A new survey of CERN suppliers: a Bayesian Network Analysis (BNA)

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Motivation and Research Hypotheses

Does CERN stimulate innovation and economic performance of firms through its procurement activity? In what way?

**H1**: the technological level and the volume of orders shape the relationship between CERN and its suppliers

**H2**: more structured types of relationships positively influence CERN suppliers’ innovation outcomes

**H3**: innovation outcomes of CERN supplier firms are expected to positively impact on their economic performance

**H4**: innovation spillovers are not only confined to CERN (first-tier) suppliers, but they spread along the supply chain
Conceptual model

Types of Relationship:
- Relational
- Hybrid
- Market

Innovation Outcomes:
- Learning Outcomes
- Technological
- Customer Outcomes

Economic Performance:
- Sales Gains
- Cost Savings

Control Variables:
- Size
- Sector
- Age
- Experience as supplier of science centers
- Country
Survey

- To all CERN suppliers which received at least 1 order > 10,000 CHF between 1995 and 2015
- 5 languages on-line survey
- Multiple-choice questions, 5 point Likert scale (strongly disagree, ..., strongly agree)

<table>
<thead>
<tr>
<th>Population</th>
<th></th>
<th>Sample (as of end April 2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,204 suppliers from 47 countries</td>
<td>538 (13%) suppliers from 31 countries</td>
<td></td>
</tr>
<tr>
<td>33,414 orders</td>
<td>6,679 (20%) orders</td>
<td></td>
</tr>
<tr>
<td>4,318 Million CHF of expenditure</td>
<td>732 (17%) Million CHF of expenditure</td>
<td></td>
</tr>
</tbody>
</table>
What was the **INNOVATION LEVEL OF PRODUCTS AND SERVICES** supplied to CERN? (Tick at most 2 options)

- Significant customisation or requiring technology development: 260
- Mostly off-the-shelf with some customisation: 196
- Cutting-edge products or services requiring dedicated R&D or co-design involving the CERN staff: 130
- Advanced commercial off-the-shelf: 130
- Commercial off-the-shelf: 90
Sample (2)

Distribution of suppliers by cumulative amount (CHF) of orders received

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Volume of orders (CHF) POPULATION</th>
<th>Volume of orders (CHF) SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>10 Thousand</td>
<td>10 Thousand</td>
</tr>
<tr>
<td>Mean</td>
<td>1.0 Million</td>
<td>1.3 Million</td>
</tr>
<tr>
<td>Median</td>
<td>67 Thousand</td>
<td>118 Thousand</td>
</tr>
<tr>
<td>Max</td>
<td>237 Million</td>
<td>173 Million</td>
</tr>
<tr>
<td>SD</td>
<td>7.6 Million</td>
<td>8.2 Million</td>
</tr>
</tbody>
</table>
Methodology of analysis

Bayesian Network Analysis (BNA):  

- **Conditional probability distributions** to find multiple relationships and dependences among variables  
- **Hierarchical arrangement** of variables via a directed acyclic graph  
- **Causal mechanisms** are revealed  
- Find **unexpected relationships** between variables

+ **Econometric analysis** to test the robustness of results
Bayesian Network

High-Tech Supplier

CHF per order

Relational Market

Hybrid

Learning outcomes

New patents and IPR

New products

New services

New technologies

Time from the last order

Customer outcomes

New customers

Increased Sales

Reduced costs

Increased profitability

Established new R&D unit

Started a new business

Entered a new market

Large laboratories

Non-science customers

 Universities / research institutes

Experience with...

Hybrid second-tier

Relational second-tier

Second-Tier HT supplier

Market second-tier

Geo-proximity

Increased know-how

Innovated products or processes

Improved production process

Attracted new customers

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Experience with...
Testing H₁: CERN-supplier relationship

H₁: the technological level and the volume of orders shape the relationship between CERN and its suppliers

During the relationship between us and CERN, we carried out project(s) with ...

- with additional inputs (clarifications, cooperation on some activities) from CERN staff: 54%
- with full autonomy and little interaction with CERN staff: 26%
- frequent and intense interactions with CERN staff: 19%
- Missing: 1%
Testing H₁: CERN-supplier relationship

**Market:** full autonomy and little interaction with CERN staff

**Hybrid:** additional inputs (clarifications, cooperation on some activities) from CERN staff

**Relational:** frequent and intense interactions with CERN staff
Testing H2: innovation outcomes

H2: more structured types of relationships positively influence CERN suppliers’ innovation outcomes

CERN RELATED LEARNING BENEFITS. Thanks to CERN, we were able to...

