Efficiency in the Canadian Life Insurance Industry: Some Preliminary Results Using DEA

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Outline of Presentation

- Introduction
- Purpose
- Literature Review: Efficiency Measurement Concepts
- Literature Review: Efficiency in Insurance
- Measures of Outputs/Inputs and their Prices
- Estimating Efficiency (DEA)
- Data
- Results
- Implications of Results
- Limitations of Study
Introduction
The Canadian L/H Market (2000)

• Over 23 billion USD in Net Premium Volume (ranked 8th worldwide). Accounts for 1.53% of the world market vs. 29.08% for the USA.

• Currently, 110 companies are monitored for financial soundness by OSFI (49 Canadian, 61 Foreign).

• Increasing concentration due to consolidation (In 2000, MS of Top 5= 64% vs. 47% in 1994).

• The market is dominated by 5 large stock co’s:
  – Canada Life, Clarica, Great-West Life / London Life, Manulife Financial, Sun Life Financial
Introduction (cont’d)

• Canada’s Life Insurance Industry has continued to consolidate since the demutualization wave of 1999-2000
  – Most of the growth by acquisition has come from outside Canada:
    • Daihyaku Mutual (Japan) by Manulife
    • Keyport Life (USA) by Sun Life
    • Ohio National –Group Business (USA) by Canada Life
  – Within Canada, acquisitions have been small:
    • Commercial Union and Zurich Life by Manulife
    • RSA Life by Maritime Life
Introduction (cont’d)

– Since 1/1/2002, lower regulatory constraints on M&As among newly demutualized insurers
  • Sun Life acquired Clarica in May 2002 becoming Canada’s largest L/H Insurer.

– According to A.M. Best (July 17, 2002):
  • Fewer (often smaller) Canadian life companies remain as potential acquisition candidates
  • Major Canadian stock companies will focus on external expansion, primarily in the USA.

– In such a context, the need for benchmarking has never been so strong.
Purpose

• Our goal is to rely on frontier methodologies to measure firm performance relative to “best practice” frontiers derived from firms operating in the Canadian L/H industry (benchmarking).

• Using the technique called DEA to estimate the cost and revenue efficient frontiers, we hope to be able to answer to the following research questions:
  - Are L/H Insurers Operating in Canada Minimizing Costs and Maximizing Revenues?
  - Is there Evidence of a Lack of « Scale » among L/H Insurers Operating in Canada?
Literature Review: Efficiency Measurement Concepts

• Farrell (1957) suggests that a firm’s economic efficiency (cost and revenue) can be computed relative to “best practice” efficient frontiers, consisting of the dominant firms in the industry.

• As defined in Cummins (1999):
  – The **efficient cost frontier** represents the lowest costs attained by firms in the industry to produce a given bundle of outputs.
  – The **efficient revenue frontier** represents the maximum revenues earned by firms in the industry with a given amount of inputs.
Literature Review: Efficiency Measurement Concepts (cont’d)

• For a specific firm, cost efficiency (the firm’s success in minimizing costs) can be decomposed as follows:

\[
\text{Cost} = \text{Technical} \times \text{Allocative Efficiency} \times \text{Allocative Efficiency}
\]

where,

\[
\text{Technical} = \text{Pure Technical} \times \text{Scale Efficiency} \times \text{Scale Efficiency}
\]

• **Pure technical efficiency** measures the firm’s success in using the best available technology. **Scale efficiency** indicates whether the firm is operating with IRS, DRS or CRS (ideal). **Allocative efficiency** measures the firm’s success in minimizing operating costs by choosing the optimal mix of inputs.
Literature Review: Efficiency in Insurance

• Bernstein & Geehan (1988) summarize previous econometric studies of economies of scale in both P&C and L/H insurance worldwide. They conclude that:
  – When present, economies of scale are found for relatively small output quantities. In general, insurance firms operate with CRS.
  – Biased estimates of scale economies are found in many studies due to inappropriate output measures;
  – Strong need to develop and empirically implement new models to investigate economic efficiency in both P&C and L/H.

