An Investigation of Life Insurer Efficiency in Canada

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Introduction

- Explore efficiency of Canadian life insurers
- First determine inefficiencies
- Then effect of inefficiency and exogenous variables on ROE
- OSFI return data from 2000 thru 2004
- By entire company and by LOB

Efficiency Calculations – Sec 2.2

- Use Stochastic Frontier Analysis (SFA)

$$\ln y_i = \ln f(x_i, \beta) + v_i - u_i$$

- $f(x_i, \beta)$ is the functional form
- β values are estimated, $\exp(v_i)$ is noise, $\exp(u_i)$ is inefficiency

Efficiency Calculations – Sec 3

- Use Translog function as functional form
- Basic Translog function:

$$\ln y = \beta_0 + \sum_{1}^{N} \beta_n \ln x_n + \frac{1}{2} \sum_{1}^{N} \sum_{1}^{M} \beta_{nm} \ln x_n \ln x_m$$

Efficiency Calculations – Sec 3

- Specific equation for profit (in)efficiency

$$\ln\left(\frac{i}{y_{Mi}(\ln A_i)} + \quad + 1\right) = \quad + \sum_n \ln\left(\frac{x_{ni}}{\ln A_i} + \quad_n + 1\right) + \sum_m \ln\left(\frac{y_{mi}}{y_{Mi}} + \quad_m + 1\right) +$$

$$\frac{1}{2}\sum\sum_{nk} \ln\left(\frac{x_{ni}}{\ln A_i} + \quad_n + 1\right)\ln\left(\frac{x_{ki}}{\ln A_i} + \quad_k + 1\right) + \frac{1}{2}\sum\sum_{mj} \ln\left(\frac{y_{mi}}{y_{Mi}} + \quad_m + 1\right)\ln\left(\frac{y_{ji}}{y_{Mi}} + \quad_j + 1\right) +$$

$$\frac{1}{2}\sum\sum_{nm} \ln\left(\frac{x_{ni}}{\ln A_i} + \quad_n + 1\right)\ln\left(\frac{y_{mi}}{y_{Mi}} + \quad_m + 1\right) + v_i + u_i \qquad (1)$$

Efficiency Calculations – Sec 3

- Profit efficiency calculated using

$$1-\frac{\Pi^{i}}{\Pi^{\max}}=1-\frac{\exp[f(x^{i},y^{i},s^{i})]\hat{u}^{i}}{\exp[f(x^{i},y^{i},s^{i})]\hat{u}^{\max}}=1-\frac{\hat{u}^{i}}{\hat{u}^{\max}} \qquad (2)$$

- Π is profit; f is functional form; x, y and s are inputs, outputs and exogenous variables; max refers to the most efficient company

Efficiency Calculations – Sec 3

- So profit efficiency is calculated such that company *i* is compared to most efficient company

- Both use inputs, outputs and exogenous variables that company *i* uses

Efficiency Calculations – Sec 3

- For time-varying efficiency enhance model with

$$\sum_i \sum_t D_t \qquad w_{it}$$

- w_{it} are exogenous variables; D_t are dummy variables
- Time-varying inefficiency scores normalized to time-invariant scores

Efficiency Calculations – Sec 3

- Output – quantity company strives to produce
- Use premiums
  net investment income
  other revenue

Efficiency Calculations – Sec 3

- Inputs – keep company viable
- Use change in policy liabilities
  commissions
  interest on PH amounts on deposit
  other interest expense
  general expenses and taxes
  dividends and ERRs

Efficiency Calculations – Sec 3

- Inputs – claims, annuity payments,
  other payments may be doubtful
- So use cases both including and excluding them

- Net of reinsurance (as can be controlled by company)
- Gross of income tax (not controllable)

Efficiency Effect on ROE – Sec 3

- Now efficiency effect on ROE

- Also year (versus 2000)
  (ln of) asset size
  debt ratio
  percent new business written
  ten year government bond yields
  domestic or foreign

Efficiency Effect on ROE – Sec 3

- Use regression equation for GLS

$$ROE_i = \beta_0 + \beta_{ineffy} PI_i + \sum_{z=2000}^{2004} \beta_z D_z + \beta_{\ln asize} \ln A_i + \beta_{drat} DRat_i +$$

$$\beta_{pnew} PNew_i + \beta_{yields} Yields_i + \beta_{dom} D_{dom}$$

- Also use MLE

Efficiency Effect on ROE – Sec 3

- Do analyses for both entire companies and lines of business (LOBs)

