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REPORT

Comments on the ATRS Benchmarking of (YQB) Québec City Jean Lesage International Airport

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Executive Summary

The ATRS Benchmarking Methodology is Flawed and Poorly Executed

ATRS (the Air Transport Research Society) conducts annual benchmarking of a number of airports around the world. This benchmarking study is highly controversial and a number of leading aviation economists are of the opinion that the flaws in both the study design and in the execution of the benchmarking are such that there is no meaningful value in the resulting comparisons. These deficiencies in the ATRS benchmarks have been known since the early 2000s through a series of presentations and at least one written paper (from the year 2006), but the ATRS project managers have been unwilling to address the fundamental flaws and continue to make major errors in the computations.

The ATRS methodology has been criticised since 2006

A 2006 paper written by Dr. Michael Tretheway and Ian Kincaid pointed out the conceptual design errors of the ATRS benchmarking design, both in terms of how it controls for differences between peer airports and in terms of the methodology for assessing airport efficiency. Dr. Tretheway is a former professor of Transportation and Economics at the University of British Columbia (UBC) and is currently Chief Economist of the global aviation consulting firm Inter*VISTAS* Consulting Inc. Ian Kincaid is an operations research graduate of the London School of Economics and is Senior Vice President of Airport Forecasting at Inter*VISTAS* in its London UK office. The 2006 paper was provided to the ATRS project manager. Further, earlier presentations and discussions pointed out the serious deficiencies in the study.

- The criticism of Dr. Tretheway is particularly meaningful as he developed with Dr. William Waters II of UBC the underlying methodology (known as Variable Factor Productivity). ATRS incorrectly implements the methodology.

- Other researchers around the world have also levied criticism of the ATRS methodology.

- At least one airport regulator (The Irish Aviation Regulator) had attempted to regulate airport fees and service quality using a benchmarking approach and rejected this approach due to the inability to develop meaningful benchmarks between airports.

The Key Findings of the Review by Inter*VISTAS*:

- **The peer airport comparisons of the ATRS benchmarks are not meaningful.** The study fails to understand and control for critical differences between YQB and the peer airports ATRS uses. For example, most of the peer comparator airports are U.S. airports of similar size, but these do not pay any rent or property taxes, they receive Federal Aviation Administration subsidies for capital expenditures on facilities and U.S. airports have access to significantly lower borrowing costs through municipal bond financing. Simply adjusting for the property tax and rent payments YQB must pay narrows or eliminates much of the gap.

- **The ATRS study is replete with data errors.** For example, ATRS data suggest an unrealistic average worker wage at Chicago's O'Hare Airport of $350,000, and large year-over-year fluctuations in average wage for the workers at Edmonton International Airport. ATRS data for YQB contains significant numerical errors that remain in published versions of the studies. ATRS acknowledgement of the errors has not resulted in a recall and replacement of their benchmarks.

- **The key methodology used by ATRS to evaluate airport efficiency completely ignores the fact that over half of the costs of an airport are fixed costs.** ATRS brushes off the dominating capital costs of airports and claims it can judge management efficiency without considering the required investments, the historical condition of facilities inherited from government, etc.

- **The ATRS methodology to adjust the Variable Factor Productivity (VFP) measure to create an index of airport efficiency is incorrect. It violates a basic tenet of economic theory.** ATRS judges the managerial efficiency of airports using an economic theory of "variable" costs (meaning ignoring the airport's enormous fixed costs of runway and terminal infrastructure), or more precisely, a methodology variant called "variable factor productivity". This is a topic taught in first semester economics courses at university. The professors teach in that first semester course that a given firm's variable costs depend on the capital investment of the airport. An airport with an old terminal with inadequate capacity will have high variable costs, but this does not mean its managers are inefficient given the facilities it currently has. It takes several years, often more than a decade, to plan, finance and build needed new airport terminal or runway system capacity. But in the interim (or short run) airport managers may be managing the airport efficiently. ATRS specifically seeks to benchmark short run, not long run managerial efficiency. However, by not controlling for differences in the infrastructure conditions at the different airports, the ATRS method cannot possibly draw conclusions about managerial efficiency. In fact, **for an airport that has to operate for some years with inadequate infrastructure, the ATRS methodology necessarily will find that airport to be inefficiently managed, even if the airport is competently managed by its officers with what they inherited from Transport Canada**. The ATRS method will inevitably and erroneously find efficiently managed airports in such conditions to be inefficient. The ATRS airport efficiency rankings are erroneous in general and erroneous and misleading for YQB in particular.

- **Our Opinion:**
  ATRS ranks YQB low in terms of airport efficiency. In our view this ranking is erroneous.

    - YQB costs are high relative to many of its peers, but for reasons that are justified. Many of the YQB peer airports are U.S. airports of similar size that receive large subsidies for major capital projects, pay no rent, pay no property tax and access tax free debt financing. These factors alone increase YQB's variable costs by 20% yet none are under control of YQB. We observe that YQB (and Aéroports de Montréal) pay the highest property taxes per passenger among all airports in Canada, creating a disadvantage among their Canadian peers. YQB is also penalized financially when it makes (desperately) needed investments in airport infrastructure. To finance these investments YQB must raise Airport Improvement Fees on passengers, but that triggers higher rent to the Federal government. The terminal YQB inherited from Transport Canada had limited potential for generating commercial revenues due to its size and design. Thus it cannot generate such revenues to offset its high costs until it opened its new terminals in 2008 and 2017. Further the way concession agreements are structured at modest sized airports, airport revenues are lower in the earlier years and higher later, so it will take time to fully realize the potential of offsetting commercial revenues.

    - Finally we note that YQB faced such a large challenge in terms of deficient terminal and airfield infrastructure that it has had to make one of the largest infrastructure investments per passenger of any airport in Canada.

    - In sum, the ATRS efficiency ranking of airports makes allowance for none of these factors. Not only is the ATRS methodology and data wrong, it does not control for the

critical and cumulative challenges YQB faces. ***The ATRS ranking are invalid and must be ignored.***

- We would like to correct and redo the ATRS study to provide a more meaningful assessment of YQB, but this benchmarking can only be fixed at great expense and time. We feel that doing so would not be useful.

- Instead we offer our opinion that YQB faces greater challenges and penalties than any U.S. airport, and among its Canadian peers YQB must pay the 2nd highest property taxes per passenger, has had to make one of the highest investments per passenger of any airport, and until its recent terminal development has not had the opportunity to generate offsetting commercial revenues.

- ***In spite of its challenges, YQB has achieved one of the highest rates of passenger growth in Canada, and is poised to achieve even higher connectivity for the capital community by management's initiative such as U.S. preclearance in the near future that will support new routes to the U.S., increased seasonal overseas services, higher commercial revenues and much higher customer satisfaction due to its investment in a new terminal.***

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1 Introduction

1.1 The ATRS Benchmarking Report and YQB

The Air Transport Research Society (ATRS) conducts an annual benchmarking exercise for a number of airports around the world. This benchmarking study is highly controversial and a number of leading aviation economists are of the opinion that the flaws in both the study design and in the execution of the benchmarking are such that there is no meaningful value in the resulting comparisons. These deficiencies in the ATRS benchmarks have been known since the early 2000s, through a series of presentations and at least one written paper (from the year 2006). However, the ATRS project managers have been unwilling to address the fundamental flaws and continue to make major errors in their computations.

This has become an issue for the assessment of the Québec City Jean Lesage International Airport (YQB), which ATRS has incorrectly ranked as a low efficiency airport. Given the issues around the ATRS benchmarking exercise, there are serious questions as to whether or not any of the study results, especially those for YQB, are meaningful in any way.

This report addresses the problems with the ATRS benchmarking methodology and argues that its results for YQB in particular should be set aside. It also identifies a major methodology flaw that suggests ATRS rankings of other airports are also likely problematic.

1.2 Dr. Tretheway and Inter*VISTAS* Consulting

Aéroport de Québec inc. retained Dr. Tretheway and Inter*VISTAS* Consulting Inc. to prepare this report on the ATRS methodology deficiencies and execution; in particular, with respect to the assessment of the Québec City Jean Lesage International Airport (YQB).

- Dr. Tretheway is an internationally recognized aviation economist, with extensive experience with airports.[1] His expertise includes airport planning, marketing, financing, taxation and governance models. Much of his career has involved assessing the efficiency of transportation companies, including airlines, airports, railways, ferry operators and pipelines as well as industrial sectors such as forest products and mining. His career includes 14 years as a professor in the Transportation and Logistics Division of the Sauder School of Business of the University of British Columbia,[2] and he has taught airport, airline and logistics management at universities and training institutes in China, Southeast Asia, North and South America and Europe. He is a frequent conference speaker and has been an expert witness on airline and airport issues before courts of law, arbitration panels, competition tribunals, government legislatures, and regulatory agencies. He has been engaged in these expert matters by airlines, airports, competition authorities in several nations, industry associations and others. Over his career he has worked with and prepared studies for over 100 airports around the globe. Between his university and consulting career he was a senior manager of the Vancouver International Airport Authority and worked with its subsidiary which has managed roughly twenty other airports. He is a cofounder of Inter*VISTAS*.

[1] Dr. Tretheway is Chief Economist & Chief Strategy Officer with the Inter*VISTAS* Consulting Group and is Managing Director of Inter*VISTAS*' Canadian operations. For several years he has also been awarded the designation of "Leading Professional" by the parent company of Inter*VISTAS*, Royal Haskoning DHV.
[2] He has also been appointed as an Adjunct Professor by UBC for several years.

