Analysis of the Stern Systemic Risk Measure and its Application to the Canadian Banking and Insurance Industries

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(with help from Anthony Vaz, GWL)
Our analysis of the SRISK measure with respect to its use in the insurance and banking industries drew the following conclusions:

1. When segregated funds are removed the SRISK measure significantly decreases: several life insurance cos move from systemically risky to no longer risky
   
   Caveat: If the guarantees are not well hedged then there may be significant debt dependence on the market which is not (currently) being accounted for.

2. Care needed when selecting the prudential capital ratio \( k \). Uncertainty continues.
   
   - Despite Canadian banks being listed under IFRS using \( k \) close to 8% (as is used for US banks under GAAP) - our work suggests 7.5% - is more appropriate than \( k = 5.5\% \) as proposed by Engle et al. (2015) for the European banks that also operate under IFRS.

3. SRISK predicts need for government “intervention” in Canada (based on 2007 market collapse): liquidity support was provided.
SRISK: An Introduction

SRISK\(^1\):

A systemic risk measure that is defined as the expected \textit{capital shortfall} of an institution conditional on a financial crisis (i.e. the capital a firm is expected to need, in addition to reserves, in a crisis)

- A function of the institution’s size, leverage, and expected equity loss conditional on a specified market decline
- Is calculated using publicly available data
- Financial crisis scenarios are defined by a prolonged market decline below a threshold \((C)\) over a time horizon \((h)\) which are specified by analyst

Capital Shortfall (CS):
The capital reserves (ex. regulatory) less the firm’s equity

\[ CS = k(D + W) - W \Rightarrow CS = kD - (1 - k)W \]

Where:
- \( W \): Market value of equity
- \( D \): Book value of debt
- \( k \): Prudential capital ratio
Brownlees & Engle’s SRISK predicts the CS of a firm in case of a systemic event:

\[
SRISK = kD - (1 - k)(Stressed Market Value)
\]

\[
SRISK = kD - (1 - k)(1 - LRMES)W
\]

- **LRMES** (Long-Run Marginal Expected Shortfall) is the expected percentage loss of a firm’s equity value during a crisis scenario.
- It is estimated by averaging the fractional returns of the firm’s equity in simulated crisis scenarios.
- It captures the co-movement of the firm’s equity with the market during a crisis.
Vlab’s Implementation

- **Prudential Capital Ratio:**
  - US & Canada: $k = 8\%$
  - E.U.: $k = 5.5\%$

- **Crisis Scenario:**
  - 40% decline in MSCI world Index
  - 6 month time horizon

- **Scenario generation:**
  - Dynamic Condition Correlation – GARCH (1,1)

- **Evaluation of LRMES:**
  - Dynamic Conditional Beta
Why SRISK?

- Straightforward calculation
- Uses non-proprietary, publically available data
- Brownlees & Engle (2016) show:
  - SRISK measure was a predictor of the Fed capital injections
  - Aggregate SRISK (the sum of SRISK across an entire country) was found to be a predictor of macroeconomic distress
Banking
Selecting Prudential Capital Ratio

SRISK as a function of prudential capital ratio, k (in million USD)
June 30, 2016

BOA  Citigroup  JPMorgan  Morgan Stanley  Goldman Sachs
Historical Capital Ratio

In Brownlees and Engle (2016), the choice of $k=8\%$ is based on the average capital ratio maintained by large, well-managed financial institutions in normal times (summer 2009-spring 2011): $k=8\%$ implies zero capital shortfall, if the capital ratio is 8\%.

\[ k_{hist} \cong 10\% \quad k_{hist} \cong 7\% \quad k_{hist} \cong 9\% \quad k_{hist} \cong 7\% \]

\[ \text{Capital Ratio} = \frac{\text{Market Value of Equity}}{\text{Debt} + \text{Market Value of Equity}} \]
Accounting standards: US GAAP vs. IFRS

- Under US GAAP, net derivatives are reported and thus derivatives represent a negligible fraction of the assets
  - Brownlees & Engle (2016) employ $k = 8\%$ for firms using US GAAP
- Under IFRS, gross derivatives are reported
  - Engle et al. (2015) report that under IFRS the assets of large US banks would increase by 40-60%. To account for this difference in accounting standards, $k=5.5\%$ is used for European firms.
Derivatives to Total Assets

Based on the differences in Canadian derivatives holdings to both US and European firms, we find that a $k = 7.5\%$ is most appropriate.
Banking Application

SRISK for US banks, $k=8\%$ (in million USD)

SRISK for Canadian Banks, $k=7.5\%$ (in million USD)
Banking Conclusions

- Based on the derivatives holdings of Canadian banks, we find that $k=7.5\%$ is more appropriate as opposed to either $8\%$ (U.S. banks) or $5.5\%$ (E.U. banks under IFRS).