- Ten LOBs on the OSFI returns

  OSFI 54 (Domestically owned) and

  OSFI 55 (Foreign owned)

Efficiency Effect on ROE – Sec 3

- Individual Life NonPar
- Individual Life Par
- Group Life NonPar
- Group Life Par
- Individual Annuities NonPar
- Individual Annuities Par
- Group Annuities NonPar
- Group Annuities Par
- Individual Accident & Sickness
- Group Accident & Sickness

Cases Explored for Profit (In)Efficiency – Sec 5

- Base Case:

  Inputs include Claims,

  Annuity Pymts & Other Pymts

  Input Numeraire = Claims

  No Companies Excluded

Cases Explored for Profit (In)Efficiency – Sec 5

- Case II:

  Exclude Claims etc. as Inputs

  Numeraire = Commissions

- Case III: Same as Case II except

  exclude specific companies

Profit (In)Efficiency – Sec 5.1.1.1

- GLS – Time-Invariant Base Case
- Effect on ROE of inefficiency and exogenous variables
- Table 5.4

Effect on ROE
Profit InEfficiency – GLS
Time-Invariant Base Case

Variable	Parameter Estimate	Standard Deviation
Profit Inefficiency	-0.355***	0.060
2001	-0.003	0.018
2002	-0.019	0.023
2003	-0.021	0.038
2004	-0.014	0.045
Ln Asset Size	-0.003	0.002
Debt Ratio	-0.034	0.080
%New Bus	-0.016*	0.009
Yields	-0.015	0.033
Domestic	0.089***	0.007
Constant	0.228	0.203

Profit Inefficiency Parameter % of Total Value of Parameters	
Including Average of Year Estimates	67.4%
Only Parameters of Variables a Company Can Control	87.0%

*** = significant to a 1% level
* = significant to a 10% level

Note that 2000 is the base year so the year variables represent the change due to operating in that year versus 2000.

Profit Inefficiency - GLS - Time-Invariant Base Case – Sec 5.1.1.1

- Profit inefficiency parameter is 87.0% of sum of parameters for variables company can control
- β_{ineffy} estimate is -0.355
- Average profit inefficiency is 6.32%
- So average decrease in ROE is 2.24%
- Current average ROE is 12.76%
- Cuts potential ROE by 15.0%

Profit Inefficiency - GLS - Time-Invariant Base Case – Sec 5.1.1.1

- Average individual company-year decrease is 16.9% of potential ROE
- 62.7% of these are more than 10%
- So effect of profit inefficiency is large

Profit Inefficiency - GLS - Time-Invariant Case III – Sec 5.1.1.3

- Case II (Sec 5.1.1.2):
- β_{ineffy} estimate is statistically insignificant

- So use Case III:

  Excludes 3 most efficient companies

  So as if they did not exist

Profit Inefficiency - GLS - Time-Invariant Case III – Sec 5.1.1.3

- Profit inefficiency parameter is 83.9% of sum of parameters for variables company can control
- β_{ineffy} estimate is -0.282
- Average profit inefficiency is 29.93%
- So average decrease in ROE is 8.44%
- Current average ROE is 13.40%
- Cuts potential ROE by 38.6%

Profit Inefficiency - GLS - Time-Varying Base Case – Sec 5.1.2.1

- β_{ineffy} estimate is -0.265
- Average profit inefficiency is 6.32%
- So average decrease in ROE is 1.67%
- Current average ROE is 12.76%
- Cuts potential ROE by 11.6%

Profit Inefficiency - GLS

- Time-Varying Case III (Sec 5.1.2.3):
  Cuts potential ROE by 28.0%

- MLE Time-Invariant Base Case (Sec 5.2.1.1):
  Cuts potential ROE by 15.1%

Profit Inefficiency - GLS

- Time-Invariant
  - Base Case: ROE cut by 15.0%
  - Case III: ROE cut by 38.6%
- Time-varying
  - Base Case: ROE cut by 11.6%
  - Case III: ROE cut by 28.0%

Cost Inefficiency – GLS – Sec 6

- Time-Invariant
  - Base Case: ROE cut by 15.7%
  - Case IV: ROE cut by 20.8%
- Time-varying
  - Base Case: ROE cut by 13.2%
  - Case V: ROE cut by 12.7%

Profit Inefficiency – Cases & Betas

- Time-invariant (Sec 5.1.1):

  Base Case: β_{ineffy} = -0.355; Significant

  Case II: β_{ineffy} = +0.006; Not significant

  Case III: β_{ineffy} = -0.282; Significant

- Time-varying (Sec 5.1.2) similar

Cost Inefficiency – Cases & Betas

- Time-invariant (Sec 6.1.1):