- Inter*VISTAS* is a global aviation, transportation, and tourism consulting practice, founded in Canada (Vancouver and Ottawa), with offices in Washington D.C., Boston, San Francisco, London UK and the Hague Netherlands. Inter*VISTAS* has been engaged for consulting assignments with the leading international aviation organizations, including Airports Council International (ACI-North America, ACI-Europe, ACI-World and ACI-Asia Pacific), the International Air Transport Association (IATA), the Organization for Economic Cooperation and Development (OECD), the Canadian Airports Council, Airlines for America (A4A), the Australia Airports Association and others. It has repeatedly been engaged by financial rating agencies. It has been involved in roughly 60 airport and ferry privatizations around the world, working for vendors, buyers and others. Inter*VISTAS* is known for its use of airline network modelling tools, usually only employed by the largest airlines, and has substantial database capabilities. Inter*VISTAS* has often been engaged to conduct due diligence of airport transactions as well as conduct management audits of airports.

1.3 Outline

This report is divided into five sections:

- Section 2 provides a summary of the ATRS Benchmarking Report;
- Section 3 provides an overview of the economics of efficiency and issues with the underlying ATRS methodology;
- Section 4 outlines additional issues with the validity of the ATRS analysis;
- Finally, Section 5 is a commentary on what can be said about the Québec City Jean Lesage International Airport.

2 The ATRS Benchmarking Report

Summary: The ATRS Benchmarking report began in 2002 as a project of certain researchers who are members of the Air Transport Research Society. It has been published annually over the past 15 years. While all of the reports aim to measure and compare some aspects of the efficiency and productivity of a number of airports globally, the scope and number of airports has varied over the years.

While originally ATRS sought to measure the overall productivity of airports, it rapidly realized that it was not capable of doing so and instead developed a methodology that only measures portions of airport efficiency. Specifically the methodology excludes any assessment of capital (the physical infrastructure of airports) which roughly accounts for half of airport costs and most of the long term focus of airport managers and their boards of directors. The key methodology used by ATRS is referred to as Variable Factor Productivity (VFP).

Even if the ATRS methodology was correctly designed an executed (issues addressed in later chapters of this report) it cannot asses the productivity and efficiency of airport managers and investment. ATRS uses a "residual method" to create its rankings of airport management efficiency. However, both VFP and the ATRS residuals fail to control for critical factors that explain major differences between airports. As an example specific to Québec City Jean Lesage International Airport, it fails to recognize that YQB pays both rent and property taxes to government; major financial expenses (roughly 20% of variable costs) are paid by none of the U.S. airports to which ATRS compares YQB. YQB starts off in the ATRS methodology with a large 20% penalty which is uncontrollable by management (and ATRS claims to assess managerial efficiency). Even among its Canadian peers, YQB pays the second highest property tax rates per passenger in Canada. It is doubly penalized in that the more the YQB airport authority invests in needed airport infrastructure, the more rent it must pay to the federal government..

2.1 History

The Air Transport Research Society (ATRS) is a global network of researchers in the aviation field, including academics and those in the industry.[3] The ATRS was originally based in Vancouver, British Columbia, but is currently based in Daytona Beach, Florida, out of Embry-Riddle Aeronautical University. The ATRS Benchmarking Report began in 2002 as a project of a small number of researchers who are members of ATRS. It is not an official publication of the Society, but rather is a product of a small number of individuals.

The ATRS benchmarking report has been published annually since 2002, though the scope of the reports has changed over the years. In the original 2002 report, the analysis was based on a series of *partial* productivity measures, and an attempt to calculate the *total* factor productivity[4] of a sample of 70 airports from around the globe.[5] In subsequent years, the scope changed to discard the attempt to measure total factor productivity; it changed several of the partial productivity metrics, attempted to calculate variable factor productivity, and added a comparison of airport charges (which started with just a comparison of security charges, which are generally not set by airports). In the most recent version of the report, over

[3] ATRS (2017).
[4] See Section 3 for a discussion of the economics of this measure.
[5] ATRS (2002).

200 airports were included in the analysis (though not for every metric) and a few airport groups (companies that operate more than one airport) were also included.

2.2 The Scope of the ATRS Analysis

Although the scope has changed, there are currently four main focuses of the ATRS analysis: efficiency, cost competitiveness, financial performance, and airport charges (e.g., landing and terminal fees).[6]

- *Efficiency*
  ATRS attempts to measure efficiency and productivity in two ways: using a series of partial productivity measures and estimating variable factor productivity for the sample airports. There are issues however in their exclusion of key components, such as level of capital and congestion;

- *Cost competitiveness*
  is measured using variable costs, and does not include fixed capital costs which typically are in the range of 50% of airport costs;

- *Financial performance*
  is simply and naively assessed via a number of simple financial ratios and other revenue metrics;

- *Airport Charges*
  ATRS attempts to rank airports based on airport charges. This is done using a number of assumptions and a sample of aircraft types. The ATRS analysis ignores the incentives and discounts increasingly offered by airports to their airlines. It also ignores the mix of aircraft landings at a given airport. If, for instance, the ATRS comparison aircraft only serves an airport for, say 5 % of the landings at this airport, the typical ATRS aircraft is not really representative of this particular airport's traffic. For Quebec City Airport, ATRS has no relevant comparison for the type of aircraft accounting for over 85% of its flights.

The data used by ATRS in the analysis come from a variety of sources including airport annual reports, industry databases, direct airport surveying, and government statistical agencies. As we will discuss, there are serious accuracy problems with some of the ATRS data, problems that are not always corrected when pointed out.

Given the intended scope of the ATRS benchmarking effort, there are some key items to note in regard to the ATRS report and benchmarking analysis:

- ATRS will provide access to their database of airport operational and financial figures, but at a significant fee. For a purported academic society the fee they charge is surprising and much higher than fees charged by commercial airport intelligence organizations such as CAPA, Momberger and Leigh Fisher, and by industry associations and governments such as ICAO and ACI. The high data access fee seems to exclude peer review of the purported ATRS productivity measures.

- ATRS attempts to provide an index of airport fees and charges, but fails to take into account important comparisons, including the impact of different charging structures and regulatory requirements.

- ATRS attempts to develop an index of airport efficiency using the Variable Factor Productivity (VFP) method, but fails to address the fundamental economic theoretical requirements for this measure. Put simply, ATRS uses a variable factor productivity measure as the starting point of its

[6] ATRS (2017).

managerial efficiency measure because it has no data on airport capital investment for many airports[7] -- yet the VFP methodology requires a precise measure of airport capital investment. In economics, the assessment of the efficiency of enterprises and their managers can only be done with a measure of capital. Using VFP rather than TFP does not eliminate the need for a measure of capital investment by airports. The ATRS problem with a lack of a consistent global measure of airport capital investment cannot be washed away by ignoring it. Economic theory is both precise and rigid on this matter. ATRS apparently is not.

[7] Airport capital investment for YQB is readily available from the published and easily accessible YQB annual reports.

3 The Economics of Efficiency

Summary: There are various ways to measure economic efficiency. Efficiency can be measured using partial metrics (which is a common practice), simply comparing a level of output to input (e.g., output per employee). Given enough information, the total factor productivity of an enterprise can be measured, which is an overall indicator of efficiency and a much more informative means to assess organizational and management efficiency.

Given the difficulties in collecting sufficient data to compute total factor productivity, some aspects of efficiency can also be measured by using the concept of variable factor productivity. This measure specifically excludes capital investment and focuses on the enterprise's use of labour, energy and materials. These are important aspects of management for many industries, but for airports, invested capital can drive half or more of the airport's costs. Being efficient in the use of airport labour and energy, when the infrastructure is decaying and incapable of facilitating rapid traffic growth, is a dubious, and we suggest counterproductive, measure of the strategic management and development of the organization. Further, by ignoring capital deficiencies and the need for replacement and expansion investment, the ATRS efficiency measure does harm to the airport enterprise, its airlines and passengers, and the economic and social connectivity of the community the airport serves. The ATRS management 'efficiency' measure rewards airports that let their capital decay and fall behind needs, and it rewards congested airports.

The ATRS' narrow focus on only a few aspects of airport development and management is harmful to focused, good governance of airports. It is harmful to the airport operator and its employees, to the airlines and passengers that must suffer from capital investment inadequacies even if the airport is nominally efficient in labour and energy use, and harmful to the economic and social connectivity of the community. ***It is difficult to attract airlines and other aviation businesses when the airport has major capital deficiencies which ATRS ignores and rewards in their rankings.***

The key issue with the ATRS measure of the efficiency of airports is the highly capital intensive nature of the business. In addition to the high levels of fixed capital, the investment pattern at airports is lumpy (e.g., you can't invest in half a runway), and subject to long life-cycles. The ATRS method of computing variable factor productivity does not account for capital, and given the importance of it to an airport, the measure of efficiency produced is erroneous (the airport may be efficient given the level of capital it has, not any given level of capital).

3.1 Introduction

This chapter deals with some technical aspects of how economists measure efficiency, particularly managerial efficiency. While we have tried to simplify the discussion and leave out the arcane mathematics of efficiency measurement used by economists, the discussion may be difficult to follow. The key points we make are as follows:

- There are multiple measures of efficiency. Some are partial measures that provide some insight but can be misleading about the true performance of an enterprise and its managers. There is a measure of total productivity but it requires more data than ATRS has collected. Instead, ATRS uses a middle measure of productivity (VFP – variable factor productivity) that, like the partial measures, can be misleading.

- Nonetheless, economic theory provides a means to use a VFP measure like ATRS computes to make inferences of managerial efficiency. It requires statistical analysis (a common type of analysis uses statistical regression) to allow adjusting the VFP measure for factors such as:

    - *Scale economies.*
      Large airports have lower costs (higher productivity) due to economies of scale. A regression of VFP on the level or airport traffic can control for this and allow creation of a scale economies adjustment for modest sized airports (such as YQB) relative to larger peers. ATRS attempts to make this type of adjustment.

