Primont and Russel (1977) point out that a consistent specification requires Cobb Douglas aggregator functions in translog cost functions.

$$\sum_{j}^{n} b_j = 1, \quad \sum_{j}^{n} b_{ij} = 0, \quad \sum_{j}^{n} e_j = 0, \qquad \text{(A.8)}$$

$$\sum_{i}^{n} g_{ij} = 0 \qquad i=1,\ldots,m$$

We take the logs of equations (A.6) and (A.7), substitute them into equation (A.5) and impose the restrictions (A.8) to obtain the final form of the estimating equation for the cost function.

Shephard's (1953) lemma implies that the share of input $\underline{i}$ in total cost (S_i) can be equated to the logarithmic partial derivatives of the cost function with respect to the $\underline{i}^{th}$ input price:

$$S_i = \frac{\partial \ln C(\cdot)}{\partial \ln W_i^*} = b_i + e_i \ln P + \sum_{j}^{n} b_{ij} \ln W_j^* + \sum_{j}^{m} g_{ij} \ln \phi_j \qquad \text{(A.9)}$$

It has become standard practice to specify classical disturbances for equations (A.5) and (A.9) and to estimate the parameters of the cost function by treating (A.5) and (A.9) as a multivariate regression. We follow this procedure iterating Zellners's (1962) technique for estimation to obtain maximum likelihood estimates.[11] To overcome the problem of singularity of the contemporaneous covariance matrix, we delete one of the share equations in estimation. The resulting maximum likelihood estimates are invariant to which equation is deleted.[12]

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[11] See Oberhoffer and Kmenta (1974).

[12] See Barten (1969).

Utilizing the result of Uzawa (1962) and Allen (1938, pp. 502-509) the Allen partial elasticity of substitution (σ_{ij}), the compensated price elasticity of input demand (E_{ij}), and the Marshallian (ordinary) price elasticity of demand (F_{ij}) can be computed as follows:

$$\sigma_{ij} = \frac{b_{ij}}{S_i S_j} + 1 \tag{A.10}$$

$$E_{ij} = \frac{b_{ij} + S_i S_j}{S_i} \quad \text{for } i \neq j \tag{A.11}$$

$$F_{ij} = E_{ij} + \eta S_j \tag{A.12}$$

where η is the own price elasticity of demand for the aggregate airline output. In view of the results obtained by Oum and Gillen (1983), we use $\eta = -1.1$.

C.1 Measurement of Economies of Scale, Density and Scope

Two of the most interesting and debated features of the airline cost structure are measures of scale economies and economies of multiple outputs (so called economies of scope). Panzar and Willig (1977, theorem 2) have shown that local ray returns to scale can be measured as

$$RTS = \left[\sum_{i}^{m} \frac{\partial \ln C}{\partial \ln Y_i}\right]^{-1} \tag{A.13}$$

"S" indicates increasing returns (>1), constant returns (=1) and decreasing returns (<1) of scale.[13] Caves, Christensen and Tretheway (1983) point out that growth in output is ambiguous in transport industries such as airlines. In particular, output growth <u>within</u> an existing network (economies of output density) is likely to have a different impact on costs than output growth due to expanding the size of the network (economies of scale). The inclusion of the network size variable, points served, in the cost function along with outputs permits us to distinguish between returns to scale and returns to density in airline operations.

We adopt the approach of Caves, Christensen and Tretheway and define returns to density as reciprocal of the proportional increase in total cost with respect to the proportional increase in physical outputs, with points served, output attributes and input prices held constant. This is equivalent to

$$RTD = \left[\sum_{i}^{m} \frac{\partial \ln C}{\partial \ln Y_i}\right]^{-1} \qquad (A.14)$$

Returns to density exist if unit costs fall as an airline adds flights to airports which it already serves and the new flight cause no change in output attributes.

We define returns to scale as the reciprocal of the proportional increase in total cost with respect to the proportional increase in outputs <u>and</u> points served made possible by a proportional increase in all inputs with output attributes and input prices held constant. This is equivalent to:

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[13] This is the reciprocal of Baumol's (1977) characterization of strictly increasing, constant and declining ray average costs.

$$RTS = \left[\frac{\partial \ln C}{\partial \ln P} + \sum_{i}^{m} \frac{\partial \ln C}{\partial \ln Y_i} \right]^{-1} \quad (A.15)$$

Returns are said to be increasing, constant, or decreasing as RTS (or RTD, as appropriate) is greater than. equal to or less than unity. Returns to scale exist if unit costs decline as an airline adds flight to an airport it had not been serving, and the additional flights cause no change in output per point (i.e., density) or output attributes. In order to identify the cost relationship between pairs of outputs, we evaluate the following second-order derivatives of each data point:

$$\frac{\partial^2 C}{\partial \phi_i \partial \phi_j} = \frac{C}{\phi_i \phi_j} \left[a_{ij} + (a_i + \sum_{\ell}^{m} a_{i\ell} \, \ell n \phi_\ell + \sum_{k}^{n} g_{ki} \, \ell n W_k^*) \right.$$

$$\left. \cdot (a_j + \sum_{\ell}^{m} a_{j\ell} \, \ell n \phi_\ell + \sum_{k}^{n} g_{kj} \, \ell n W_k^*) \right] \quad (A.16)$$

The right hand side of equation (A.16) is the expression for this derivative when using the translog total cost function, equation (A.5). If this derivative is negative. then cost complementarity exists between outputs i and j.