• In a study of the Canadian P&C insurance industry using a translog cost function, Suret (1991) concludes as follows:
  – “Our evidence of slight economies of scale and no economies of scope is compatible with observation that many insurance companies in Canada are small and undiversified”.
Literature Review: Efficiency in Insurance (cont’d)

• Cummins (1999) uses DEA to characterize the cost and revenue efficiency of U.S. life insurers because of its convenience for estimating economies of scale. His main conclusions are:
  – TE is generally quite low in the industry, leading to low average cost efficiency scores;
  – RE is also highly dispersed and very low on average;
  – Most small insurers operate with IRS, whereas most large insurers operate with DRS. About 20% of the firms in the industry operate with CRS;
  – The most efficient insurers tend to specialize, and a strong performance seems possible regardless of the choice of distribution systems.
Literature Review:
Efficiency in Insurance (cont’d)

• To the best of our knowledge, DEA has not been used to study the efficiency of the Canadian L/H insurance sector.

• U of T’s CMTE has an ongoing research program on firms’ performance in the Canadian financial services industry (Banks, Mutual Funds, P&C Insurers):
  – Hewlitt (1998) uses DEA to measure the relative efficiency of 120 Canadian P&C insurers. She concludes that variable returns to scale (VRS) exist in the industry.
Measures of Outputs/Inputs and their Prices

• As in Cummins (1999), we define five output variables for the five major lines of business offered by life insurers (individual life, group life, individual annuities, group annuities and accident and sickness insurance) as follows:
  
  Incurred Benefits + Additions to Reserves

• The price of each insurance output is equal to the sum of premiums and investment income minus output for the line divided by output (measure of value-added):

  Price = \frac{[Premiums + Investment Income – Incurred Benefits – Additions to Reserves]}{[Incurred Benefits + Additions to Reserves]}
Measures of Outputs/Inputs and their Prices (cont’d)

• Also like Cummins (1999), we define four insurance inputs: administrative labor, agent labor, business services and financial capital.

• Input prices are based on survey data compiled by Statistics Canada

• Estimates of the quantity of each input for all insurers in our sample are obtained by dividing expenditures on these three expense categories by their respective wage variables
  – For agent labor, we use a yearly average wage variable weighted according to an insurer’s premium volume in each province.
  – For administrative labor and business services, we use a yearly wage variable for the province where the home office is located (more often Ontario).
Measures of Outputs/Inputs and their Prices (cont’d)

- The quantity of financial capital is measured as the amount of equity capital reported to the regulatory body.
- In order to estimate an insurer’s yearly cost of equity capital, we adopt the following approach (CAPM):
  1. Average the annualized monthly returns on 10-year Federal Bonds as a yearly proxy for $R_f$ (e.g. 5.5% in 1999)
  2. Use Great-West stock’s beta for each year (e.g., $\beta_{99} = 0.622$)
  3. Use an equity risk-premium of 5.7% to get GW cost of equity capital (e.g. 9% in 1999) as our base case (AA++)
  4. Use each insurer’s 1999 Best’s rating in order to adjust estimate by adding an extra premium as follows:
     AA++  No further adjustment (same estimate than GW)
     A+   add 0.5%
     A    add 1.0%
     etc.,
Estimating Efficiency (DEA)

- DEA is a non-parametric mathematical approach to frontier estimation that is implemented by solving linear programming problems. Following Cummins (1999), DEA efficiency is measured for every insurer (DMU’s) in our sample. We use CRS and VRS models as proposed by Banker, Charnes and Cooper (1984). Such a specification permits the calculation of TE devoid of SE effects.