- SRISK predicts need for government “intervention” in Canada (based on 2007 market collapse): liquidity support was provided.
Insurance
Insurance Industry Concerns

- SRISK does not address the presence of segregated funds on insurer balance sheets
- Selection of a suitable prudential capital ratio \( (k) \)
- SRISK assumes that the expected value of debt does not change during a financial crisis
  - Insurance companies have variable annuity guarantees included in their liabilities. If not properly hedged, these guarantees will change in value during a financial crisis. Currently SRISK will miss this.
Segregated Funds

- Segregated funds include products such as variable life insurance policies, variable annuities, and pension products—all of which have some market based risks that are borne by contract and account holders.

- To address this issue we propose an adjusted SRISK value:
  - Adjusted SRISK: SRISK value calculated using Debt net of the segregated funds.

- Note that if the guarantees are not well hedged there may be significant debt dependence on the market which is not being accounted for when the segregated funds are removed.
## Segregated Funds

### US insurance companies (in million USD) - June 30, 2016

<table>
<thead>
<tr>
<th></th>
<th>SRISK</th>
<th>Adjusted SRISK</th>
<th>Seg. Funds</th>
<th>Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prudential</strong></td>
<td>42,524</td>
<td>20,004</td>
<td>281,501</td>
<td>723,730</td>
</tr>
<tr>
<td><strong>Metlife</strong></td>
<td>49,179</td>
<td>24,695</td>
<td>306,047</td>
<td>841,463</td>
</tr>
<tr>
<td><strong>Lincoln National</strong></td>
<td>15,942</td>
<td>6,062</td>
<td>123,506</td>
<td>241,060</td>
</tr>
<tr>
<td><strong>Hartford</strong></td>
<td>6,924</td>
<td>0</td>
<td>118,361</td>
<td>209,381</td>
</tr>
<tr>
<td><strong>Genworth</strong></td>
<td>6,745</td>
<td>6,135</td>
<td>7,624</td>
<td>91,200</td>
</tr>
</tbody>
</table>

### Canadian insurance companies (in million USD) - June 30, 2016

<table>
<thead>
<tr>
<th></th>
<th>SRISK</th>
<th>Adjusted SRISK</th>
<th>Seg. Funds</th>
<th>Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manulife</strong></td>
<td>28,107</td>
<td>0</td>
<td>386,046</td>
<td>848,689</td>
</tr>
<tr>
<td><strong>Great-West Life</strong></td>
<td>7,726</td>
<td>0</td>
<td>249,452</td>
<td>476,373</td>
</tr>
<tr>
<td><strong>Sun Life</strong></td>
<td>3,421</td>
<td>0</td>
<td>116,059</td>
<td>291,983</td>
</tr>
</tbody>
</table>
Seg. Funds: US Insurance

SRISK for US insurance companies (in million USD)

Adjusted SRISK for US insurance companies (in million USD)
Seg. Funds: Canadian Insurance

SRISK for Canadian insurance companies (in million USD)

Adjusted SRISK for Canadian insurance companies (in million USD)
Historical Capital Ratio: Insurance

- There is evidence that suggest the prudential capital ratio of 8% is too conservative for some insurance companies (Acharya & Richardson, 2014)
  - This is especially true for P&C insurance companies as their market value of equity covers a higher fraction of their total assets

- Historical Capital Ratio analysis for the insurance industry suggests:
  - U.S. insurance companies: $k \approx 6.5\%$
  - Canadian insurance companies: $k \approx 14\%$
Conclusions

- When segregated funds are removed the SRISK measure significantly decreases. This results in several life insurance moving from systemically risky to no longer risky under this measure.
  - There may be a significant debt dependence on the market if the guarantees are not well hedged. This has not been accounted for.

- Careful consideration needs to be given when selecting the prudential capital ratio ($k$):
  - Historical capital ratios can differ between industries and institutions
  - Accounting standards as well as the size balance sheet constituents should be taken into account when selecting $k$
    - Despite Canadian banks being listed under IFRS, our work suggests that using $k = 7.5\%$ is more appropriate than $k = 5.5\%$ as proposed by Engle et al. (2015) for the European banks that also operate under IFRS.

- SRISK predicts need for government “intervention” in Canada (based on 2007 market collapse) : liquidity support was provided.
Thank You
SRISK Formulation

\[
SRISK = (\text{Prudential Capital}) - (\text{Stressed Market Value})
\]

\[
= k(D + \text{Stressed Market Value}) - (\text{Stressed Market Value})
\]

\[
= kD - (1 - k)(\text{Stressed Market Value})
\]

\[
= kD - (1 - k)(1 - LRMES)\text{Equity}
\]
LRMES

\[ LRMES = 1 - e^{(\log(1-d) \cdot \beta)} \]

Where:
- \( d \) is the six-month crisis threshold for the market index decline (40% was used in this study)
- \( \beta \) is the firm’s Dynamic Conditional Beta – tells us how sensitive the firm’s equity is to the market in question

- The explicit formula enhances transparency, reproducibility, and flexibility by allowing a crisis threshold different from the default 40%.
- Results show that LRMES estimation based on standard GARCH-DCC time series model strikes a good balance between prediction accuracy and model complexity.
- DCC: Dynamic Conditional Beta (DCB) is an approach to estimating regressions with time varying parameters. The conditional covariance matrices of the exogenous and dependent variable for each time period are used to formulate the dynamic beta.