    - *Traffic Mix.*
      Airports differ in the mix of traffic, both the mix of destinations (regional, vs domestic, vs transborder, vs long haul international) and the mix of aircraft types. Airports serviced by large heavy aircraft are able to have lower landing fees (which are weight based) and small aircraft at these airports may pay modest fees, whereas airports primarily served by turboprop aircraft must load almost all of their costs on to smaller aircraft as they have little other traffic that can support those costs.

    - *Subsidies, rents, property taxes.*
      Some airports receive capital subsidies, pay no rents for their land, pay no taxes and receive low financing rates from tax free bonds (all of this is common in the U.S.) while other airports like YQB do not. ATRS ignores the need for this adjustment and this results in unfairly penalizing YQB's managerial performance.

    - *Special operating conditions such as cold climates.*
      Some airports incur higher costs because they operate in cold or remote locations where operating and/or procurement costs are higher. ATRS ignores the need for this adjustment. YQB operates in a cold climate (hence needs capital and labour for snow clearing and removal) that many of the peer airports ATRS uses to compare to YQB do not. Again, YQB is unfairly penalized by the ATRS managerial efficiency measure.

    - *Airport terminals that are too small to develop commercial revenue.*
      Some airports have higher operating costs and less opportunity for commercial revenues that can offset airport costs because they inherited terminal and runway facilities that were aged and in need of replacement, and/or are undersized for development of food/beverage/retail that can generate offsetting commercial revenues. Because ATRS has no measure of airport capital investment, much less capital deficiencies from ageing and high traffic growth, it cannot control for higher operating costs that result from non-optimal investment. YQB, like some, but not all Canadian airports, inherited airport infrastructure from Transport Canada which had been allowed to age without adequate renewal, and which was not expanded at the time of transfer from the federal government to the Québec City Airport Authority to accommodate the subsequent high rates of traffic growth to the capital region. Again, the ATRS deficiency unfairly penalizes its assessment of YQB efficiency.

    - *A fundamental violation of economic theory by the ATRS methodology*.
      The last point is one which is fundamental but also difficult to explain as the discussion is necessarily mathematical or requires complex economic theory diagrams. The point is that the ATRS methodology for controlling for the above types of factors is fundamentally in error, and because of this, the regression analysis it estimates and the resulting measures of airport efficiency are wrong and have no meaning.

        - To an economist, we say that one cannot estimate a VFP function (or its 'dual' variable cost function) without a meaningful measure of airport capital investment. Without the measure of capital, the regression estimates nothing.

The omitted variables bias is fundamental and fatal. The ATRS regressions will necessarily find a firm that is 100% efficient in variable costs to be inefficient. The ATRS measure of efficiency measures nothing – it has no interpretation.

- To the non-economist we offer an analogy. ATRS has designed a peculiar automobile. It has an adequate engine (the ATRS measure of VFP), and it has good wheels intended to move the car (the hoped-for ATRS measure of airport efficiency). But the car lacks a transmission and drive shaft (the VFP regressions which *must* control for an airports capital investment and whether that investment is adequate or deficient for its historic traffic level). Hence the wheels do not turn. ATRS cannot assess airport efficiency. It cannot estimate management efficiency. The car has no transmission.

The problems of the ATRS methodology deficiencies are particularly stacked against YQB. Among its peer airports, YQB has had to make perhaps the highest level of airport investments per passenger, as will be discussed later. Its infrastructure, like that of many but not all Canadian airports, was not in adequate condition when transferred from Transport Canada to the YQB airport authority. (This inability of the Federal Government to invest in airports was the main reason that airports were transferred to local authorities, who could make the investments, albeit by heavy borrowing and higher fees.) The key and fatal deficiency of the ATRS methodology is its exclusion of adjustments for airport capital needs, which unfortunately is the key distinction of YQB from the peer airports ATRS established for YQB.

In the following sections we seek to explain these economic concepts of assessing airport efficiency.

3.2 Productivity Measures

In economics there are various ways in which efficiency can be measured. Each of these measures have their positive and negative aspects.

- **Single Factor Productivity**
  Single Factor Productivity (SFP) measures are simple measures of some narrow aspects of efficiency. These simply compare the amount of output per some factor input. A common SFP is labour productivity: output per worker hour. A company might achieve high labour productivity through making extremely large labour saving capital (machines and systems) investments. But this does not mean the investments were efficient. If the costs of the capital exceed labour savings, the enterprise is worse off. Productivity measures have cost equivalents. SFPs correspond to unit costs, such as cost per labour hour.

- **Total Factor Productivity (TFP)**
  This measure seeks to address the limitation of SFPs like labour productivity by considering all costs (all factors of production). It essentially computes output per unit of all factors. The mathematics of this measure are a bit complicated but essentially it takes a weighted average of the amount labour, capital, energy and materials needed to produce a unit of output. This measure will identify cases where firms were unproductive by achieving high labour productivity by using even more costly capital and energy investments, for example. TFP corresponds to the total of the enterprise. There is wide acceptance among economists that TFP is a preferred measure of productivity and efficiency of firms (and industries). It requires much more data than SFPs, like output per labour hour, and the computations are a bit more complex, but still tractable. A number of governments produce TFP measures, including the Government of Canada, as Transport Canada annual assesses the collective national TFP of rail and air carriers.

- **Variable Factor Productivity**
  VFP is an intermediate measure. It compares output to a weighted average measure of labour, energy and materials, but excludes capital. It corresponds to variable costs. Variable cost is a

measure widely used, at least conceptually, by economists, but not typically computed by accountants. Although the comparison is not complete correct, variable costs corresponds somewhat with EBIDTA (earnings before interest, depreciation, taxes and amortization). EBIDTA is a useful although partial measure for many industries as a stage (not the endpoint) in overall performance assessment. However, for airports, the interest, depreciation, taxes and amortization (i.e., the costs of capital investment) is roughly half of the airport's costs. Having good performance on EBIDTA can still result in bankruptcy or at least deficient performance if an airport cannot cover the costs of renewing its infrastructure and expanding to accommodate growth. If correctly measured, VFP can provide some insights about an enterprise and its management, but it is deficient as an overall measure of managerial and enterprise efficiency. Over the past 30 years, Canadian aviation is littered with scores of airline bankruptcies (roughly 60), in many cases of carriers that could breakeven on an EBIDTA basis but could not service their debt and pay for fleet replacement.

3.3 Beyond VFP to Efficiency Assessment

ATRS abandoned its attempts to measure TFP because it did not have a ready measure of airport capital investment that was consistently available for all the airports it wanted in the peer group for assessing relative performance of airports.[8]

VFP by itself cannot measure efficiency.
It instead started to undertake the easier measure of VFP, ignoring airport capital investment and needs. VFP is a measure of the use of labour, energy and materials per unit of output (such as per passenger or per aircraft landing or per cargo ton or some weighted average of these). By itself, VFP is meaningless as a measure of managerial efficiency. For example, airports in warm climates (e.g., Australia) do not have the expense of providing equipment for runway snow removal that an airport like Québec City incurs. Thus YQB requires more labour, energy and materials than an airport of similar traffic levels in a consistently warm climate, resulting in a lower VFP measure. A low or high VFP number does not say anything meaningful about the efficiency of airport management.

VFP must be adjusted or controlled for factors that cause one airport's costs to be higher than others.
To its credit, ATRS recognized this and realized that after producing VFP numbers it would need to control for the types of factors that can explain why one airport's VFP might be lower than its peers because of cold climate, lower traffic base, etc.

Regression analysis is a means to estimate the controlling factors.
Again, to its credit, ATRS recognized that it needed to undertake analysis of VFP using a technical such as statistical/econometric regression analysis to reveal how these factors affect VFP. This will allow estimates to be developed of the parameters of an equation that can adjust the raw VFP measure for the various factors.

[8] Having measured TFP (and VFP) for many economic sectors since roughly 1976, I recognize that measuring capital has its challenges. Accounting measures of capital investment do not correct for inflation, for example, and use of incentive depreciation schedules rather than true actual decay of capital productivity somewhat obscures accounting measures for economists. There are also issues of airports (especially U.S. airports) that received large capital subsidies and access to tax free financing. However, since the late 1960s economists have known how to use accounting data to produce the capital measures needed by economists. This does require collecting additional data and coming to understand the industry and its true use of capital (distinguished from standard accounting schedules), but the problem is tractable if somewhat time consuming the first time it is done.

Economic theory provides guidance on how to specify the regression equation.
The analyst cannot simply regress a raw measure like VFP on a number of controlling factors. Economic theory dictates how the regression must be 'specified'. In particular, economic theory dictates (absolutely requires) that a variable cost regression (hence a VFP regression since the two are dual to each other) **MUST have in the regression equation an appropriate and meaningful measure of the amount of capital** an airport has as well as a measure of the output (traffic level) of the airport.

Without a meaningful measure of airport capital in the regression the result has no meaning – none at all. It cannot be used to assess airport efficiency.
Without a measure of capital in the variable cost/VFP regression, the analyst is not estimating anything that is consistent with economic theory. Without such consistency the results are meaningless. The regression is not estimating an airport variable cost relationship and it certainly is not estimating a total cost relationship. Whatever the result of the regression, it has no interpretation as a means to adjust the raw VFP measure for factors that would allow an assessment of airport efficiency.

3.4 A first year economics student demonstration of why the ATRS regressions are wrong and have no meaning

This section uses some economic jargon to make the point that the ATRS regression is incorrectly specified and cannot have any meaning.

In the first semester course in microeconomics, students learn about key cost concepts such as average cost, marginal cost, total cost and variable costs. Variable costs are referred to as short run variable costs to underscore that in the short run a firm is unable to optimize its costs. It is stuck with its existing productive plant (for airports the operator is stuck with its existing runway, terminal and other infrastructure). If traffic grows it might need a larger plant (a larger terminal, a longer runway) but it has to make do in the short run with the infrastructure it has. In the long run it may be able to get to the optimal plant capacity (airport infrastructure) for the higher traffic level; but not immediately.