The expression (A.16) depends upon the data. We can scale the data such that the point of approximation becomes $\phi_i = W_j = 1$ for all i=1, m and j = 1, n. The cost complementarity of the point of approximation then becomes:

$$\left.\frac{\partial^2 C}{\partial \phi_i \, \partial \phi_j}\right|_{\phi_i = W_j = 1} = a_i a_j + a_{ij} < 0.$$

We can now impose $a_i a_j + a_{ij} = 0$ on the cost function and test for the lack of cost complementarity, i.e., cost independence between outputs at the point of approximation.

C.2 Total Cost Function Results

The cost function and input share equations were jointly estimated using 117 observations (7 firms for 1964-1981). There are 41 parameters to be estimated in the general model of cost. Seventeen of these parameters are identified in the input share equations. We have normalized our data around the 1980 CP Air observation. This normalization allows us to interpret the first order coefficient as the cost elasticities for CP Air in 1980.

The general translog total cost models with hedonic output specification were estimated with the data normalized around the 1980 CP Air data point. The empirical results using the translog function are contained in Table A-2. The difference between the two specifications in the table is again the inclusion or exclusion of firm specific dummy variables. The argument for including the firm dummies in a panel data set (i.e., time-series data for a cross-section of firms) is to capture significant differences between firms not explicitly included in our model. Failure to include them could bias some coefficients because of correlation between the included and excluded variables.

Table A-2

TRANSLOG TOTAL COST REGRESSIONS
Normalized at the 1980 CP Air Data Points

(T-Statistics in parenthesis)

Coefficient	Variable	Model (a) (firm dummies included)	Model (b) (firm dummies not included)
a_0	Intercept	18.02 (46.1)	17.42 (339.8)
b_L	Labour Price	.16 (4.7)	.18 (4.9)
b_F	Fuel Price	.04 (2.3)	.05 (3.0)
b_{KM}	Capital/ Materials Price	.80 (19.2)	.77 (18.2)
a_1	Passenger	.10 (.7)	.82 (9.6)
a_2	Freight	-.04 (.38)	-.02 (.28)
a_3	Charter	.10 (1.6)	.07 (2.7)
a_P	Points Served	.23 (.6)	.16 (1.1)
β_{12}	Stage Length	-2.84 (3.3)	-.26 (4.1)
α_L	Technology- Labour	.01 (.5)	-.03 (4.4)
α_F	Technology-Fuel	.08 (4.3)	-.02 (2.2)
α_{KM}	Technology- Capital/Materials	.07 (5.3)	-.01 (1.5)

(continued)

Table A-2 (cont'd)

Coefficient	Variable	Model (a) (firm dummies included)	Model (b) (firm dummies not included)
f_{AC}	Dummy-Air Canada	.49 (1.2)	-
f_{PW}	Dummy-PWA	-1.62 (3.6)	-
f_{TA}	Dummy-Transair	-1.80 (3.3)	-
f_{QA}	Dummy-Quebecair	-1.85 (2.9)	-
f_{EP}	Dummy-EPA	-1.94 (3.6)	-
f_{NA}	Dummy-Nordair	-1.96 (4.1)	-
a_{11}	Passenger-Passenger	-.04 (.7)	.08 (1.0)
a_{22}	Freight-Freight	-.06 (1.1)	.02 (.5)
a_{33}	Charter-Charter	.01 (.6)	.06 (5.7)
a_{12}	Passenger-Freight	-.07 (1.1)	.02 (.3)
a_{13}	Passenger-Charter	.04 (1.2)	-.01 (.3)
a_{23}	Freight-Charter	-.01 (.5)	-.05 (3.7)
b_{LL}	Labour-Labour	.12 (4.0)	.15 (4.4)
b_{FF}	Fuel-Fuel	.12 (12.8)	.12 (13.7)
$b_{KM,KM}$	Capital/Mtl.-Capital/Mtl.	.25 (7.0)	.23 (6.4)

Table A-2 (cont'd)

Coefficient	Variable	Model (a) (firm dummies included)	Model (b) (firm dummies not included)
b_{LF}	Labour-Fuel	.01 (.9)	-.02 (1.3)
$b_{L,KM}$	Labour-Capital/Mtl.	-.13 (4.2)	-.13 (3.9)
$b_{F,KM}$	Fuel-Capital/Mtl.	-.13 (9.4)	-.11 (7.7)
c_{pp}	Points-points	-.19 (.4)	.02 (.7)
d_1	Points-Passenger	.38 (2.8)	.17 (2.3)
d_2	Points-Freight	.04 (.2)	-.12 (1.4)
d_3	Points-Charter	.10 (1.1)	-.04 (1.1)
e_L	Points-Labour	-.00 (.1)	.04 (2.9)
e_F	Points-Fuel	-.00 (.1)	-.02 (3.2)
e_{KM}	Points-Capital/Mtl.	.00 (.1)	.02 (1.1)
g_{L1}	Labour-Passenger	.02 (2.7)	-.01 (4.9)
g_{L2}	Labour-Freight	.01 (1.2)	.00 (.7)
g_{L3}	Labour-Charter	-.01 (3.2)	-.01 (4.2)
g_{F1}	Fuel-Passenger	-.01 (2.4)	.01 (1.4)
g_{F2}	Fuel-Freight	-.00 (1.2)	-.00 (1.4)
g_{F3}	Fuel-Charter	.01 (4.6)	.01 (6.9)

Table A-2 (cont'd)