- DEA seeks a set of other insurers from the industry that dominate the insurer in question (e.g., a set of insurers that have lower costs than a specific insurer while having similar outputs and inputs).
Estimating Efficiency (DEA) (cont’d)

• If a dominating set exits, then the insurer in question is identified as being less than fully efficient. Its efficiency is measured relative to this set:
  – Its cost efficiency score (between 0 and 1) is the ratio of the costs that would have been expended by the dominating combination of insurers to the costs the insurer actually incurred.
  – Its revenue efficiency score (between 0 and 1) is the ratio of the revenues of the given insurer to the revenues of the dominating set of insurers.

• Of course, when no dominating set exits, the insurer is considered “self efficient” and is given a score of 1.
Data

- **Sources:**
  - A. M. Best’s WinTRAC 2000 (L/H) for yearly financials (drawn from the regulatory annual statements filed by insurers with OSFI) and 1999 ratings.
  - **Statistics Canada** (Catalogue No.72-002-XPB) for the wage variables of labor and business services inputs.
  - **Bank of Canada’s Web site** for average yearly risk-free rates (10-year Gov. Bonds) for cost of equity capital estimation.

- **Period covered:** 1996-1999
- **Sample:** We eliminated firms with unusual characteristics and/or incomplete information. Final sample consisted of 69 firms per year (about 97% of industry assets).
Results on Average Efficiencies and Inter-Firm Performance

• Efficiency (all types) averages (arithmetic and asset-size weighted) for the entire sample and for the Big 6 companies over the period 1996-1999 are shown in Table 1, with their corresponding standard deviations shown in Table 2.

• It appears that:
  – the overall profile is quite different when we compare simple versus asset-size weighted averages.
  – when the same weight is given to all insurers, average (simple) efficiencies increased over the sample period, whereas the dispersion in efficiencies decreased.

• CE averages are relatively low (due mostly to low AE averages), whereas RE averages are higher.
Results on Average Efficiencies and Inter-Firm Performance (cont’d)

- when insurers are weighted according to their total assets in each year, averages are indicative of a strongly efficient industry. Indeed, we have high TE scores and increasingly stronger RE scores over the sample period. Likewise, standard deviations for TE and RE decreased.

- on an asset-size weighted basis, Canadian insurers are showing relatively high, but declining, CE and AE average scores. Moreover, the dispersion of these efficiency scores has increased over the sample period.

- The Big 6 insurers have been struggling a bit more since 1998 in managing their operating costs and in choosing their mix of inputs. There is something peculiar about 1998 which needs to be analyzed further.
Table 1
Efficiency in the Canadian Life Insurance Industry (Averages)

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
<th>Allocative</th>
<th>Technical</th>
<th>Pure Technical</th>
<th>Scale</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arithmetic Average - All companies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>29.00%</td>
<td>32.88%</td>
<td>79.61%</td>
<td>98.80%</td>
<td>80.45%</td>
<td>60.18%</td>
</tr>
<tr>
<td>1997</td>
<td>30.81%</td>
<td>34.04%</td>
<td>84.87%</td>
<td>98.58%</td>
<td>85.87%</td>
<td>70.20%</td>
</tr>
<tr>
<td>1998</td>
<td>71.54%</td>
<td>75.48%</td>
<td>94.62%</td>
<td>98.60%</td>
<td>95.82%</td>
<td>69.92%</td>
</tr>
<tr>
<td>1999</td>
<td>32.41%</td>
<td>34.54%</td>
<td>93.84%</td>
<td>98.99%</td>
<td>94.64%</td>
<td>88.17%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
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<th>Pure Technical</th>
<th>Scale</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weighted Average - All companies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>87.83%</td>
<td>88.70%</td>
<td>96.37%</td>
<td>98.24%</td>
<td>98.04%</td>
<td>84.55%</td>
</tr>
<tr>
<td>1997</td>
<td>88.37%</td>
<td>88.95%</td>
<td>98.25%</td>
<td>99.31%</td>
<td>98.89%</td>
<td>84.69%</td>
</tr>
<tr>
<td>1998</td>
<td>69.65%</td>
<td>70.48%</td>
<td>98.83%</td>
<td>99.68%</td>
<td>99.10%</td>
<td>74.26%</td>
</tr>
<tr>
<td>1999</td>
<td>76.54%</td>
<td>77.12%</td>
<td>98.61%</td>
<td>99.59%</td>
<td>98.97%</td>
<td>93.73%</td>
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<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
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<th>Pure Technical</th>
<th>Scale</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weighted Average - Big 6</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>98.42%</td>
<td>98.78%</td>
<td>97.40%</td>
<td>98.19%</td>
<td>99.15%</td>
<td>88.77%</td>
</tr>
<tr>
<td>1997</td>
<td>99.16%</td>
<td>99.16%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>87.51%</td>
</tr>
<tr>
<td>1998</td>
<td>69.15%</td>
<td>69.15%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>78.72%</td>
</tr>
<tr>
<td>1999</td>
<td>86.47%</td>
<td>86.47%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>97.03%</td>
</tr>
</tbody>
</table>
Table 2
Efficiency in the Canadian Life Insurance Industry (Std. Deviations)