Further, for airports the transition from short run plant non-optimality to long run optimal conditions can take 10-20 years. While a bakery can easily move to a larger store and add additional ovens and sales counters fairly quickly, airports require years to make changes. In most communities, airports occupy the single largest contiguous property for one purpose. Changes require years to design, to plan, to consult with users (e.g., airlines) and the community, to get permits and approvals, to finance, to build, to test, etc.[9] If subsidies are available, an airport might be able to undertake its investment quickly (as is the case in the U.S. and developing country peer airports), but this is not the case for Canadian airports that are self-funding via fees paid by passengers. The capital investment challenges faced by YQB required investment in several stages, all the while its traffic was growing ever more rapidly making it difficult to keep infrastructure investment apace with traffic needs.

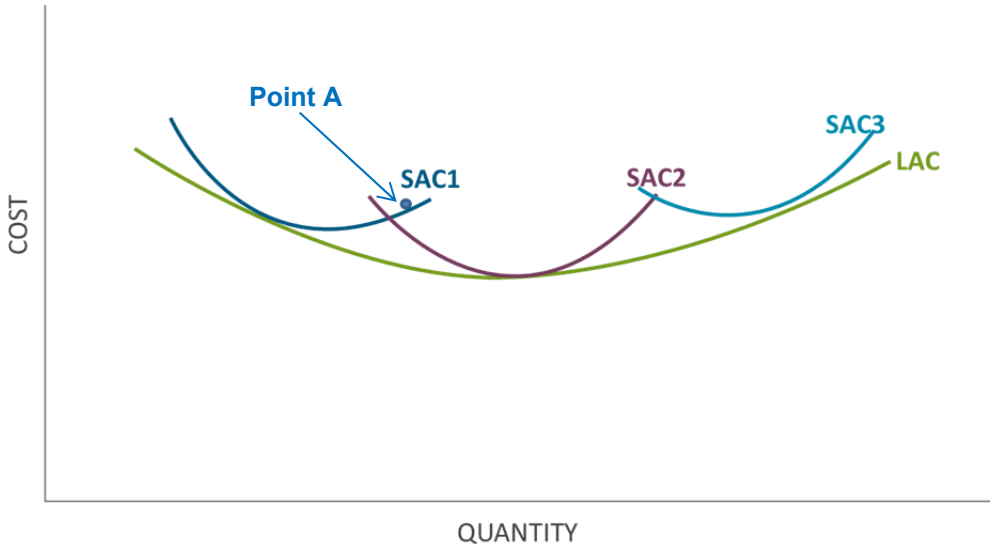
The point of this is simple: the variable cost relationship/function for an airport (or any firm) depends on the amount of capital it has at any given time. There is not one single airport variable cost function. There are different functions for each level of airport capital. Mathematically, this means that the variable cost function equation must include a meaningful measure of the level of infrastructure capital the airport has. This is not an option or a desirable thing, it is mandatory – no exceptions.[10]

[9] An interesting example is that a new runway cannot be operated as soon as the concrete is 'dry'. Concrete needs considerable time to harden sufficiently to take the stress of the weight of a heavy aircraft concentrated on a small tire area with an impact from speeds of several kilometres per hour.
[10] Even in the classroom ideal of an industry with constant returns to scale and perfect competition, the variable cost function must contain the level of capital.

ATRS's regression does not have a meaningful measure of airport capital investment. It violates this core and fundamental requirement of economic theory. Thus the ATRS regression suffers from what statisticians call omitted variables bias. Sometimes omission of a variable only biases the results slightly. That is not the case for omission of the measure of airport capital from a variable cost function (or its dual, VFP function). This omitted variable is fatal.

What is important is how the ATRS estimating equation (lacking a measure of capital) severely biases conclusions about airport efficiency. Figure 3-1 will be familiar to a first semester economics student. It shows a set of short-run average variable cost functions, one for each level of capital. Or you can think of it as one cost curve for each airport and its unique level of capital investment at a given point in time. The vertical axis is dollars and it tracks the variable cost per unit of traffic (e.g., airport variable cost per passenger or per aircraft landing). The horizontal axis is quantity, or for airports it is the total level of traffic. The U-shaped short run average cost curves indicate that for a given investment, there are some economies of utilization that results in average variable cost falling as traffic grows. But at some point traffic has outgrown the design capacity of the airport and unit variable cost rises. A simple example is that as traffic grows beyond design capacity, the terminals may need more frequent cleaning, more security staff may be required, heating costs are higher as doors are almost continually open with the high in and out traffic. The LAC curve is called the envelope of short run average variable cost curves. It is the long run average cost curve, showing for any traffic level the lowest unit variable cost if the airport could adjust its capital investment to exactly the optimum level for any traffic level.

Figure 3-1
Short and Long Run Average Cost Curves



Traffic

Now that we have covered the basics of the diagram we show why the ATRS methodology is wrong. Let's say that an airport like YQB is at Point A in the diagram. This shows its current average variable cost and its current traffic level. At Point A, airport YQB is perfectly efficient for the level of capital investment/infrastructure it has. The first year economics student would say that the airport is on its short run average cost curve. It is as efficient as it can be with its current infrastructure.

Here's the problem with the ATRS regression.
The individual short run average cost curves can only be estimated if the analyst has a measure of capital investment. That and only that variable is what distinguishes the average variable cost curves. What is estimated without that variable? It's not the family of short average cost (SAC1, SAC2 …) curves. It's not

the long run variable cost curve (LAC). **What we can say for sure, based on economic theory, is that what ATRS estimates has no economic meaning. And we can say that an airport at Point A, even though it is actually short run efficient, will only be found to be efficient by the ATRS regression by pure coincidence.** It is likely that ATRS will find the airport at Point A to be inefficient, even though it is not. The ATRS approach is also likely to claim that some airports are efficient that in fact are not.

Some might claim that the ATRS regression estimates LAC. We are not convinced of this, and in any event it would leave the same problem, likely worse. Point A is actually short run optimally efficient, but ATRS will find that because it is above the regression line it is not only inefficient, it is highly inefficient. This is not the case.

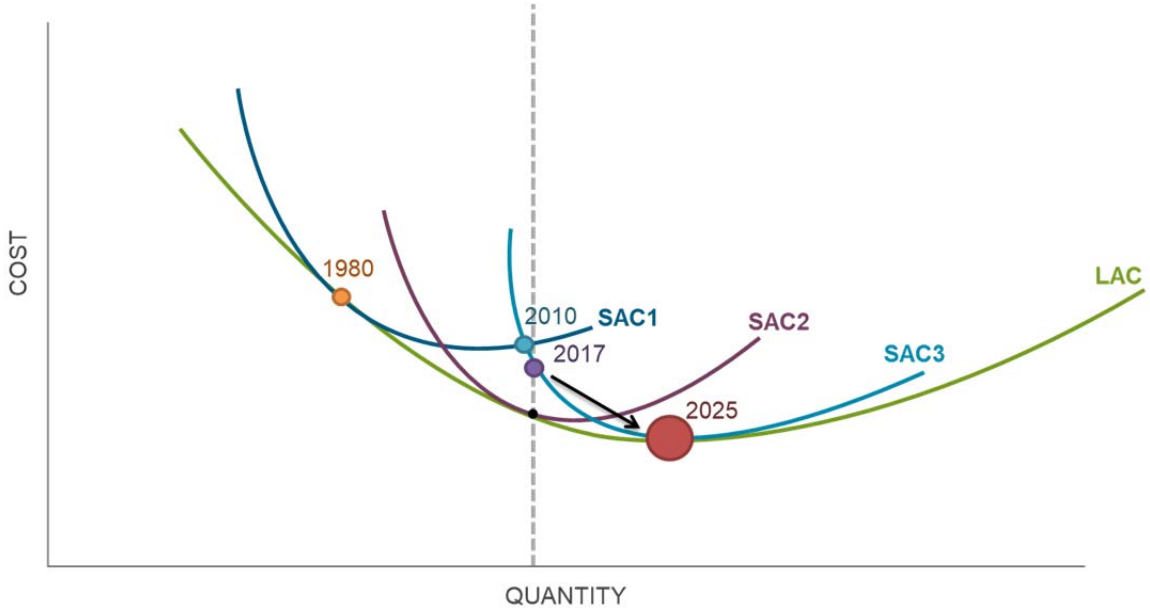
The ATRS regression methodology is fatally flawed because it lacks the required variable – a measure of airport capital investment. It finds efficient airports to be inefficient.
One diagnostic test is whether the ATRS regression coefficients are stable in different years. Airport technology is very stable and coefficients should be relatively stable from year to year if the regression is estimated with a correct specification consistent with economic theory. If misspecified and subject to serious omitted variables bias, the coefficients, and hence the airport efficiency rankings can be unstable from year to year, even though airport variable cost efficiency changes take years to achieve. We return to this later.

3.5 Growing Airports Cannot Achieve Long Run Efficiency in the Short Run

This is another technical topic addressed to the technical economists. In brief, because it takes so long for airports to plan, finance and make lumpy investments in infrastructure, when they do build new capacity they are likely to not build for today's traffic level, but to build for expected capacity in 5-10 years' time. One can observe this in airport master plans. They all begin with a medium to long term forecast so that the planning team can design not for today but for the reasonably expected traffic levels in the medium to long term.

We demonstrate this, without explanation, in a diagram that should be understandable to the professional economists. It shows how an airport that inherited infrastructure build for traffic levels in 1980 would not undertake a project that begins in 2010 and opens in 2017 for the 2017 traffic level. Instead it will prudently build for a medium term traffic level such as 2025. Across Canada, we have seen airports from Toronto to Edmonton, Ottawa, Montréal, Québec, Moncton, etc. prudently build for the medium term, not for next year. This is because they are not optimizing short run variable costs, as ATRS seeks to evaluate. They are optimizing for their medium term traffic expectations, and doing so is prudent and long run efficient.