Coefficient	Variable	Model (a) (firm dummies included)	Model (b) (firm dummies not included)
$g_{KM,1}$	Capital/Mtl.-Passenger	-.01 (1.8)	.00 (.3)
$g_{KM,2}$	Capital/Mtl.-Freight	-.00 (.7)	-.00 (.0)
$g_{KM,3}$	Capital/Mtl.-Charter	.00 (.4)	.00 (.1)
RTD	Returns to Density	6.12 (4.8)	1.14 (2.0)
RTS	Returns to Scale	2.55 (1.8)	.96 (.4)
COMP12	Complimentarity: Passenger-Freight	-.03 (.3)	-.07 (1.3)
COMP13	Complimentarity: Passenger-Charter	.05 (1.5)	.06 (1.7)
COMP23	Complimentarity: Freight-Charter	-.02 (.5)	-.05 (3.7)

Our translog specification in model (b) includes as network variables the number of points served, average stage length of scheduled services, as well as the three output measures. In the translog models of Table A-2 we allow second order effects of these variables with respect to cost. In Table A-2, the Air Canada dummy is insignificant. This result provides some support for the idea that the variations in the observed network and output variables across the carriers largely reflect any systematic differences in costs across firms.

We believe that the hedonic output variables such as average stage length, and the multiple output specifications (scheduled passenger, scheduled freight, freight and charter services) take into account the effects in our cost model of the major components of the firm. Therefore, we choose the translog model [Model (b)] without firm effects as our preferred model. The results of model (b) in Table A-2 are used in all subsequent calculations.

C.3 Economies of Scale and Density, and Inter-Product Cost Complementarity

In city pair markets density economies result when costs decrease as flight frequency and/or average aircraft size (or the number of seats per aircraft departure) increase, all factors cited above held constant. Scale economies are evident when a proportional increase in output <u>and</u> size of network (points served) is greater than the proportional increase in inputs, all else (other network characteristics and input prices) held constant.

Scope economies refer to cost savings from multiple outputs. It asks whether it is cheaper to produce two outputs by separate, specialized firms or via joint production by one firm. If the latter is the case we say there are economies of scope. Whether scope economies exist and the extent to which they exist depends upon both the number of products and level of each output. In order to completely evaluate economies of scope, one would need to evaluate the estimated cost function by setting one or more outputs to a zero value. This implies that the results of estimation are used to simulate the costs well beyond the ranges of the actual data. In addition, the translog cost function is undefined at zero output levels. Therefore, we are not able to measure the economies of scope in a formal sense. However, we are able to evaluate at each data point how the marginal cost of one product changes as the amount of another product is changed by computing cross partial derivatives of the cost function with respect to each pair of outputs. The formula for doing so is given in equation (A.16). We refer to this as a measure of inter-product cost relations.

We now proceed to examine economies of density and scale, and inter-product cost relationships measured at each observation in our sample. We turn first to economies of density and scale. Table A-3 reports the measures of ray cost elasticity, density and scale economies for each airline for selected years. It also reports these measures evaluated at each airline's mean data point and at the overall industry mean data point. Air Canada exhibits slight decreasing returns to scale in 1980, .85 with a calculated t-statistic = 1.5. Nordair in 1980 had increasing returns to scale of 1.19 with a t-statistic of 2.0. All other carriers experienced constant returns to scale in 1980. Air Canada appears to have experienced signifi-

Table A-3

RAY COST ELASTICITY, ECONOMIES OF DENSITY AND SCALE

	YEAR	RCELAS	DENSITY	SCALE
AIR CANADA	1964	.86	1.15	.87
	1971	.87	1.14	.94
	1978	.91	1.09	.87
	1980	.92	1.08	.85
	MEAN	.89	1.11	.88
C.P. AIR	1964	.82	1.21	.95
	1971	.83	1.20	.97
	1978	.86	1.15	.96
	1980	.88	1.13	.95
	MEAN	.84	1.18	.99
PWA	1964	.71	1.39	1.35
	1971	.80	1.24	1.09
	1978	.84	1.19	1.02
	1980	.86	1.15	.94
	MEAN	.82	1.21	1.05
QUEBECAIR	1964	.70	1.41	.95
	1971	.76	1.31	1.04
	1978	.82	1.20	1.05
	1980	.82	1.21	.99
	MEAN	.79	1.25	1.04
EPA	1964	.66	1.49	1.45
	1971	.75	1.32	.99
	1978	.80	1.23	.98
	1980	.81	1.22	.92
	MEAN	.77	1.28	1.02
TRANSAIR	1964	.72	1.38	1.30
	1971	.78	1.27	1.00
	1978	.81	1.22	1.02
	MEAN	.78	1.27	1.05
NORDAIR	1971	.65	1.52	2.29
	1978	.73	1.35	1.58
	1980	.80	1.24	1.19
	MEAN	.74	1.33	1.46
	IND. MEAN	.84	1.18	.97

RCELAS: Ray cost elasticity with respect to density: $\sum_i \frac{\partial \ln C}{\partial \ln Y_i}$

DENSITY: Ray economies of output density: 1/RCELAS

SCALE: Ray economies of scale: $1/(\text{RCELAS} + \frac{\partial \ln C}{\partial \ln PT})$

cant decreasing returns to scale throughout the period 1964-81. Nordair experienced significant economies of scale throughout the period for which we have data, but the magnitude of economices of scale decreased quite rapidly over time as Nordair expanded. Although it is the fourth largest scheduled carrier in Canada, Nordair appears to be realizing economies of scale because of the longer haul orientation of its network relative to other regional carriers.

