Interpreting Innovation Surveys 2
1. A note on interaction effects

• Serious issue that affects use of sector, size, or other dummy variables.
• Assumption is that sector effects are parallel – no difference in effect of sector on dependent variable across other variables such as firm size.
• Often not the case – need to introduce interaction variables and/or calculate separate regressions by major criteria of interest: ie separate regressions for small and large firms.

– Note: Very few econometric studies using innovation survey data include 2. Econometric research interaction effects
2.1 Main Econometric research topics

1. Who innovates?
   - at what level (novelty, in-house...)

1. If a firm innovates, what are its innovation strategies?

2. What effect do these strategies have on performance outcomes?
2.2 Who innovates

Determinants of innovative status

– What differentiates innovative from non-innovative firms?

– or firms that introduce different types of innovations?

• Products
• Processes
• Organisational methods
2.3 Innovation strategies

• Innovation objectives and obstacles.
  – Little work on this topic, even though obstacles should be of great interest to policy

• Effect of public funding on innovation intensity – additive or substitutes?

• External sourcing of knowledge.
  – Collaboration and innovation

• Appropriation and intellectual property rights.
2.4 Innovation and performance

Three common measures:
- Change in employment
- innovation sales share for products (best)
- productivity (sales per employee – no value added data; requires linking to other data files)

• Plus, patenting status sometimes used (Don’t do it for all sectors – OK within sectors)
2.5 CDM model (Crepon-Duguet-Mairesse)

• 3-stage model for solving cross-sectional nature of CIS data in analyses of performance
  – Probit selection model to identify determinants of innovative status (did they innovate, yes or no, but usually R&D)
  – Research equation (Tobit) for the intensity of innovation (almost always R&D)
  – Innovation output equation: dependent variable can be innovative sales share, patents, etc
2.6 Some performance results

• Knowledge management policies improve patent rates (Kremp & Mairesse, 2004)
• Innovation intensity determined by share of highly-skilled employees (Janz & Peters, 2002)
• Labour productivity *increases* with innovation intensity (Janz et al, 2003; Loof, 2004)
• Labour productivity in the service sector *decreases* with innovation intensity (Ferreira and Mira, 2005).
2.7 Appropriation example

Does the use of formal appropriation methods such as patents improve the probability of collaborating?

Illustrates the problems of using an innovation survey to address a policy issue.
2.8 Appropriation options

• Use strong **formal** protection methods (patents, copyright, design registration)
• Use ‘**strategic**’ or non-formal protection methods such as secrecy, first mover advantages, and technical complexity.
Relationship between appropriation methods & collaboration

<table>
<thead>
<tr>
<th>Formal methods (patents, etc)</th>
<th>Positive correlation with collaboration</th>
<th>No effect or negative correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dachs, 2004 (Finland)</td>
<td>Loof &amp; Brostrom, 2004 (Sweden)</td>
<td>Schmidt, 2004 (Germany)</td>
</tr>
<tr>
<td>Arundel, 2001 (7 countries)</td>
<td>Brouwer &amp; Kleinknecht, 1999 (Netherlands)</td>
<td>Dachs, 2004 (Austria)</td>
</tr>
<tr>
<td>Czarnitzki et al, 2004 (Finland and Germany)</td>
<td>Czarnitzki &amp; Fier, 2003 (Germany)</td>
<td>Bonte &amp; Keilbach, 2004 (Germany)</td>
</tr>
</tbody>
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<tr>
<th>Strategic methods (secrecy, etc)</th>
<th>Positive correlation with collaboration</th>
<th>No effect or negative correlation</th>
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</thead>
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<tr>
<td>Cassiman &amp; Veugelers, 2001 (Belgium)</td>
<td>Dachs, 2004 (Finland)</td>
<td>Veugelers &amp; Cassiman, 2004 (Belgium)</td>
</tr>
<tr>
<td>Bonte &amp; Keilbach, 2004 (Germany)</td>
<td></td>
<td>Dachs, 2004 (Austria)</td>
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</tbody>
</table>
2.9 Formal or strategic?

• Not clear that strong formal protection methods are promoters of collaboration, since most studies did not look at both methods.

• Exception: study by Bonte and Keilbach:
  – A multinomial model with three different cooperation categories with suppliers or customers as the dependent variable.
    • Informal cooperation
    • Formal cooperation
    • No cooperation
Bonte and Keilbach (cont)

- Includes both strategic and formal protection methods in each model:
  - Strategic protection methods (aggregation of ordinal scores for secrecy, lead time, complexity)
  - Industry level measure of scores for formal protection method (patents, copyright, brand names)
- Compared to ‘no cooperation’, formal protection methods has no effect on either formal or informal collaboration.
- Compared to no cooperation, strategic protection methods have a strong positive effect on collaboration.
Bonte and Keilbach (cont)