Figure 3-2
Example of an Airport's Movements Along their Cost Curves
Results taking capital into account



4 Other Issues in the ATRS Benchmarking Report

Summary: Aside from the fundamental economic theory errors of the ATRS methodology for assessing airport efficiency (errors that are fatal and remove any meaning from their airport rankings), there are other issues with the data and results that raise questions of the validity of the results.

We observe examples of serious errors in the data, such as using data where the average wage paid to airport employees at Chicago Midway airports is US$420,000. Statistical analysis with such implausible data must be viewed with great scepticism and interpretation of results is not merely problematic but potentially misleading and dangerous if used as a basis for either management of the airport, or the development of government policy. Further, these errors seem to persist for years before being corrected, if corrected at all. This is suggestive of data development and analysis that is mechanical, without common sense checks.

We also observe regression results that are not robust (coefficient estimates change dramatically from year to year such as positive to negative than back again), an observation consistent with a severely misspecified model. Rankings of airports are unstable from one year to another in many cases even though airports cannot change their technology, employment, energy use and capital investment quickly.

Most significantly, as already discussed, the ATRS methodology does not control key factors that account for cost (hence productivity) differences between airports, such as access to subsidies of various types, whether an airport must pay rent and property tax or not, whether the airport incurs cold weather operating conditions (hence costs), etc. These omissions, combined with the issue of the previous chapter of not including capital costs in the assessment of airport efficiency particularly stack the deck against YQB that has been severely challenged in inheriting an airport with inadequate infrastructure, must pay rent (which increases as it invests more, which starts a cycle of further rate increases), must pay property taxes, operates in a cold climate, and inherited a terminal with limited opportunity for commercial revenue developments. The ATRS finding of low efficiency for YQB must be set aside as it fails to consider any of these cost increasing aspects of YQB.

4.1 Introduction

Aside from the underlying model used in the analysis, there are issues with the data used by ATRS to compute their efficiency measures. ATRS data for YQB contains significant numerical errors that remain in published versions of the studies. These data errors have been brought to the attention of the ATRS, but this has not resulted in a recall and replacement of their benchmarks. In addition to this, there are issues with the regression analysis and robustness of their results.

4.2 Erroneous Average Compensation Estimates

We have not undertaken a comprehensive review of the ATRS data. In part it is a matter the huge amount of time required but also cost. For an academic society, the cost of obtaining the ATRS data is extremely high, higher than other commercial and industry association sources of data. Instead, we focused on a few variables that are key to their analysis and airport rankings.

We looked at an important variable cost data element: average salaries of the airport's employees. Table 4-1 shows a number of examples of airports with average salaries that are implausible or have such large fluctuations from year to year that there are likely errors in the data.

- Our favourite observation is the 2015 average salaries of airport workers (not the pilots at the airlines, only those working for the Department of Aviation at these two airports) for the two Chicago Airports. The Midway average salary exceeds the official salary of the U.S. President, and the purported salary at O'Hare is quite respectable as well. Clearly these numbers and several others in the selection in the table are implausible.

- Now consider Edmonton, whose ATRS salary values jumped dramatically in 2012, was not corrected in 2013, then was revised downward in 2014 and further downward in 2015. The lack of correction in what are clearly data anomalies is troubling as it suggests a mechanical approach to data entry with no common sense/intuitive assessment of the data.

What is worrying is that these data points were used by ATRS in the measurement of VFP, SFPs and in the critical VFP regressions used to assess airport management efficiency.

Table 4-1
Examples of Average Salaries Reported by ATRS
2011-2015

Airport	Average Annual Employee Compensation ($US)				
	2011	2012	2013	2014	2015
Salt Lake City (SLC)	82,814	84,034	82,229	86,212	66,957
Edmonton (YEG)	90,805	135,251	151,614	95,273	82,243
Minneapolis (MSP)	117,756	120,825	125,631	126,279	86,454
Victoria (YYJ)	101,622	102,895	105,169	102,801	89,279
St. John's (YYT)	115,910	133,830	102,108	124,762	112,384
Chicago O'Hare (ORD)	103,583	107,010	109,152	109,033	357,879
Chicago Midway (MDW)	181,645	177,020	183,424	173,160	419,258

Source: Adapted from ATRS (2017)

There is no indication that these erratic fluctuations and extreme values are addressed in the computations of overall efficiency, and not doing so would lead to erroneous and misleading results. The fact that the ATRS presents this data with no indication of adjustments made for possible errors brings into question the validity of the overall results. Regarding Chicago's airports in 2015, ATRS does note the possible misleading results,[11] but there is no indication of whether or not this was accounted for in the overall productivity calculation. The fact that these airports were ranked and the data table not corrected

[11] The increase in wages was due to a required increase in pension benefits.

strongly suggests that the incorrect values, of which ATRS has suspicions, were nevertheless used and the airports ranked. It's not merely a matter of the Chicago airports being incorrectly ranked. The errors in their data change the VFP regression coefficients which in turn affects the rankings of all the airports.

For those of us with actual airport experience, many of the numbers in Table 4-1 are implausibly high.

These data issues are not limited to the North American airports; there are a number of examples of airports in the Asia Pacific and European data which have large increases, decreases, or exhibit large fluctuations in average salary.

4.3 Issues with Landing Fee Comparisons

One section of the ATRS benchmarking exercise focuses on the comparison of landing fees for a sample of airports. Benchmarking landing fees is a complex exercise, and there are important subtleties of which the ATRS fails to account for. For example, in the most recent ATRS report (2017), the Australian airports are excluded from the landing fee comparison as they use a charging structure based on passenger charges, not weight based landing fees, and the passenger fees are intended to cover both terminal and airfield costs. ATRS does include a comparison combining terminal and landing fees, but the inclusion of a landing-fee-only comparison is misleading. It is naïve to assume, as ATRS does, that landing fees are intended only to cover airfield costs and passenger charges only terminal costs. Certainly for airports in Canada this is not the case (yet another ATRS distortion affecting YQB) where the Airport Improvement Fee is used to finance airfield and terminal projects. ATRS seems to want to impose a 1980s approach to airport charging that is no business practice for many if not most airports.

There are other subtleties to analysing airport charges, including the use of commercial contracts and airport incentive/discount programs. In work we are currently undertaking we are finding that actual average airport charges are significantly less than posted airport fees.

In addition to the computational issues, there is the misleading impact of comparing airport charges without taking into account other exogenous factors. These include the regulatory environment and capital investment, whether airports are single or dual till, among others. By ignoring the regulatory environment, the finding of high or low airport charges could be of little influence by airport management (e.g., comparing airports under single-till and dual-till regulation). An airport may also have high aeronautical charges due to major capital investments in the airport, which would benefit the users (airlines and passengers).

We note that there are commercial sources of landing comparisons that are more carefully constructed.[12]

4.4 Robustness of Regression Analysis

The ATRS analysis does note that VFP analysis alone would not be a complete comparison, as it does not take into account factors which are outside of management control (for example, the split of domestic and international passengers).[13] To account for some of these factors, regression analysis is done. There is a lack of robustness to this analysis though. Reviewing the regression results shows changes in magnitude and sign for variables, as well as issues when pooling multiple years of data. In addition to this, the regression models change in the annual reports, making comparisons more difficult. Table 4-2 provides examples of changes in the regression analysis from various ATRS Benchmarking Reports.

[12] E.g., See the Leigh Fisher (formerly Travers Morgan, and TRL) survey of airport charges. This survey is decades old and carefully constructed.
[13] ATRS (2017).

Another factor that is not taken into account is the issue of capital. As airports are highly capital intensive businesses, not including this would likely result in biased results (in this case, omitted variable bias). This would imply that the other estimates are inherently incorrect. However, the magnitude of this bias is unknown without statistical analysis. ATRS does not indicate which, if any, additional statistical tests are undertaken when computing the residual regressions.

Table 4-2
Examples of Lack of Robust Regression Results

Variable	Change in Results
% Non-Aeronautical	Europe model has magnitude change when adding three years of data • 0.39 (2000-2004) • 0.57 (2001-2007)
% International	Asia Pacific model has sign changes when adding three years of data • 0.01 (2001-2004) • -0.03 (2001-2007) • 0.01 (2009-2015)
% Cargo	Europe model has sign changes when adding three years of data • 0.11 (2000-2004) • -0.04 (2001-2007)
Aircraft Size	Asia Pacific model has sign changes when adding three years of data • 0.53 (2001-2004) • -0.10 (2001-2007) • 0.28 (2009-2015)

Source: Inter*VISTAS* Review of ATRS Benchmarking Reports (2003, 2004, 2005, 2006, 2007, 2009, 2017)

4.5 Unstable Rankings and Comparisons

Given the nature of business at airports, one would expect that efficiency would be relatively stable year to year, unless a major investment was made in a given year. Unfortunately, many of the ATRS airport rankings are quite unstable, which questions the validity of multiyear comparisons.