For CP Air, the point estimates for the scale measure is consistently less than one, but there is not sufficient evidence to conclude that it is operating with decreasing returns to scale. PWA, Transair and EPA began the period exhibiting increasing returns to scale but gradually moved towards constant or decreasing returns. Their scale measures at 1980 data points are not statistically different from one. Quebecair effectively exhibited constant returns to scale.

A second and increasingly important (for policy evaluation) cost characteristic is the measure of economies of density. It measures the cost changes which occur when an existing network is used more intensively. The results are reported in Table A-3, column 2. It illustrates that unit costs would decrease for all carriers if they carried more traffic within their given network. The only possible exception is the case of Air Canada for which since 1978 the hypothesis of constant returns to density could not be rejected. This implies that Air Canada had probably exploited all of the returns to traffic density as of the late 1970s, and thus may not be able to reduce its unit cost by increasing average traffic density.

Returns to density result from the fixed costs associated with a network; costs which are independent of the level of output. Such things as maintenance, administrative, and passenger and traffic servicing units would represent such costs. Notice that the extent of returns to density is quite similar across the smaller regionals and somewhat smaller for PWA. the larger regional, at 1.15 (1980).

The translog cost function (model (b)) reported in Table A-2 exhibits a lack of cost complementarity between scheduled passenger and scheduled freight service for smaller firms (Quebecair, EPA, Transair, and Nordair) but cost complementarity for Air Canada, CP Air and PWA, as reported in Table A-4. A negative sign in column 1 indicates that the marginal cost of providing scheduled passenger services decreases as scheduled freight output is increased. The sign differences between the two groups of airlines could be attributable to the lack of opportunity for the Regionals to expand into more dense and distant scheduled passenger markets. By being confined to smaller regional markets, this group of smaller (regional) carriers were put at a cost disadvantage. In addition, the regional carriers, especially EPA and Nordair, operated with fairly high freight proportions, particularly in early years. In addition, they operate aircraft with limited belly space for cargo, relative to CP Air and Air Canada. We may be observing competition for aircraft space between passengers and freight for these carriers, and thus lack of cost complementarity. In contrast, CP Air and Air Canada may be observing cost complementarity since freight can travel in belly space which has no opportunity costs for passenger service.[14]

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[14] At extreme ranges or at high takeoff altitute airports there may be an opportunity cost. Weight will be restricted in such cases and even if there are empty seats in the passenger compartment, adding freight may require bumping passengers.

Table A-4

INTERPRODUCT COST-RELATIONSHIPS
(Signs of Cross-partial Derivatives Evaluated
at Selected Data Points)

	Passenger-Freight $\frac{\partial^2 C}{\partial Y_1 \partial Y_2}$	Percent of Scheduled Freight Service in Total	Passenger-Charter $\frac{\partial^2 C}{\partial Y_1 \partial Y_3}$	Percentage of Charter Service in Total
AIR CANADA				
1964		13%	+	6%
1971		14	+	7
1978	—	12	-	4
1980		12	-	3
C.P. AIR				
1964	-	12		10
1971	+	13		6
1978	-	12	+	9
1980	-	11		10
PWA				
1964	+	19		43
1971	-	10		57
1978	-	9	+	52
1980	-	9		36
QUEBECAIR				
1964	+	16	-	1
1971	+	15	+	28
1978	-	5	+	75
1980	+	4	+	48
EPA				
1964		27	+	13
1971		14	-	3
1978	+	12	+	20
1980		12	+	8
TRANSAIR				
1964		13		70
1971	+ –	9	+	26
1978		9		45
NORDAIR				
1971		25		47
1978	+ –	18	+	65
1980		14		44

Note: Negative values indicate cost complementarity (i.e., local economies of scope).

The interproduct cost relationship between scheduled passenger and charter services exhibits a strong and consistent pattern. When the percentage of charter services in total output is less than 5%, the production of charter services reduces the marginal cost of scheduled passenger services (a negative sign) otherwise there is a cost disadvantage in producing charter services.

C.4 Variable Cost Function Results

In the TFP analysis conducted above, we noted that Canadian airlines have not been able to adjust their capital stocks to an optimal level. To take into account the disequilibrium adjustment in capital stock, we estimated many variants of the translog variable cost function, treating capital stock level as the quasi-fixed factor. Table A-5 reports estimates of two models. In both, the data has been normalized at the mean data point.

The only difference between the two models in Table A-5 is that model (2) allows for different coefficients on the capital stock variable for Air Canada, CP Air, and PWA for those years it was owned by the Alberta Government. This is implemented by including interaction terms between the capital stock variables and the dummy variables for Air Canada, CP Air and PWA. Although most of the empirical results are quite similar between the two models, the following differences are noticeable:

1. The coefficient of stage length is smaller and insignificant in model (2) while it is larger and significant in model (1).
2. There are some differences in the first-order coefficients for points served (P), Passenger (A1), Freight (A2) and Charter (A3).
3. There is a difference in the measure of scale economies; significant diseconomies of scale for model (1) versus constant returns to scale for model (2).