Base Case: β_{ineffy} = -0.373; Significant

Case II: β_{ineffy} = +0.300; Not significant

Case III (Excl most efficient companies):

β_{ineffy} = +0.552; Significant

Case IV (Incl claims etc as inputs):

β_{ineffy} = -0.501; Significant

Cost Inefficiency – Cases & Betas

- Time-Varying (Sec 6.1.2):

Base Case: β_{ineffy} = -0.305; Significant

Case II: β_{ineffy} = +0.361; Significant

Case IV (Incl claims etc as inputs):

β_{ineffy} = -0.253; Not significant

Case V (Excl most efficient companies):

β_{ineffy} = -0.386; Significant

Cost Inefficiency – Cases & Betas

- So questions the exclusion of claims, annuity payments and other payments as inputs
- At least regarding Canadian data
- Will see for Australian and US data

LOB Profit Inefficiency – Sec 7

- Proportion of individual company-year potential ROE values cut by more than 10% range from

  50.3% to 77.8%

- For the five LOBs that this can be calculated for

Discussion – Sec 8

- For Base Case & Case IV average inefficiency ranges from 6.3% to 6.6%
- These cases include claims, annuity payments & other payments as inputs
- For both profit and cost inefficiency

Discussion – Sec 8

- For Case II average inefficiency is 46% for profit and 16% for cost inefficiency
- This case excludes claims, annuity payments & other payments as inputs
- So further questions the exclusion (at least re Canadian data)

Discussion – Sec 8

- For LOBs average inefficiency ranges from 2.3% to 3.7% for 5 of 7 non-A&S
- Two average A&S scores are much higher
- Suggests fundamental difference between non-A&S and A&S business

Discussion – Sec 8

- β_{ineffy} parameter estimate has more than 70% of influence of variables company can control

  where it has statistical significance
- Eight of ten are more than 80%
- So inefficiency is (potentially) of great importance

Profit Inefficiency GLS Time-Invariant Base Case - Sec 8.1

- Average decrease in ROE caused by inefficiency is 2.24%

- Explore actions necessary to change ROE by 1% (e.g. from 10% to 11%) or 2.24% using variables company can control

Profit Inefficiency GLS Time-Invariant Base Case - Sec 8.1

- To increase ROE by 1% must decrease asset size by 96.0%
- Using end of 95% confidence interval gives needed decrease of 74.6%
- So clearly impossible

Profit Inefficiency GLS Time-Invariant Base Case - Sec 8.1

- To increase ROE by 1% must decrease debt ratio by 29.5%
- Average debt ratio is only 2.56%
- Using end of 95% confidence interval gives needed decrease of 5.2%
- So clearly impossible
- Even difficult at max debt ratio = 43.0%

Profit Inefficiency GLS Time-Invariant Base Case - Sec 8.1

- To increase ROE by 1% must decrease percent new business written by 62.4%
- Average % new business only 35.4%
- Using end of 95% confidence interval gives needed decrease of 29.2%
- So clearly impossible or difficult

Profit Inefficiency GLS Time-Invariant Base Case - Sec 8.1

**Necessary Changes (as % of Current Value)
to Increase ROE by 1% (e.g. from 10% to 11%)
or by Average Change of ROE Due to Profit Inefficiency
GLS - Time-Invariant Base Case**

		Increase ROE by 1%	Increase ROE by Amt Due to InEfficiency
Asset Size	Using Parameter Estimate	96.0%	
	Using end of 95% CI Value	74.6%	
Debt Ratio Max	Using Parameter Estimate	68.5%	Impossible
	Using end of 95% CI Value	12.1%	27.2%
Debt Ratio Ave	Using Parameter Estimate	Impossible	
	Using end of 95% CI Value	Impossible	
%New Bus Ave	Using Parameter Estimate	Impossible	
	Using end of 95% CI Value	82.5%	Impossible

Profit Inefficiency GLS Time-Invariant Base Case - Sec 8.1

- For government bond yields need change of 0.677% to increase

  ROE by 1%

- Average in five years is 0.270%

Profit Inefficiency GLS Time-Invariant Base Case - Sec 8.1

- Recall Equation (2) shows we are comparing efficiencies when companies have identical inputs, outputs and exogenous variables
- To increase ROE by 1% need to decrease inefficiency by 2.8%
- Average inefficiency is 6.3%

Profit Inefficiency GLS Time-Invariant Base Case - Sec 8.1

- So changing inefficiency is easiest and quite possibly only way to increase ROE

