Contagion
Prof. dr. Roger J. A. Laeven

September 6, 2012
CONTAGION

Challenges in Risk and Insurance

Inaugural Lecture

delivered upon appointment to the chair of
Full Professor of Risk and Insurance
at the University of Amsterdam
on Thursday 6 September 2012

by

Prof. dr. Roger J. A. Laeven
1988

- Roger “Urbanus” Laeven
2012
2012

- Sit back, relax and enjoy your stay.
September 21, 2005

- Essays on Risk Measures and Stochastic Dependence, with Applications to Insurance and Finance.
September 6, 2012

- Contagion: Challenges in Risk and Insurance.
Outline

- A Brief History of Risk and Insurance
- Basic Principles of Risk and Insurance
- Risk and Insurance: Stochastics and Economics
- Challenges in Risk and Insurance
- Future of Risk and Insurance
- Tot Slot
Jacob (James) Bernoulli

- 1691
- Law of Large Numbers (Wet van de Grote Aantallen)
Excerpt of the Bernoulli Family Tree

Nicolaus

Jacob

Nicolaus

Nicolaus

Johann

Daniel
Jacob Bernoulli

- Law of Large Numbers:
  “The average loss in an expanding pool of risks eventually becomes certain (or predictable).”

- Pooling risks can serve as a basic risk mitigation technique.
Jacob Bernoulli

- *Acta Eruditorum*

- Correspondences with Leibniz

- *Monumentum aere perennius* (Horace)
  (Een monument duurzamer dan brons)
Daniel Bernoulli

- 1731
- Risk Measurement and Utility
Daniel Bernoulli

- Expectations are no proper descriptions of risk.
- St. Petersburg paradox.
- Subjective elements (utilities).
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Law of Large Numbers

- Implications poorly understood.

- “The average loss in an expanding pool of risks eventually becomes certain (or predictable).”

  - Average not aggregate
  - Pooling large numbers of risks
Car

- Frederike Laeven, 3 years
Example I: 1 car

<table>
<thead>
<tr>
<th>Probability</th>
<th>99%</th>
<th>1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss</td>
<td>EUR 0</td>
<td>EUR 10,000</td>
</tr>
</tbody>
</table>
Pool of Cars

- Matthijs Laeven, 5 years
**Example I: 1,000 cars**

<table>
<thead>
<tr>
<th>Probability</th>
<th>99%</th>
<th>1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss</td>
<td>EUR 0</td>
<td>EUR 10,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Probability</th>
<th>99.999%</th>
<th>0.001%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Loss</td>
<td>$\leq$EUR 250</td>
<td>$&gt;$EUR 250</td>
</tr>
</tbody>
</table>
**Example I: 1,000,000 cars**

<table>
<thead>
<tr>
<th>Probability</th>
<th>99%</th>
<th>1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss</td>
<td>EUR 0</td>
<td>EUR 10,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Probability</th>
<th>99.999%</th>
<th>0.001%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Loss</td>
<td>≤EUR 104.26</td>
<td>&gt;EUR 104.26</td>
</tr>
</tbody>
</table>
Lesson

“While the loss of a single individual may be highly unpredictable, the average loss, averaged over an expanding pool of risks, eventually becomes predictable: EUR 100.”
Fallacies

- Average versus Aggregate
- Independent versus Dependent
- Infinite versus Finite
Example II: Average vs. Aggregate (1,000 cars)

<table>
<thead>
<tr>
<th>Probability</th>
<th>Average Loss</th>
<th>Aggregate Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>99.999%</strong></td>
<td>≤EUR 250</td>
<td>&gt;EUR 250</td>
</tr>
<tr>
<td><strong>0.001%</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Probability</th>
<th>Aggregate Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>95%</td>
<td>≤EUR 150,000</td>
</tr>
<tr>
<td>5%</td>
<td>&gt;EUR 150,000</td>
</tr>
</tbody>
</table>
Vulcano