Table A-5

TRANSLOG VARIABLE COST REGRESSIONS
Normalized at the Mean Data Points
(Standard Errors in Parentheses)

Coefficient	Variable	Model (1)	(differential capital stock effects) Model (2)
A0	Intercept	18.785 (.053)	18.780 (.058)
P	Points Served	0.418 (.137)	0.268 (.122)
S	Stage Length	-0.241 (.127)	-0.113 (.150)
H	Capital Stock (KSTK)	0.162 (.067)	0.012 (.082)
HAC	KSTK*Air Canada	-	0.041 (.093)
HCP	KSTK*CP Air	-	-0.090 (.075)
HPWGOV	KSTK*PW*GOV	-	0.021 (.044)
AT	Time Trend	-0.012 (.003)	-0.021 (.003)
A1	Passenger	0.490 (.068)	0.640 (.060)
A2	Freight	0.060 (.054)	0.084 (.055)
A3	Charter	0.035 (.023)	0.058 (.021)
B1	Labour Price	0.372 (.009)	0.433 (.008)
B2	Fuel Price	0.254 (.004)	0.210 (.005)
B3	Materials Price	0.374 (.009)	0.356 (.009)
B11	Labour*Labour	0.109 (.034)	0.119 (.030)
B12	Labour*Fuel	-0.041 (.010)	-0.000 (.009)
B22	Fuel*Fuel	0.120 (.006)	0.078 (.006)
B13	Labour*Materials	-0.068 (.033)	-0.119 (.029)
B23	Fuel*Materials	-0.079 (.009)	-0.078 (.009)
B33	Materials*Materials	0.147 (.034)	0.197 (.031)
A11	Passenger*Passenger	0.239 (.074)	0.164 (.064)
A12	Passenger*Freight	-0.155 (.060)	-0.063 (.052)

Table A-5 (cont'd)

Coefficient	Variable	Model (1)	(differential capital stock effects) Model (2)
A13	Passenger*Charter	-0.053 (.022)	-0.070 (.018)
A22	Freight*Freight	0.197 (.080)	0.097 (.069)
A23	Freight*Charter	-0.024 (.019)	-0.023 (.017)
A33	Charter*Charter	0.060 (.009)	0.040 (.007)
DL1	Labour*Passenger	-0.044 (.008)	-0.009 (.007)
DF1	Fuel*Passenger	0.026 (.004)	-0.007 (.004)
DL2	Labour*Freight	0.008 (.007)	0.006 (.007)
DF2	Fuel*Freight	-0.004 (.004)	-0.006 (.004)
DL3	Labour*Charter	-0.022 (.003)	-0.011 (.003)
DF3	Fuel*Charter	0.016 (.001)	0.006 (.001)
DM1	Materials*Passenger	-0.018 (.008)	0.016 (.007)
DM2	Materials*Freight	-0.003 (.007)	-0.000 (.007)
DM3	Materials*Charter	0.006 (.003)	0.005 (.003)
PP	Points*Points	-0.146 (.180)	-0.060 (.154)
SS	Stage Length*Stage Length	0.318 (.243)	0.077 (.288)
HH	Capital Stock*Capital Stock	0.021 (.073)	-0.067 (.066)
PY1	Points*Passenger	0.087 (.077)	0.116 (.074)
STY1	Stage Length*Passenger	0.272 (.100)	0.202 (.087)
HY1	Capital Stock*Passenger	-0.133 (.069)	-0.053 (.060)
PY2	Points*Freight	-0.185 (.091)	-0.245 (.084)
STY2	Stage Length*Freight	-0.142 (.096)	-0.071 (.097)
HY2	Capital Stock*Freight	0.010 (.052)	0.023 (.045)
PY3	Points*Charter	-0.062 (.037)	0.024 (.033)

Table A-5 (cont'd)

Coefficient	Variable	Model (1)	(differential capital stock effects) Model (2)
STY3	Stage Length*Charter	0.068 (.038)	0.054 (.033)
HY3	Capital Stock*Charter	0.010 (.017)	0.037 (.015)
GPH	Points*Capital Stock	0.239 (.087)	0.184 (.076)
GPS	Points*Stage Length	0.039 (.131)	-0.039 (.127)
GSH	Stage Length*Capital Stock	-0.169 (.092)	-0.047 (.089)
PTL	Points*Labour	0.059 (.013)	-0.013 (.012)
STL	Stage Length*Labour	-0.025 (.012)	-0.051 (.011)
HL	Capital Stock*Labour	0.044 (.008)	0.035 (.007)
PTF	Points*Fuel	-0.064 (.006)	-0.003 (.007)
STF	Stage Length*Fuel	0.004 (.006)	0.031 (.006)
HF	Capital Stock*Fuel	-0.006 (.004)	0.003 (.004)
PTM	Points*Materials	0.006 (.013)	0.016 (.012)
STM	Stage Length*Materials	0.021 (.012)	0.021 (.011)
HM	Capital Stock*Materials	-0.038 (.008)	-0.038 (.007)
DENSITY	Returns to Density	1.433 (.171)	1.262 (.118)
SCALE	Returns to Scale	0.836 (.060)	0.940 (.088)
SCASTG	Returns to Scale and Stage Length	1.100 (.255)	1.053 (.186)
COMP 12	Cost Relation: Passenger-Freight	-0.125 (.069)	-0.010 (.069)
COMP 13	Cost Relation: Passenger-Charter	-0.036 (.028)	-0.033 (.027)
COMP 23	Cost Relation: Freight-Charter	-0.022 (.020)	-0.018 (.020)
Value of Log-Likelihood Function		683.965	700.945

Although we do not observe a clear domination of one model by the other in terms of reasonableness of the coefficients, we decided to use model (2) in our subsequent discussions for three reasons: (i) the likelihood ratio rest based on asymptotic χ^2-statistic, - 2[log-likelihood value for restricted model (683.965) - log-likelihood value for unrestricted model (688.134)], rejects model (1) in favour of model (2); (ii) in view of the TFP analysis results, it is important to identify the impacts of using non-optimal capital stock levels by carrier; and (iii) model (2) has more consistent results concerning major aspects of cost structures with that of the total cost model used earlier.