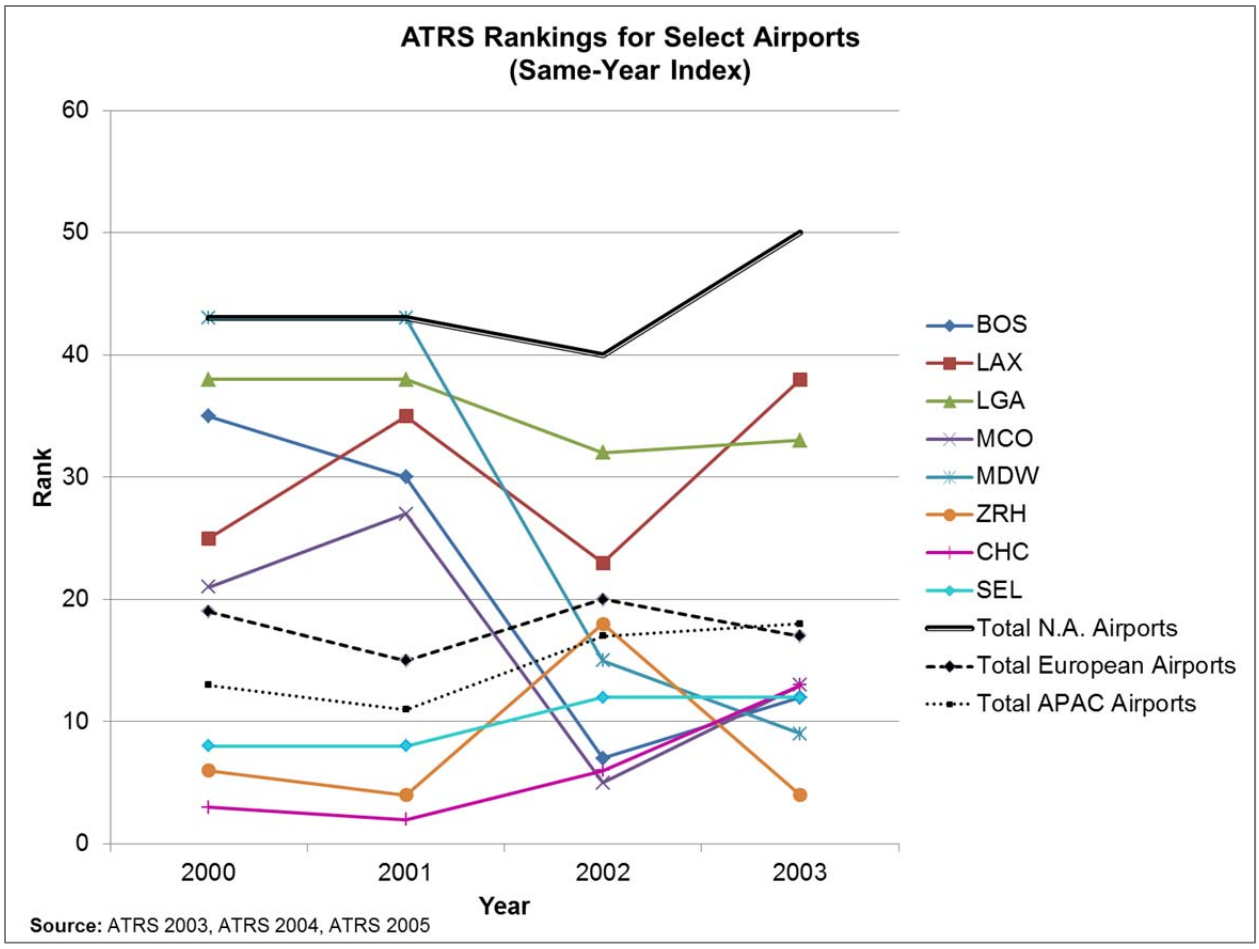
Figure 4-1 shows examples of unstable year by year rankings.[14] While an airport could be expected to move around a few spots in the ranking year to year, moving up ten spots and then back down the rankings the following year seems improbable in the airport industry. The charts highlight the key trends in rankings for a selection of airports including:

[14] This figure shows the year over year rankings, without indexing to a specific year.

- *Volatility* – some airports show wide variation in their rank each year but maintain a stable average rank. For example, the Los Angeles International (LAX) ranking in the same-year index (Figure 4-1) changes by -10, +12, and -15 between 2000-2003 out of a set of 40-50 airports. We note that this volatility occurs regardless of change in the number of airports included in the set, i.e., the relative rank of the affected airports shifts each year.

- *Dramatic shifts in relative rank within a short period of time* – for instance, in the same-year index (Figure 4-1) Christchurch (CHC) moves from the second best Asia-Pacific airport to one of the lowest ranked airports within a two-year span (2001-2003).[15]

Figure 4-1
Examples of Unstable Residual VFP Rankings
Year by Year Comparison



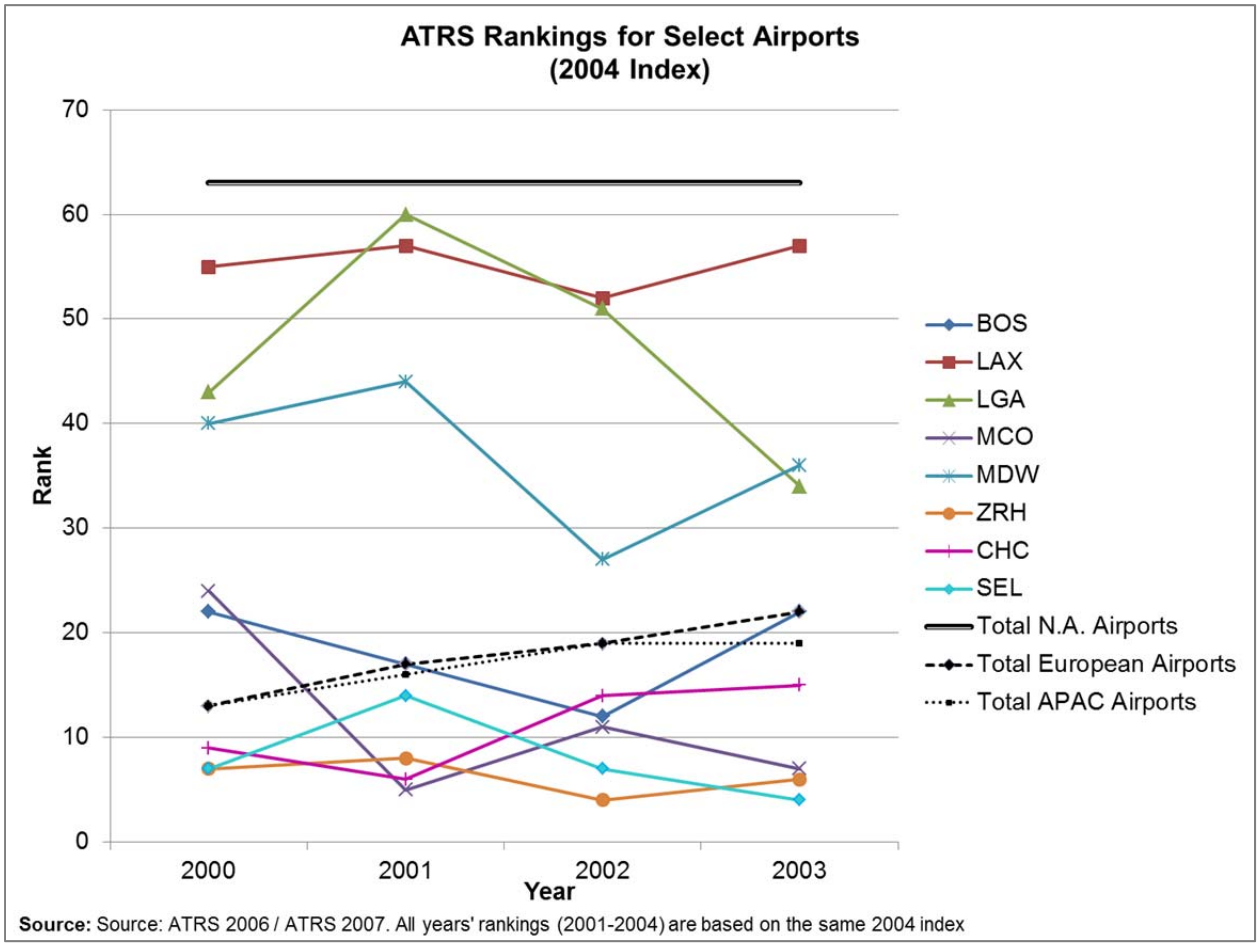
[15] Christchurch airport was affected by a major earthquake, the type of event that could change an airport's ranking suddenly. However that event was almost 10 years after the observed shift in rankings.

Figure 4-2 shows the change in rankings, but the results of each of the years 2000 to 2003 are indexed to the rank results for the 2004 analysis. This figure shows that there are major differences in the relative rank of airports between the same-year index (simply comparing the ranks year by year) and indexing to a specific year (2004 in this case).

- Simply indexing to a different year can cause major discrepancies in an airport's rank. According to the same-year comparison, Chicago Midway Airport (MDW) ranks around the top-third or higher for all North American airports in 2002 and 2003. However, the 2004-index (Figure 4-2) shows MDW in the bottom-third for 2002 and around the middle of the group for 2003.

While certain shifts in rank may reasonably indicate real change in an airport's performance, the above trends observed across several airports allude to inconsistency and non-robustness in the ATRS VFP methodology.

Figure 4-2
Examples of Unstable Residual VFP Rankings
Specific Index Year Comparison



Source: Source: ATRS 2006 / ATRS 2007. All years' rankings (2001-2004) are based on the same 2004 index

4.6 The Impact of Ignoring Quality of Service Measures

An important element in assessing efficiency of any organization is to have an appropriate measure of output. The ATRS measure of output does not include any element of quality. Quality comes at a price – airports that offer a low level of service will require fewer resources/inputs to move a given number of passengers than an airport that offers a high level of service. ATRS is essentially assuming airports offering a wide range of service quality are all apples and thus comparable.

4.7 The Implications of the ATRS Benchmarking Report Errors

While there is merit in the exercise of benchmarking airports for efficiency, given the data and model issues, the use of the results of the ATRS benchmarking exercise can and has led to the erroneous judgement of airports; these airports may be efficiently managed, but due to the deficiencies in the model, are found to be (erroneously) inefficient.

5 What Can We Say About YQB?

Our Opinion:
ATRS ranks YQB low in terms of airport efficiency. In our view this ranking is erroneous.