• Comments:
  – Results only applicable to vertical supply chains (suppliers and customers). These could differ from cooperation with competitors, universities, etc.
  – Not clear why variable for formal protection methods (patents) is entered as an industry dummy.
  – No data on if value of formal or informal protection methods are directly linked to cooperation – only firm averages.
Veugelers & Cassiman, 2005

• Focus on collaborations between firms and universities
• Same construction of formal and strategic variables as with Bonte & Keilbach (strategic at firm level, formal at industry level)
• Strategic protection methods have no effect, whereas formal protection methods have a strong positive effect
Veugelers & Cassiman, 2005

• Comments:
  – Gives opposite result, but for collaboration with universities – is this the reason?
  – Using industry level variables for formal protection methods creates a confounding problem:
    • Sectors with high importance given to patent protection have a high probability of collaborating with universities: pharmaceuticals and ICT
    • Do not know if formal protection actually used with universities
    • Is the driver of collaboration related to formal protection, or is formal protection really relevant?

Globelics Tampere 2008
2.10 Why do we find conflicting results?

• **Country effects** (National innovation systems)?

• **Over-interpretation of the data**
  – No direct link between the value of appropriation to the firm (a market variable) and the use of patents and strategic methods as enablers of collaboration

• **Different model formulations**? – problem with using cross-sectional data to explore causation.
3. Lessons for survey-based research
3.1 Main problem

• Conflicting results from study to study on some issues of major interest (appropriation, performance, etc).

• Creates ‘unease’ among policy makers – what to believe?
3.2 Limitations of surveys

There is a “long standing tension between [innovation surveys], with their advantage of generality but lack of depth, versus case study methods, which offer richness at the expense of generalizability”.


• Need in-depth research to explain the ‘why’ of innovation survey results
3.3 Hazard of over interpreting data

• Trying to fit a square peg into a round hole is a common problem with innovation survey research – theory driven analysis can conflict with the actual question.

• If you use published papers on survey data in your research, find the original survey questionnaire and check how the author’s have interpreted the questions.
  – Also look for data on the reliability of the survey.
3.4 Carefully sift through data

• Both positive and negative results can be limited to specific sectors or conditions.
  – Break up analyses to identify the drivers of specific results – are they consistent across sectors or firm size classes?
    • Note: Controlling for sectors or size classes in a model assumes no interaction effects, which may not be true.

• What methods did the authors use to evaluate their data?
4. Future research areas
4.1 Heavily explored topics:

- Knowledge sourcing
- Collaboration
  - *Exception – with competitors*
- Effect of R&D status on performance
- Appropriation (patents, etc)
- Role of ‘public science’
- *If you look at these topics, you need something new!*
4.2 ‘Unexplored’ topics

- What factors hinder *innovative* firms in their ability to innovate?
- Effects of innovation on “non economic” outcomes:
  - Environmental
  - Market strategies
  - Process flexibility
- Interaction between different types of innovative activities (product, process, organisational) on firm performance
- Process innovation and performance
- Innovation among non-R&D performing innovators
- Role of markets – domestic, international etc.
A note on environmental innovation

2c. During 2005 to 2007, did your enterprise introduce any environmentally beneficial innovations specifically in response to the following:

1. Legal prohibitions or technology/performance standards
2. Environmental taxes, subsidies, other financial incentives
3. Tradable permits or quotas
4. Information measures such as eco-labels
5. Voluntary codes of practice or negotiated agreements/covenants

Yes No

Are firms reacting to policy signals?
A few slides on neglected innovators

• Main results of study for non-R&D innovators:
  – Their activities are similar to R&D performers: 71% develop innovations in-house compared to 91% of R&D performers.
  – They are less likely to benefit from innovation support programmes including programmes that do not require R&D.
  – There is no revenue penalty for not performing R&D.
## R&D status by change in turnover 2004 to 2006

<table>
<thead>
<tr>
<th>Change in income</th>
<th>No R&amp;D</th>
<th>R&amp;D in-house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased &gt; 25%</td>
<td>1.7%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Decreased 5% - 25%</td>
<td>7.8%</td>
<td>7.8%</td>
</tr>
<tr>
<td>Little change</td>
<td>54.6%</td>
<td>52.9%</td>
</tr>
<tr>
<td>Increased 10% to 50%</td>
<td>32.7%</td>
<td>34.6%</td>
</tr>
<tr>
<td>Increased &gt; 50%</td>
<td>3.2%</td>
<td>3.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>100.0%</strong></td>
</tr>
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</table>

Source: Arundel, Bordoy & Kanerva, 2008

Results confirmed in an econometric model that controls for size, sector, country, total innovation expenditures, innovative capabilities.
Conclusions
Five conclusions

1. Survey data requires appropriate statistical models – be careful about causality and interaction effects!
2. Do not over interpret your data – assume that respondents answer your questions literally.
3. Often helpful to supplement survey research with in-depth interviews.
4. If you are interested in ‘heavily explored’ topics, find something new and of interest.
5. Still many ‘unexplored’ areas, even using existing survey data.