In order to examine the optimality of capital stock level for each carrier, we need to derive the condition of optimality. The total cost (TC) can be expressed as the sum of variable cost (VC) and the capital cost (rK) as follows:

$$TC = VC(Y,W,t;K) + rK \text{ where}$$

Y = output vector

W = input price vector

t = technology and network vector

K = level of real capital stock

r = user cost of capital

The first order condition for minimization with respect to capital stock becomes:

$$\frac{\partial TC}{\partial K} = \frac{\partial VC}{\partial K} + r \qquad = 0$$

$$= \frac{\partial VC}{\partial \ln VC} \; \frac{\partial \ln VC}{\partial \ln K} \; \frac{\partial \ln K}{\partial K} + r = 0$$

$$= \frac{VC}{K} \cdot \varepsilon_K^* + r \qquad = 0$$

where ε_K^* = elasticity of variable cost with respect to capital stock K at the point where costs are optimized with respect to capital. Therefore, the optimality condition becomes:

$$\varepsilon_K^* = \frac{-rK}{VC} = \frac{-\text{ total capital cost}}{\text{total variable cost}}$$

At the mean of our sample, capital cost is approximately 13% of total cost. Thus, we have at the mean the optimality condition: $\varepsilon_K^* = -0.145$. Using model (2), one can test the hypothesis of the optimal capital stock condition for each of Air Canada, CP Air, PWA and the Regionals:

Test Construction	Air Canada	CP Air	PWA (1975-81)	Regionals
$(H + HAC) - \varepsilon_K^*$ 0.198	(t=2.45)			
$(H + HCP) - \varepsilon_K^*$		0.067 (t=0.83)		
$(H + HPWGOV) - \varepsilon_K^*$		(=-1.64)	0.178	
$H - \varepsilon_K^*$				0.157 (t=1.91)

Except for CP Air, we reject the hypothesis that the airlines have been using optimal capital stock in favour of the hypothesis that they use excess capital stock. The point estimates indicate that Air Canada has the most excess capital stock, followed by PWA and then by the other Regional carriers. There is inconclusive evidence that CP Air's capital stock has been excessive. In addition, there is only weak statistical evidence that Air Canada has a significantly higher excess capacity than CP Air; difference in the coefficient of capital stock is 0.131 [= 0.041 - (-0.090)] and its t-ratio is 1.31.

Caves, Christensen and Swanson (1981) derive the following formulae to compute the economies of density and scale from a variable cost function:

$$\text{Density} = \frac{1 - \varepsilon_K^{VC}}{\sum_i^m \varepsilon_{Y_i}^{VC}}$$

$$\text{Scale} = \frac{1 - \varepsilon_K^{VC}}{\sum_i \varepsilon_{Yi}^{VC} + \varepsilon_P^{VC}}$$

where

$\varepsilon_K^{VC} = \frac{\partial \ln VC}{\partial \ln K}$; elasticity of variable cost with respect to capital stock,

$\varepsilon_{Yi}^{VC} = \frac{\partial \ln VC}{\partial \ln Yi}$; elasticity of variable cost with respect to output,

$\varepsilon_P^{VC} = \frac{\partial \ln VC}{\partial \ln P}$; elasticity of variable cost with respect to points served, These are evaluated and reported at the bottom of Table A-5, along with the measures for interproduct cost relationships. The results at the mean data point are by and large similar to those obtained from the total cost model:

1. Increasing returns to traffic density; economies of density = 1.26 with a standard error of 0.12,

2. Constant returns to scale; economies of scale = 0.940 with a standard error of 0.088,

3. There is no statistically significant cost complementarity between scheduled passenger and charter services, at the mean data point of our sample.

Appendix B

Institutional Data Base:
Carrier Histories and Descriptions

SUMMARY OF SIGNIFICANT EVENTS 1964-85

Air Canada

1964-65: - Approximately 80% of fleet turboprop

1966-68: - Approximately 60% of fleet turboprop

1969:
- Diversified into other areas.
- Acquired 30% of Air Jamaica.

1970:
- Changed management structure.
- Developed "Reservac II" - a computer reservation service.

1971:
- Strike. 12,600 man-days lost. (Machinists, AFL-CIO/CLC)
- Acquired first jumbo jet (Boeing 747)

1972:
- Operated Air Transit as a subsidiary from 1972 to 1974.
- Entered hotel and tourism industry.
- Held 30% of Canada National Realties.
- Strike. 2000 man-days lost. (Airline Pilots)

1973:
- Strike. 38,300 man-days lost. (Machinists, AFL-CIO/CLC, Canadian Airline Employees' Association - CLC)

1974:
- Air Jamaica, PWA, EPA became Air Canada reserve customers.
- Strike. 6,560 man-days lost (C.A.L.E.A. - CLC; Machinists - AFL-CIO/CLC)

1975:
- Developed ACCESS System (For computerized cargo control and accounting system.)
- Achieved all jet fleet.
- Formed CANAV consulting Ltd. with C.N.
- Strike. 200 man-days lost. (Airline Employees - CLC)

1976: - Reduces service in western Canada in a deal with Transair.
- Acquired 5 flight simulators

1977: - Amendment to Air Canada Act put Air Canada on an equal footing with other carriers.
- Introduced the first Charter Class Canada Fares (CCFs)

1978: - Lost special status through the new Air Canada Act (Bill C-3).
- Acquired Venturex Ltd., Airline Maintenance Bldg. Ltd.; and MATAC Cargo Ltd.
- Strike. 58,930 man-days lost. (Machinists, AFL-CIO/CLC).
- Introduces Nighthawk service for select points in Canada.