Profit Inefficiency GLS Time-Invariant Case III - Sec 8.2

**Necessary Changes (as % of Current Value)
to Increase ROE by 1% (e.g. from 10% to 11%)
or by Average Change of ROE Due to Profit Inefficiency
GLS - Time-Invariant Case III**

		Increase ROE by 1%	Increase ROE by Amt Due to InEfficiency
Asset Size	Using Parameter Estimate	99.1%	
	Using end of 95% CI Value	78.9%	
Debt Ratio Max	Using Parameter Estimate	78.1%	Impossible
	Using end of 95% CI Value	12.2%	Impossible
Debt Ratio Ave	Using Parameter Estimate	Impossible	
	Using end of 95% CI Value	Impossible	
%New Bus Ave	Using Parameter Estimate	Impossible	
	Using end of 95% CI Value	68.5%	Impossible

Profit Inefficiency GLS Time-Invariant Case III - Sec 8.2

- To increase ROE by 1% need to decrease inefficiency by 3.5%
- Average inefficiency is 29.9%

Profit Inefficiency GLS Time-Varying Base Case - Sec 8.3

**Necessary Changes (as % of Current Value)
to Increase ROE by 1% (e.g. from 10% to 11%)
or by Average Change of ROE Due to Profit Inefficiency
GLS – Time-Varying Base Case**

		Increase ROE by 1%	Increase ROE by Amt Due to InEfficiency
Asset Size	Using Parameter Estimate	97.2%	
	Using end of 95% CI Value	75.9%	
Debt Ratio Max	Using Parameter Estimate	65.1%	Impossible
	Using end of 95% CI Value	12.0%	20.1%
Debt Ratio Ave	Using Parameter Estimate	Impossible	
	Using end of 95% CI Value	Impossible	
%New Bus Ave	Using Parameter Estimate	Impossible	
	Using end of 95% CI Value	81.6%	Impossible

Profit Inefficiency GLS Time-Varying Base Case - Sec 8.3

- To increase ROE by 1% need to decrease inefficiency by 3.8%
- Average inefficiency is 6.3%

Profit Inefficiency GLS Time-Varying Case III - Sec 8.3

**Necessary Changes (as % of Current Value)
to Increase ROE by 1% (e.g. from 10% to 11%)
or by Average Change of ROE Due to Profit Inefficiency
GLS – Time-Varying Case III**

		Increase ROE by 1%	Increase ROE by Amt Due to InEfficiency
Asset Size	Using Parameter Estimate	99.99%	
	Using end of 95% CI Value	83.7%	
Debt Ratio Max	Using Parameter Estimate	49.6%	Impossible
	Using end of 95% CI Value	11.1%	58.0%
Debt Ratio Ave	Using Parameter Estimate	Impossible	
	Using end of 95% CI Value	Impossible	
%New Bus Ave	Using Parameter Estimate	Impossible	
	Using end of 95% CI Value	63.5%	Impossible

Profit Inefficiency GLS Time-Varying Case III - Sec 8.3

- To increase ROE by 1% need to decrease inefficiency by 5.7%
- Average inefficiency is 29.9%

Profit Inefficiency MLE Time-Invariant Base Case - Sec 8.4

**Necessary Changes (as % of Current Value)
to Increase ROE by 1% (e.g. from 10% to 11%)
or by Average Change of ROE Due to Profit Inefficiency
MLE - Time-Invariant Base Case**

		Increase ROE by 1%	Increase ROE by Amt Due to InEfficiency
Asset Size	Using Parameter Estimate	99.95%	
	Using end of 95% CI Value	85.1%	
Debt Ratio Max	Using Parameter Estimate	54.5%	Impossible
	Using end of 95% CI Value	11.5%	26.8%
Debt Ratio Ave	Using Parameter Estimate	Impossible	
	Using end of 95% CI Value	Impossible	
%New Bus Ave	Using Parameter Estimate	Impossible	
	Using end of 95% CI Value	64.8%	Impossible

Profit Inefficiency MLE Time-Invariant Base Case - Sec 8.4

- To increase ROE by 1% need to decrease inefficiency by 6.5%
- Average inefficiency is 14.9%

Cost Inefficiency GLS Time-Invariant Base Case & Case IV - Sec 8.5

**Necessary Changes (as % of Current Value)
to Increase ROE by 1% (e.g. from 10% to 11%)
or by Average Change of ROE Due to Cost Inefficiency
GLS – Time-Invariant Base Case (Case IV)**