Simon Laeven, 7 years
### Example III: Independent vs. Dependent

<table>
<thead>
<tr>
<th>Probability</th>
<th>99%</th>
<th>0.9%</th>
<th>0.1%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Loss</strong></td>
<td>EUR 0</td>
<td>EUR 10,000</td>
<td>EUR 10,000</td>
</tr>
</tbody>
</table>

Similar to Example I:

<table>
<thead>
<tr>
<th>Probability</th>
<th>99%</th>
<th>1%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Loss</strong></td>
<td>EUR 0</td>
<td>EUR 10,000</td>
</tr>
</tbody>
</table>
Example III: Independent vs. Dependent

<table>
<thead>
<tr>
<th>Probability</th>
<th>0.1%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average Loss</strong></td>
<td><strong>EUR 10,000</strong></td>
</tr>
</tbody>
</table>

Not similar to Example I:

<table>
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<tbody>
<tr>
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Independent vs. Dependent

Examples of Systematic Insurance Risks:
- Longevity
- Interest rate
Infinite vs. Finite

“The expanding pool of risks, eventually pooling infinitely many risks, only exists in the mathematician’s imagination.”
Basic Principle?

- Pooling of risks does not lead to risk reduction on the aggregate level of the pool.

- Why is the Law of Large Numbers at the core of risk and insurance?
Owners: Risk Pooling and Risk Spreading

- Matthijs Laeven, 5 years
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Fundamental Questions

- How to measure risk?
- How to price risk?
- How to deal with dependences between risks?
Risk and Stochastics: Idea and Language*

Probability Theory
Mathematical Statistics
Financial Mathematics
Insurance Mathematics

Economic Theory
Financial Economics
Insurance Economics
Econometrics

*Source: Norberg
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Risk Measures

- Axiomatic characterization:

  Economic properties of risk measures
  \[\leftrightarrow\]
  Mathematical representation of risk measures
Risk Measures

- Implications for
  - Risk management and capital requirements;
  - Pricing in incomplete markets; and
  - Portfolio choice and asset allocation.
Contagion

- Linguistically, contagion is synonymous with infection.
- Main challenge in Risk and Insurance.
Contagion

Transmission of shocks takes place:

in **space** (across countries or regions of the world)

and

in **time** (successive shocks in affected countries)
Contagion

- Shocks generated from our model *self-excite* and *cross-excite*

  mimicking the patterns in the data.
Contagion

- Earthquake analogy.

- *Non in cauda sed in caudis venenum* (Laeven)
  (Niet in de staart maar in de staarten zit het venein)
Contagion

- Implications for
  - Risk management and capital requirements;
  - Pricing; and
  - Portfolio choice and asset allocation.

- “This matters because the risk management technique of diversification fails to be rewarding when it is needed most urgently.”
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Insurers and Pensions

“Against this backdrop, there are important opportunities for insurers to develop transparent and intelligent pension contracts, with unconditional promises and guarantees.”
Insurer Solvency and Supervision

- “The time dimension should be acknowledged and more explicitly incorporated in solvency supervision.”
Education in Risk and Insurance

- “Integrated approaches to Risk and Insurance, and specifically Integrated Risk Management, will become a central part of the education programs.”

- Amsterdam Executive MSc Insurance Studies
- MSc Actuarial Science and Mathematical Finance
- Amsterdam Executive MSc Actuarial Science
Education in Risk and Insurance

- Actuarial Society (AG-AI)
- Tinbergen Institute Graduate School
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Contagion

“Financial contagion: crucial challenge and exciting research.”

(“Besmettingsgevaar in financiële markten: cruciale uitdaging en aanstekelijke problematiek.”)
Enjoying Modern Actuarial Risk Theory

- Simon, Matthijs en Frederike Laeven.
Full text

Full text of the inaugural lecture is available from:

http://www.rogerlaeven.com/

(then under Miscellaneous -> Inaugural Lecture)