1979: - C.P. Air was allowed to compete openly with Air Canada.
- Acquired 86.4% of Nordair.
- Sold its 26% share of Air Jamaica.
- Introduced its first seat sales.

1980: - Purchased 29% of Guinness Peat Aviation Ltd.

1981: - Acquired 30% of Innotech Aviation Ltd.
- Acquired Touram Inc.
- Experienced a 5.4% reduction in passenger volume.
- Offered seat sales at 35% of the standard economy fare.

1982: - 50% discount on flights between June 19th to Sept. 7th. As a result, 50% of the domestic volume in June was from discount sales.

1984: - Sold all Nordair shares.
- New Canadian Air Transport Policy prevents Air Canada from initiating Competitive Pricing and Scheduling practice.

1985: - Acquired 24.5% or Air Ontario (as did PWA).

SUMMARY OF SIGNIFICANT EVENTS 1964-1986

CP Air

1965: - During the 60's, CP Air was only allowed to have 25% of the transcontinental market served by Air Canada.

1968: - 30% of its revenue came from piston aircraft.

1970: - Attained all-jet fleet by end of year.

1971: - Strike. 54,310 man-days lost. (Machinists, AFL-CIO/CLC).

1974: - Acquired first jumbo jet (Boeing 747-200).

1975:
- Strike. 750 man-days lost. (Machinists, AFL-CIO/CLC)
- Acquired 2 simulators.

1978:
- Allowed to have 35% annual growth in transcontinental market.
- Enters Saskatchewan market.
- Introduces 'Courier Fares' to compete with Air Canada's 'Nighthawk Fares'.

1979:
- Permission to compete with Air Canada.
- No limitation on growth in transcontinental service.
- Introduction of Skybus program.
- Removal of Capacity Restrictions on transcontinental routes (a gradual implementation).

1981:
- Engaged in discount fare war with Air Canada.
- Agreement with EPA; Air B.C.; and four other American carriers to provide connecting service.

1982: - Engaged in discount fare war with Air Canada. 13% of June volume was from discount sales.

1983:
- Changed debt/equity ratio from 96/4 to 65/35.
- Acquired C.P. Hotels.

1984: - Announcement of its intention to acquire EPA.

1986:
- Acquired Nordair
- Nordair Metro (35% owned) acquires 35% of Quebecair.

SUMMARY OF SIGNIFICANT EVENTS 1964-86

Eastern Provincial Airways (EPA)

1967: - Received subsidy through Regional Air Carrier Policy.

1968: - Awarded Charlottetown - Bathurst - Montreal route.

1970: - Acquired first jet (Boeing 737-200).

1971: - Air Canada withdrew from Goose Bay - Montreal service.

1973: - Completely nationalized fleet from a mixture of 28 aircraft to 8.

1974: - Received rights to serve Halifax-Fredericton-Montreal, and Halifax-Saint John-Montreal.

1976: - Strike. 1,990 man-days lost. (Airline Employers' Association, CLC).

1977: - Acquired first simulator.

1981: - Acquired by Newfoundland Capital Corporation.

1982: - Formed a subsidiary: Air Maritime.

1983: - Strike. 15,800 man-days lost. (Machinists - AFL-CIO/CLC).

1984: - Purchased by C.P. Air.

1986: - Merged in Canadian Pacific Airlines (new name for CP Air).

SUMMARY OF SIGNIFICANT EVENTS 1964-1986

Nordair

1969: - Services to Hamilton, Montreal, Ottawa, Windsor, and Pittsburg.
- Acquired 2 Boeing 737-200 jet aircraft.

1972: - Strike. 7,680 man-days lost. (Machinists - AFL-CIO/CLC).
- Fleet becomes large and diverse.

1973: - Strike. 15,850 man-days lost. (Canadian Airline Flight Attendants' Association - CLC).

1977: - Rationalizes fleet.

1978: - Obtained all Transair routes east of Winnipeg.
- Permitted to serve Toronto-Montreal route.
- Strike. 250 man-days lost. (Airline Pilots).

1980: - Air Canada purchased 86.5% of Nordair's shares.

1981: - Strike. 2,730 man-days lost. (Airline flight Attendants, CLC).

1982: - Major work stoppage from July 82 to Jan 83 - 49,640 man-days lost. (Machinists, AFL-CIO/CLC).

1984: - Air Canada's shares of Nordair were sold to Innocan.
- Other shares of Nordair eventually acquired by Quebecair.

1985: - Acquired 35% of Nordair Metro.
- Nordair Metro acquires 35% of Quebecair.

1986: - Purchased by CP Air (originally 66%, later 100%).

SUMMARY OF SIGNIFICANT EVENTS 1964-1985

Pacific Western Airlines (PWA)

1962: - Acquires first jet (Boeing 707-138B).

1970: - Purchased B.C. Airlines.

1974: - Government of Alberta obtained 99% of PWA.

1976: - Operates first domestic ABC's (with Suntours) between Toronto/ Vancouver via Niagara Falls and Seattle.
- Rationalizes fleet; 64% jet.
- Applies to acquire control of Transair.

1978: - Purchased Transair.
- Gave away Transair's terminus in Toronto in return for many exclusive western routes from Air Canada.
- Strike. 9,830 man-days lost (Canadian Airline Employees - CLC).