- Acquire new knowledge about market needs and trends: 4% Strongly disagree, 14% Disagree, 28% Neutral, 47% Agree, 6% Strongly Agree
- Improve our technical know-how: 4% Strongly disagree, 10% Disagree, 34% Neutral, 42% Agree, 6% Strongly Agree
- Improve the quality of our products/services: 3% Strongly disagree, 12% Disagree, 38% Neutral, 39% Agree, 9% Strongly Agree
- Improve our production processes: 4% Strongly disagree, 17% Disagree, 49% Neutral, 25% Agree, 6% Strongly Agree
- Improve our R&D and innovation capabilities: 4% Strongly disagree, 13% Disagree, 49% Neutral, 27% Agree, 6% Strongly Agree
- Improve our management/organisational capabilities: 3% Strongly disagree, 16% Disagree, 16% Neutral, 22% Agree, 5% Strongly Agree
Testing H2: innovation outcomes (cont.)

As a result of new knowledge acquired and improvements, we were able to develop **TECHNOLOGICAL OUTCOMES**. Specifically...

<table>
<thead>
<tr>
<th>Option</th>
<th>N of suppliers that ticked the option</th>
</tr>
</thead>
<tbody>
<tr>
<td>new products</td>
<td>233</td>
</tr>
<tr>
<td>new services</td>
<td>164</td>
</tr>
<tr>
<td>new technologies</td>
<td>114</td>
</tr>
<tr>
<td>Not Applicable (no one of the above options)</td>
<td>65</td>
</tr>
<tr>
<td>new patents, copyrights, or other intellectual property rights</td>
<td>20</td>
</tr>
</tbody>
</table>

**CERN RELATED CUSTOMER BENEFITS.** Because of the relationship with CERN, we...

- 14% strongly disagree
- 31% disagree
- 30% neutral
- 43% agree
- 47% strongly agree

- 28% strongly agree
- 7% agree
- 3% neutral
- 25% disagree
- 15% strongly disagree

- obtained new customer contacts directly from CERN
- used CERN as an important marketing reference
- improved our credibility as a supplier
Testing H2: innovation outcomes (cont.)

- Hybrid
- Relational
- Market

- New patents and IPR
- New services
- New products
- New technologies
- Learning outcomes
- Customer outcomes
- New customers
- Relationship duration
- Time from last order

13/19
Testing H3: economic performance

**H3: innovation outcomes in CERN supplier firms are expected to positively impact on their economic performance**

**ECONOMIC PERFORMANCE.** Because of the work with CERN, we ...
Testing H3: economic performance

H3: innovation outcomes in CERN supplier firms are expected to positively impact on their economic performance

**ECONOMIC PERFORMANCE.** Because of the work with CERN, we ...

- Share of respondent suppliers which agree or fully agree:
  - Total 18%
  - Hi-Tech 22%
  - Lo-Tech 13%

- Increased total sales to other customers (not CERN):
  - Total 3%
  - Hi-Tech 5%
  - Lo-Tech 2%

- Reduced production costs:
  - Total 11%
  - Hi-Tech 12%
  - Lo-Tech 9%

- Increased overall profitability:
  - Total 6%
  - Hi-Tech 8%
  - Lo-Tech 3%

- Established a new R&D team/unit:
  - Total 6%
  - Hi-Tech 6%
  - Lo-Tech 5%

- Started a new business unit:
  - Total 6%
  - Hi-Tech 6%
  - Lo-Tech 5%

- Entered a new market:
  - Total 20%
  - Hi-Tech 17%
  - Lo-Tech 12%
Testing H3: economic performance (cont.)

- Increased Sales
- Reduced costs
- Increased profitability

- Established new R&D unit
- Started a new business
- Entered a new market

- Learning outcomes
  - New patents and IPR
  - New services
  - New technologies

- Customer outcomes
  - New products
  - New customers

- New outcomes
  - New technologies
  - New patents and IPR
  - New services

- Customer outcomes
  - New products
  - New customers
**Testing H4: spillovers to value chain**

H4: innovation spillovers are not only confined to CERN (first-tier) suppliers, but they spread along the supply chain.

In order to carry out the CERN project(s), has your company ever mobilised any subcontractor?

- YES: 37% (199)
- NO. Never: 63% (339)
Testing H4: spillovers to value chain (cont.)

Potential innovation outcomes as perceived by CERN suppliers
Conclusions

• This study provides empirical evidence about the various types of benefits accruing to companies involved in a procurement relationship with CERN:
  o Technological benefits
  o Learning benefits
  o Market benefits

• **Key mechanisms** which explain the type and size of benefits enjoyed are:
  o The way how CERN interacts with its suppliers
  o The type and volume of orders