<table>
<thead>
<tr>
<th>Sample Standard Deviation - All companies</th>
<th>Cost</th>
<th>Allocative</th>
<th>Technical</th>
<th>Pure Technical</th>
<th>Scale</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>34.37%</td>
<td>35.44%</td>
<td>22.00%</td>
<td>2.40%</td>
<td>21.84%</td>
<td>23.44%</td>
</tr>
<tr>
<td>1997</td>
<td>33.38%</td>
<td>32.94%</td>
<td>19.27%</td>
<td>3.09%</td>
<td>18.69%</td>
<td>24.24%</td>
</tr>
<tr>
<td>1998</td>
<td>24.68%</td>
<td>25.77%</td>
<td>8.96%</td>
<td>2.59%</td>
<td>7.35%</td>
<td>20.78%</td>
</tr>
<tr>
<td>1999</td>
<td>24.31%</td>
<td>24.36%</td>
<td>11.74%</td>
<td>2.44%</td>
<td>10.66%</td>
<td>15.85%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weighted Standard Deviation - All companies</th>
<th>Cost</th>
<th>Allocative</th>
<th>Technical</th>
<th>Pure Technical</th>
<th>Scale</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>25.87%</td>
<td>25.11%</td>
<td>7.98%</td>
<td>4.16%</td>
<td>6.34%</td>
<td>17.38%</td>
</tr>
<tr>
<td>1997</td>
<td>25.09%</td>
<td>24.10%</td>
<td>6.79%</td>
<td>2.91%</td>
<td>5.78%</td>
<td>17.93%</td>
</tr>
<tr>
<td>1998</td>
<td>23.60%</td>
<td>23.97%</td>
<td>4.81%</td>
<td>1.34%</td>
<td>3.95%</td>
<td>20.56%</td>
</tr>
<tr>
<td>1999</td>
<td>36.52%</td>
<td>36.00%</td>
<td>6.06%</td>
<td>1.87%</td>
<td>5.18%</td>
<td>11.86%</td>
</tr>
</tbody>
</table>
Results on Efficiency and Size

• The next figure tabulates efficiency (all types) by size quartile, where size is measured by total assets. The figure is based on efficiency and assets (arithmetic) averages over the sample period. It appears that:
  – efficiency scores in the industry vary significantly by insurer size, with larger firms being, on average, more efficient than smaller firms.
  – size has a significant impact on CE and its determinants TE (due mostly to SE but not PTE) and AE.
  – size does not matter as much when it comes to RE.
Efficiency by Asset-Size Quartile over the Period 1996-1999
Analysis of Efficiency for 1999

• Because efficiency generally increased over the period 1996-1999, we focus our attention on the results for 1999.

• In the following six transparencies, you find the frequency distribution of efficiency scores (all types) for the entire sample in 1999.