1980: - Began to relinquish some of the northern routes to local carriers.

1983: - Alberta government sells 84% of PWA.

1984: - Alberta government reduced its holding of PWA to 4%.
- Acquired 40% of Timeair.

1985: - Acquired 24.5% of Air Ontario (as did Air Canada).

SUMMARY OF SIGNIFICANT EVENTS 1964-1981

Transair

1967: - Received subsidy for regional service.

1968: - Received subsidy for regional service.

1970: - Received subsidy for regional service.

1971-72: - Fleet extremely diverse across types and size of aircraft.
- Acquired 2 Boeing 737-200 jets in 1971.

1975: - Strike. 19,970 man-days lost. (Machinists, Reservation Employees - AFL-CIO/CLC).

1976: - Withdrew from long range charters and terminated money losing domestic routes.

1978: - Bought by PWA.

1980: - Fully integrated into PWA.

SUMMARY OF SIGNIFICANT EVENTS 1964-1981

Quebecair

1965: - Acquired by Northern Wings Ltd.
- Acquired Matane Air Servide; Northern Wing and Northern Wings Helicopters.

1967: - Acquired Propair.
- Received federal assistance in support of regional air services.

1968: - Strike. 620 man-days lost. (Machinists, AFL-CIO/CLC).

1969: - Shares of Quebecair owned by Northern Wing Ltd. were transferred to Hochigan.

1970: - Beginning of charter service which extends to all points in Canada, U.S., Mexico, the Caribbean and in South America.
- Acquires 2 BAC-111 jets.

1971: - Gained exclusive right to Saguenay/Bagotville (due to withdrawal of Air Canada).

1972: - Charter services extended to Bermuda and Bahamas.
- Fleet becomes large and diverse.

1973: - New service to Val d'Or and La Grande.

1974: - Acquired Air Gaspe.

1975: - Developed new destinations in the South with new tour operators, and summer operations to many European destinations.

1976: - Expansion of European destinations.

1977: - Replaced manual reservation system with a computerized system called Rebeca.

1978: - Strike. 310 man-days lost.
- Authorized to service La Granda II Airport directly from Quebec City.

1979: - Hochigan Ltd. was purchased by Mr. Alfred Hamel.
- Temporary suspension of the oversea's chartered flights.

1980: - Start of a new direct service Quebec City - Gatineau/Hull.

1981: - Restructured finance; re-equipped and re-scheduled route system.
- Introduced new service to Toronto.
- Strike. 640 man days lost. (Machinists. AFL-CIO/CLC).
- Sold all aircraft except jets; all jet fleet of 6 aircraft.
- Province of Quebec acquires Nordair preferred shares convertable to common. If converted, province would have 87% of equity.

1983: - 100% of shares acquired by Quebec government.

1985: - acquired 34% of Nordair.

1986: - Sold to Nordair Metro (35%), Nordair Metro executives (55%) and others (10%)
- Shares in Nordair sold to CP Air.
- Significant reduction in personnel effected by new owners.

Appendix C

Summary of Major Industry Events
1964-1986

1965: - Introduction of Inclusive Tour Charter regulations.

1966: - Wardair provides international charter service between Western Canada and Europe.

- Aviation policy statement that transcontinental carriers are to co-operate, not compete. Policy directed at protecting Air Canada's domestic transcontinental routes. Regional carriers should be financially stable but not at the extreme of Air Canada.

1967: - Passage of National Transportation Act (NTA).

- CP Air given permission to operate up to 25% of transcontinental capacity.
- Creation of CTC.
- Regional Air Carrier Policy established.

1973: - ATC allows international ABC charters.

- Four restrictions on tour charters.

1974: - Of 17 new transborder routes, Air Canada receives 14 and CP, Nordair and PWA receive one each.

- PWA sold to Alberta government (August).
- Canada-U.S. sign Non-Scheduled Air Service Agreement. U.S. carriers allowed 25% of forecasted seats from Canada to select U.S. destinations.

1975: - John Robson appointed chairman of U.S. CAB (by President Ford).

1976: - Air Canada/CP Air affer limited CCCF's (international).

- U.S. allows domestic ABC's.

1977:	- Permission was given for Domestic Advance Booking Charters (ABCs).
	- Alfred Kahn appointed chairman of U.S. CAB (by Pres. Carter).
	- U.S. deregulates Air Cargo.
	- U.S. allows Supersaver air fares.
	- Passage of new Air Canada Act (Bill C-3).
1978:	- U.S. airline Deregulation Act passed.
	- Amended International Advance Booking Charter regulations.
	- Discount fares were permitted.
	- PWA purchases Transair.
1979:	- Set guidelines on discount fares.
	- Wardair received license to provide domestic non-scheduled service in transcontinental market.
	- Air Carrier Regulations were amended.
1980:	- Escalating fuel prices and recession.
	- Domestic ABC and schedule service were allowed to compete freely.
1984:	- Announcement of the New Canadian Air Transport policy.
	- CTC allowed frequent promotional campaigns.
	- CTC air fare hearings.
	- Both U.S. and Canadian governments agreed to ease transborder air traffic restrictions.
	- Amendment proposed to the Combines Investigation Act (CIA) which makes all crown corporation subject to the CIA (not passed).
	- U.S. CAB ceases to exist, 31 December 1984.
1985:	- White Paper, "Freedom to Move" released.
	- House Standing Committee on Transport hearings on Freedom to Move.
1986:	- Bill C-126, "National Transportation Act of 1986: introduced.

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