ATRS ranks YQB very low only in one measure. For most of the other measures YQB is ranked average, a bit below average or a bit above average relative to its 'peers'. However, it is important to understand that the 'peer' airports are almost uniformly of much greater size. Of the 'peer' airports, 86% are U.S. airports, all of which are many times larger than YQB. Of the 73 U.S. peer airports, 55% serve more than 10 million passengers per year, compared with YQB's 1.6 million. Only three of the Canadian airports are of similar size to YQB and the rest are much larger.

ATRS ranks YQB as being in the middle of the pack of its much larger peer airports in terms of landing & terminal fees and its non-capital costs (which ATRS calls 'soft' costs). It finds YQB has lower than average labour productivity, but ATRS makes no adjustment for the relatively small size of YQB (96% of the peer airports are much larger than YQB with roughly one-third being ten times larger), nor for the much higher crew requirements at YQB to deal with what is likely the 2nd highest snow removal challenge among all the peer airports.

The one measure where ATRS ranks YQB very low is the residual variable factor productivity measure which it claims is a measure of managerial efficiency. This ATRS ranking is erroneous. As already described, the ATRS methodology is inconsistent with economic theory, its execution of the method uses erroneous data, and most importantly it does not control for key cost elements which are beyond the control of management, including rents and property taxes (the 86% of peer airports that are US airports pay not rent or taxes) or snow removal costs. These non-controllable costs alone increase YQB's variable costs by 20% yet ATRS makes no allowance or adjustment for them. The ATRS measure of managerial efficiency is no such measure – it measures nothing with any valid economic meaning.

In actual fact, YQB has had a remarkable record. After 12 years of no growth (actually a small decline in traffic) under federal government operation, its traffic has grown every single year under the management of Aéroport de Québec inc., and that growth has been much higher than the national average. The terminal it inherited from Transport Canada was completely inadequate to handle this growth and AQi has had to make two major investments in terminal capacity to facilitate traffic and enable the consequent benefits from greater air connectivity to tourism and the community generally.

In sum, the ATRS efficiency ranking of airports makes allowance for none of these factors. Not only is the ATRS methodology and data wrong, it does not control for the critical and cumulative challenges YQB faces. ***The ATRS efficiency rankings are invalid.***

We would like to correct and redo the ATRS study to provide a more meaningful assessment of YQB, but this benchmarking can only be fixed at great expense and time. We do not feel that doing so would be useful. Instead we offer our opinion that YQB faces greater challenges and penalties than any peer U.S. airport, and among its Canadian peers, YQB must pay the second highest property taxes per passenger, and until its recent terminal development has not had the opportunity to generate offsetting commercial revenues. Its development has been expensive largely due to factors beyond the control of management. ***In spite of its challenges, YQB has achieved one of the highest rates of passenger growth in Canada, and is poised to achieve even higher connectivity for the capital community by management's initiatives, such as U.S. preclearance in the near future that will support new routes to the U.S., increased seasonal overseas services, higher commercial revenues, and much higher customer satisfaction due to its investment in two new terminals.***

5.1 The Extraordinary Growth of YQB

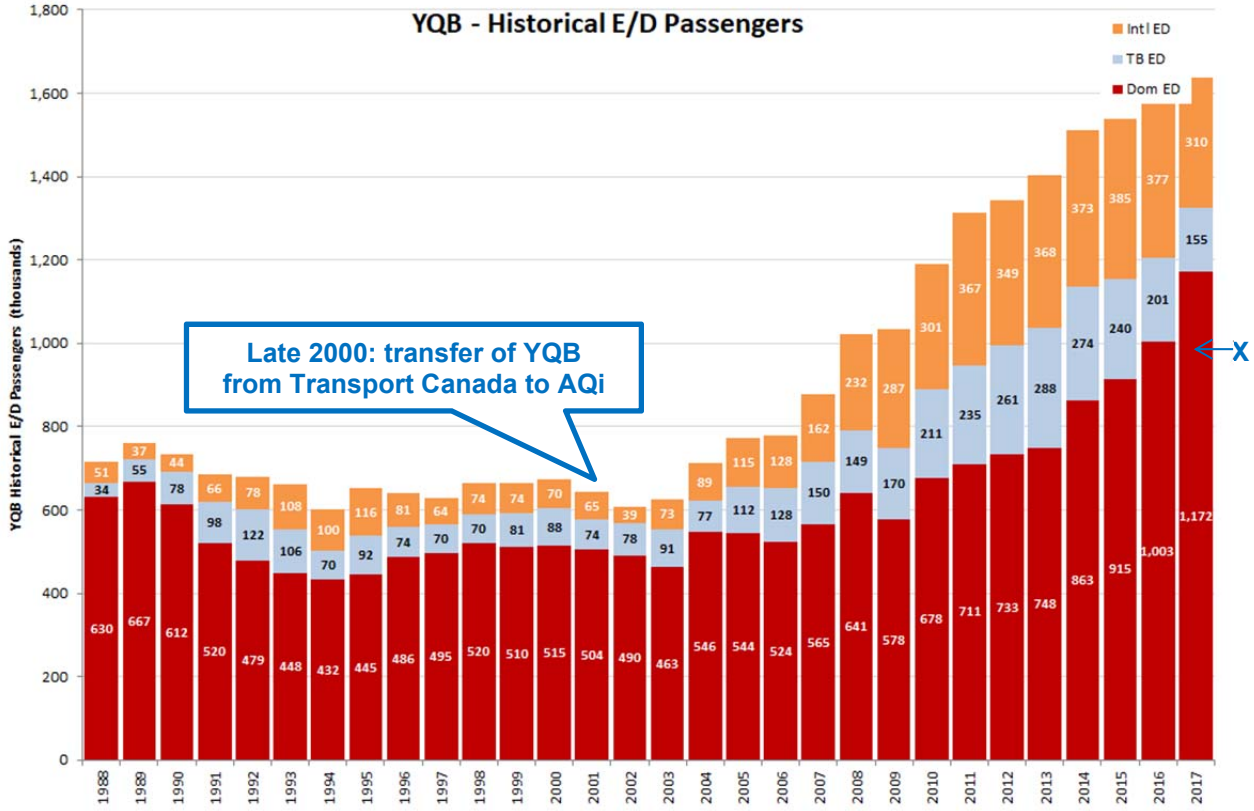
YQB is one of the fastest growing airports in Canada. In the 12 years prior to the late 2000 transfer of YQB from the Federal Government to management by Aéroport de Québec inc. (AQi), passenger traffic was stagnant, and actually fell slightly. Immediately following the economic slowdown of 2000/2001 and the air passenger traffic decline due to 9/11, YQB's passenger numbers started to grow, and have grown *every single year* since, as shown in Figure 5-1. Few airports in Canada have achieved such a record. From 2002 (the year following 9/11) and 2011, YQB doubled its traffic; and in either 2018 or 2019, YQB will have tripled its traffic.

Not only has YQB traffic grown under AQi management it has consistently grown at a rate higher than the national average. From 2000 to 2016, the average growth of air passenger traffic in Canada was 63%. At YQB, traffic under AQi management grew 135%. YQB traffic grew by double the amount of the average national airport growth.

One other comparison is useful. At the time the airport transfer was being negotiated, Transport Canada forecast that in 2016 YQB passenger traffic would be 945,200 passengers, indicated by the blue X to the right of the chart.[16] Actual traffic in 2016 was 1,580,000 -- 67% higher than projected.

[16] Transport Canada Aviation Forecasts, August 1998.

Figure 5-1
Growth in YQB Passenger Traffic
1988-2017



Source: Statistics Canada and YQB site statistics.

5.2 Previous Infrastructure Inadequate for Growth: Investment Necessary to Increase Airport and Airline Productivity

The challenge faced by AQi was that the terminal and airside infrastructure it inherited from Transport Canada, while adequate for the stagnant traffic up to 2000, was inadequate for the growth to come. At that time of transfer, YQB handled roughly 670,000 passengers with a terminal designed for no more than 500,000. AQi quickly set a priority to make a major investment in a terminal that would have more than double the capacity. This required AQi to increase its charges, including the Airport Improvement Fee, to finance this urgently needed capacity. The terminal expansion opened in 2008 with a capacity of 1.4 million passengers.

However, as air traffic continued to grow at unexpectedly high rates, it became clear that a further major terminal expansion would be required. By 2014, traffic exceeded the 1.4 million design capacity of the 2008 terminal. Thus AQi undertook a second major terminal investment program, the first phase of which opened in late 2017. The new terminal will eventually double the area of the terminal building.

A proposed U.S. preclearance facility, a service not currently available at YQB, will also greatly improve the ability of YQB to host flights to U.S. destinations. Research has shown that transborder air services (to/from the U.S.) grow significantly after preclearance services become available. Transborder services are typically operated by the same aircraft used for domestic services by U.S. carriers. Without preclearance, when an aircraft arrives from YQB, it must go to the international terminal at the U.S.

destination airport, after which the plane is typically towed to the domestic terminal for aircraft's next flight. This is time consuming and lowers productivity for the airlines, reducing the total number of flights that can be undertaken in a given day by an aircraft. As a result, without a preclearance facility, it is difficult for a Canadian airport to attract and maintain service by U.S. carriers. Canadian carriers can also benefit from preclearance via the code sharing and potential joint venture alliances with U.S. carriers. Preclearance facilities are an example of airport investments (and their associated expenses) which increase the productivity of air carriers. Airport costs are higher but carriers' costs are lower and passenger convenience greatly enhanced.

Further the new terminal investment will allow for productivity improving technologies not commonly seen at mid-sized airports. These include self-service baggage drop off and check-in facilities, kiosk based border processing (both Canada and U.S. preclearance) and dynamic communications and signage systems. Again, these are examples of investments that initially increase airport costs but which result in productivity improvements for both the airport and airlines.