• Based upon these frequency distributions, it appears to be more difficult to achieve CE (in particular AE) than RE.
Allocative Efficiency Frequency Distribution - 1999
Scale Efficiency Frequency Distribution - 1999
Pure Technical Efficiency Frequency Distribution - 1999

The diagram shows the frequency distribution of pure technical efficiency across different percentage ranges for the year 1999. The x-axis represents the percentage ranges of efficiency, while the y-axis indicates the frequency. The distribution appears to be concentrated in the 95% to 100% range, with a significant peak at the 95% mark.
Results on the Industry’s Efficiency Leaders

- Efficiency (simple) averages and standard deviations over the period 1996-1999 for the top 10 firms are shown in Table 3 (firms appearing in the largest number of dominating sets every year during the sample period).
- It appears that the leading firms:
  - all have TE equal to 1 but much lower AE scores, leading to an average CE score of 39.7% in 1999, compared to 32.41% for the entire sample.
  - are quite efficient in choosing their mix of outputs. Indeed, their RE average score is 98% in 1999 compared to 88% for the entire sample.
- Nearly all the firms in the top 10 are specializing firms (more than ½ of their revenues come from one line).
Table 3
Efficiency Scores-Top 10 Leaders

Panel A: Averages

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
<th>Allocative</th>
<th>Technical</th>
<th>Pure Technical</th>
<th>Scale</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>51.47%</td>
<td>51.47%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>90.03%</td>
</tr>
<tr>
<td>1997</td>
<td>56.51%</td>
<td>56.51%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>95.48%</td>
</tr>
<tr>
<td>1998</td>
<td>67.86%</td>
<td>67.86%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>81.81%</td>
</tr>
<tr>
<td>1999</td>
<td>39.70%</td>
<td>39.70%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
<td>97.95%</td>
</tr>
</tbody>
</table>

Panel B: Std.Deviations

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
<th>Allocative</th>
<th>Technical</th>
<th>Pure Technical</th>
<th>Scale</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>39.30%</td>
<td>39.30%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>15.42%</td>
</tr>
<tr>
<td>1997</td>
<td>42.88%</td>
<td>42.88%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>10.40%</td>
</tr>
<tr>
<td>1998</td>
<td>32.09%</td>
<td>32.09%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>23.56%</td>
</tr>
<tr>
<td>1999</td>
<td>32.44%</td>
<td>32.44%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>5.37%</td>
</tr>
</tbody>
</table>
Results on Returns to Scale

- Scale economies (SE) for life insurers operating in Canada are shown in the next figure.
- It graphs the percentages of firms operating with IRS and CRS in 1999 (no DRS that year).
- The majority of firms in the two smallest asset-size quartiles are operating with IRS, i.e., these firms can reduce average costs by becoming larger.
- The majority of firms in the two largest asset-size quartiles have achieved the economic ideal of operating with CRS.
Returns to Scale by Asset-Size Quartile in 1999

- **1st Quartile**: Increasing
- **2nd Quartile**: Constant
- **3rd Quartile**: Decreasing
- **4th Quartile**: Constant
Implications of Results

• The main implications of this preliminary efficiency analysis of the Canadian L/H sector are as follows:
  – many insurers seem to have a hard time choosing the cost-minimizing combination of inputs.
  – the most efficient insurers are close to achieving the optimal choice of outputs, therefore maximizing revenues.
  – there is evidence of a lack of “scale” mostly among small insurers.
  – the potential acquisition candidates are indeed among the small insurers which badly need to increase their CE through an improvement of their AE.
Limitations of Study

• General limitations of DEA apply.
  – DEA being an extreme point technique, measurement error (noise) can cause problems.
  – Need to analyze 1998 results further.

• Time period is rather short.
  – Need to extend tracking window.

• Causal factors underlying observed efficiency patterns remain, for the most part, unknown.
  – Additional work on the drivers of insurer efficiency in Canada is needed