		Increase ROE by 1%	Increase ROE by Amt Due to InEfficiency
Asset Size	Using Parameter Estimate	83.8% (100%)	
	Using end of 95% CI Value	67.3% (92.1%)	
Debt Ratio Max	Using Parameter Estimate	70.9% (34.9%)	166.9%(Impossible)
	Using end of 95% CI Value	13.1% (10.2%)	30.9% (33.7%)
Debt Ratio Ave	Using Parameter Estimate	Impossible (Imp)	
	Using end of 95% CI Value	Impossible (Imp)	
%New Bus Ave	Using Parameter Estimate	Impossible (Imp)	
	Using end of 95% CI Value	78.2% (67.5%)	Impossible (Impossible)

Cost Inefficiency GLS Time-Invariant Base Case & Case IV - Sec 8.5

- Base Case: to increase ROE by 1% need to decrease inefficiency by 2.7%
- Average inefficiency is 6.3%
- Case IV: to increase ROE by 1% need to decrease inefficiency by 2.0%
- Average inefficiency is 6.6%

Cost Inefficiency GLS Time-Varying Base Case & Case V - Sec 8.5

**Necessary Changes (as % of Current Value)
to Increase ROE by 1% (e.g. from 10% to 11%)
or by Average Change of ROE Due to Cost Inefficiency
GLS – Time-Varying Base Case (Case V)**

		Increase ROE by 1%	Increase ROE by Amt Due to InEfficiency
Asset Size	Using Parameter Estimate	83.1% (100%)	
	Using end of 95% CI Value	66.8% (88.6%)	
Debt Ratio Max	Using Parameter Estimate	103.2% (41.4%)	199.0%(74.9%)
	Using end of 95% CI Value	14.0% (10.8%)	27.0% (19.5%)
Debt Ratio Ave	Using Parameter Estimate	Impossible (Imp)	
	Using end of 95% CI Value	Impossible (Imp)	
%New Bus Ave	Using Parameter Estimate	Impossible (Imp)	
	Using end of 95% CI Value	78.7% (62.2%)	Impossible (Impossible)

Cost Inefficiency GLS Time-Varying Base Case & Case V - Sec 8.5

- Base Case: to increase ROE by 1% need to decrease inefficiency by 3.3%
- Average inefficiency is 6.3%
- Case V: to increase ROE by 1% need to decrease inefficiency by 2.6%
- Average inefficiency is 4.7%

Profit Inefficiency GLS Time-Invariant Individual Life NonPar - Sec 8.6

**Necessary Changes (as % of Current Value)
to Increase ROE by 10%
or by Average Change of ROE Due to Profit Inefficiency
GLS - Time-Invariant Base Case**

		Increase ROE by 10%	Increase ROE by Amt Due to InEfficiency
Asset Size	Using Parameter Estimate	11.0%	31.5%
	Using end of 95% CI Value	6.0%	18.4%
Debt Ratio Ave	Using Parameter Estimate	10.0%	32.5%
	Using end of 95% CI Value	6.8%	22.2%
%New Bus Ave	Using Parameter Estimate	9.1%	29.7%
	Using end of 95% CI Value	5.0%	16.2%

Profit Inefficiency GLS Time-Invariant Individual Life NonPar - Sec 8.6

- To increase ROE by 10% need to decrease inefficiency by 0.25%
- Average inefficiency is 3.66

Conclusions – Sec 9

- Inefficiency has decreased the ROE of life insurers by between 11% and 38% of its potential
- Large percentages of the individual company-year ROEs are decreased by more than 10% of their potential

Conclusions – Sec 9

- To change ROE by even 1% a life insurer has to change its business radically
- Or else is impossible
- But changing inefficiency is easier to the extent that it is easiest and possibly only way to do so

Conclusions – Sec 9

- This research adds to

  Information concerning expenses and efficiency in life insurance

  Knowledge of regulating life insurance and determining warning signs concerning viability

Conclusions – Sec 9

- Efficiency is considered to be more accurate to consider than (items similar to) expense ratios
- So efficiency can be an improvement of existing methods as it is more accurate than simply using expenses or expense ratios

Conclusions

- May be possible to determine the best inputs and outputs to use for future studies regarding life insurer efficiency
- Also help insurers learn which areas to concentrate on when making management decisions regarding expenses, efficiency, and similar concepts

Conclusions – Sec 9

- Bowie et al. (1996): “difficulty with the computational tool is not a good reason to dismiss the model”
- So including efficiency in an analysis of life insurance may be a better way
- Therefore this can be deemed both desirable and necessary

Questions? / Comments