The new terminal investments are also enabling development of new commercial income from food/ beverage/retail, which can be used to offset aeronautical costs. Small terminals have limited opportunities to develop such revenues, and this was the case for YQB. As the terminal is expanded, AQi will be able to accommodate more commercial opportunities to offset its core costs.[17]

5.3 The ATRS Comparison of YQB to Dramatically Larger Airports

ATRS provides 11 benchmarking measures.[18] YQB is assessed relative to a peer group of North American Airports, 73 US airports and 12 Canadian airports. First, some key observations about YQB versus the peers it is benchmarked against:

- While it has the data, ATRS provides no ranking of the peer airports by size.
- If it had done so, it would reveal that none of the U.S. airports to which YQB is compared is remotely close in size (passenger traffic) to YQB. 40 of the 73 US airports in the peer group (55%) have traffic greater than 10 million passengers. Just under half of these have traffic of 25 million passengers or greater. It is our opinion that these are not appropriate peers for YQB.
- YQB is being compared with the largest airport in the world, Atlanta (with over 100 million annual passengers compared with YQB at 1.6 million passengers).
- Among the Canadian airports in the peer group YQB is among the three smallest.
- Thus, out of 85 airports in the ATRS peer group, YQB is essentially tied with two other Canadian airports as the smallest. Ninety six percent of the peer airports are larger than YQB, with most being dramatically larger.[19]

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[17] As a not-for-profit organization, AQi must invest any income from commercial activities into core airport infrastructure and services. This is not the case for many airports elsewhere in the world.
[18] These include three partial factor productivity measures (labour, soft cost and "capital"), "gross" variable factor productivity, "residual' variable factor productivity, unit cost (cost per enplaned passenger), cost competitiveness, landing fees, terminal fees, combined landing and terminal charges, and landing charges for an A320 aircraft (ATRS does not assess YQB on its most common aircraft (Bombardier Q400),
[19] Statistically, it might be possible to describe YQB as an outlier in the peer group, meaning it is the most extreme 4% of the sample on a one tailed test.

- The peer group includes US airports that do not pay rent or property taxes. These are major cost elements for YQB and are zero for the U.S. peers. Relative to the Canadian airports (which unlike US airports must pay property tax), YQB has to pay the 2nd highest property tax per passenger.[20] Rent and property tax are cost elements that are beyond the control of AQi. Further, AQi's rent increases as it earns more revenue. Since ATRS benchmarks airports based on costs and productivity, as YQB grows, its ATRS cost competiveness will necessarily decline in this dimension.

- ATRS makes no allowance for weather related costs. YQB has the second highest snowfall of the Canadian airports and incurs the related costs. Almost all of the U.S. airports have much lower snow removal requirements. To deal with snow removal YQB requires roughly a 8.5 % yearly increase in staff.[21]

- ATRS makes no allowance for the safety requirements of airports and the associated costs. YQB is a category 8 airport which has 24 hour safety crew requirements and the requirement for substantial investment in rescue and firefighting equipment. While most of the peer airports are category 8 to 10, the small traffic base of YQB (relative to the 82 larger airports in the peer group) means that its safety costs per passenger are much higher than almost all peers.

In sum, ATRS is inappropriately comparing YQB to airports that are dramatically larger and with no adjustments being made for key cost elements that are beyond the control of AQi management such as rent, property tax, safety and snow removal. The ATRS comparisons of YQB are dubious, at best.

5.4 Errors in ATRS Data for YQB

Section 4 raised the general problem of data inaccuracies in the ATRS data and the lack of stability/robustness in its statistical analysis. There are specific problems in the ATRS data for YQB.

- An example is the ATRS claim that YQB's 56% ratio of nonaeronautical revenue to total revenue. The correct number is 38%.[22]

- In a past version of the ATRS Report, YQB passenger traffic was misstated by 30%. This was due to a data entry error, but given that ATRS had data on earlier year's traffic, if care had been used, the data error should have been obvious.

5.5 The ATRS Ranking of YQB

Notwithstanding the ATRS major error in its methodology for assessing airport productivity, its errors in execution of their "research" with problems such as major errors in data, and its failure to control for critical factors affecting YQB such as rent and property taxes being beyond the control of management, we now make some comments on how YQB compared.

- On many dimensions, ATRS found YQB to be in the middle of the pack of peer airports, even though 96% of them are much larger. YQB's landing fees for an A320 (the only comparable aircraft in the ATRS analysis) are almost exactly the average of the larger peers. Its ranking on

[20] Montreal is the other high property tax per passenger airport.
[21] This shows up in the ATRS analysis as an increase in "soft" costs.
[22] The comparison is done for 2015 data from AQi's annual report. ATRS uses 2015 data.

soft costs productivity is also at the average of its much larger peers. The overall measure of cost competitiveness is only just a bit above the mean of the peer airports.[23]

- For the percent of revenue from commercial services (non-aeronautical revenues), YQB ranks around the average, although the ATRS data for YQB is erroneous. Using the correct data, YQB ranks midway between the average and the lowest performing airports, as would be expected for one the three smallest airports in the peer group. In fact, in 2015, YQB outperformed many of the smaller airports (due in part to its investment in the terminal expansion). Further, ATRS finds that some of the largest US airports performed much worse than YQB on this measure, airports such as Chicago, Houston and Newark.[24]

- YQB's ranking on labour productivity is lower than average, but is not the lowest. This ATRS ranking does not control for factors such as snow removal, nor for its very small traffic base relative to the set of peer airports. In fact, YQB ranks almost identical with LAX (Los Angeles International Airport) in labour productivity, one of the largest airports in the world.

The one measure where YQB is ranked lowest is the 'residual' Variable Factor Productivity Measure.[25] However, this result is without any meaning.

- YQB's ranking on this measure is almost identical to that of major airports such as Pittsburgh, Memphis, Anchorage, Cleveland and Cincinnati, among others.

- As discussed in Chapter 3, the methodology is inconsistent with economic theory. What ATRS computes as residual VFP is not a measure of management efficient. It is not a measure of anything that has any economic meaning. It is a blind computation from equations that violate economic concepts and is based on incorrect data. There is no meaning in this measure.

- Even if the methodology was correctly specified and used accurate data, it would still lack validity as a basis for comparing managerial efficiency, as it does not control for key items beyond management control. Among these are the high rents and property taxes paid by YQB (which amount to 15-20% of non-capital costs for AQi) which US airports do not pay, and which are higher per passenger for YQB than the other Canadian airports. It does not control for required safety expenditures, nor for high snow removal costs. This is a critical point, as ATRS is claiming that their residual VFP number is a measure of managerial efficiency. By not controlling for major

[23] I note that I am not confident of the ATRS measure of unit costs for a number of reasons, and thus do not place much weight on this finding.
[24] Given the errors in the ATRS data on this measure (YQB is not the only data error), I am unwilling to draw any precise conclusion on any airport in the ATRS study.
[25] YQB ranks below average but is not the lowest on the ATRS measure of 'gross' VFP. It performs better than airports such as Oakland, Baltimore, Cleveland, Pittsburgh and others. Again, because of the execution errors of the ATRS report, these rankings have no meaning.

cost elements that are beyond the control of managers, residual VFP, even if properly computed, cannot be a measure of management performance.[26]

We would like to correct the errors of the ATRS data and methodology and offer a meaningful alternative measure for AQi in its management of YQB airport productivity and managerial efficiency. Unfortunately, we are unable to do so, as this would require fixing data problems for all the ATRS airports and fixing and re-executing the ATRS methodology.

Nevertheless, based on our extensive experience with over 100 airports, we offer the opinion that YQB's performance should be viewed positively. It is an airport that was severely challenged by inheriting a terminal and runway system that was inadequate for its future needs, and this was compounded by an unanticipated high growth rate. It had to transition from 12 years of no traffic growth to one of the highest growth rates of airports it size. It could only do that by making a series of major investments to accommodate that growth. This necessitated higher fees, both to cover the needed investments and to pay rent (which did not have to be paid in the previous years and which its US peers still do not pay) and the 2nd highest property tax per passenger in Canada (a distinction shared with Montreal relative to other Canadian airports). YQB faced these challenges and has delivered the infrastructure necessary for serving the community and achieved a tremendous record of air service growth and greater connectivity.

[26] Even if residual VFP were computed correctly according to economic theory (which it is not) and with correct data, at best it would be a mixed measure of managerial efficiency *plus* penalties the airport must endure due to location, government policy (property taxes, rents), safety requirements and especially its small size. The ATRS measure is not a measure of managerial efficiency. The ATRS authors may claim that their regression analysis controls for airport size, but a) the existing regression results are wrong and if corrected would undoubtedly have a higher adjustment (coefficient) for airport size, and b) making inference for an airport that is exceeded in size by 96% of the peer airports would be unwarranted. In statistical parlance, inference for data points so far from the mean would have very large standard errors around the residuals meaning that the residual VFP measure is not a precise number but rather a random variable with a very large confidence range.

List of Abbreviations

A4A	Airlines for America
ACI	Airports Council International
APAC	Asia Pacific Airports
ATRS	Air Transport Research Society
BOS	Boston Logan International Airport
CAC	Canadian Airports Council
CAPA	formerly, Centre for Asia Pacific Aviation; now simply CAPA
CHC	Christchurch International Airport (New Zealand)
IATA	International Air Transport Association
ICAO	International Civil Aviation Association
IDTA	Interest, Depreciation, Taxes and Amortization
LAC	Long-Run Average Cost
LAX	Los Angeles International Airport
LGA	New York LaGuardia Airport
MCO	Orlando International Airport
MDW	Chicago Midway Airport
OECD	Organization for Economic Cooperation and Development
SAC	Short-Run Average Cost
SEL	Seoul Incheon International Airport
SFP	Single Factor Productivity
TFP	Total Factor Productivity
UBC	University of British Columbia
VFP	Variable Factor Productivity
YQB	Québec City Jean Lesage International Airport
ZRH	Zurich International Airport

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