Survey-based approaches to measuring innovation: Two approaches

Wesley M. Cohen
Duke University and NBER

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Agenda

- Two survey-based measures of innovation
  - Community Innovation Survey (CIS)
  - The “Division of Innovative Labor” (DoIL) innovation survey by Arora, Cohen and Walsh

- Question: Innovation?
  - What do respondents mean?
  - How can we achieve greater interpretability and precision?
    - Suggestions from the Arora, Cohen and Walsh’s survey on the Division of Innovative Labor (DoIL) in U.S. mfg.

- What are we learning about innovation from these surveys (focusing mostly on DoIL survey)
“Innovation” per the Community Innovation Survey (CIS)
Key CIS questions  (CIS, harmonized, July 2014)

• During the prior three years, 2012-2014, “did your enterprise introduce”:
  • Product innovations: “New or significantly improved goods”
  • Were any of your product innovations:
    • “New to your market”
    • “Only to your enterprise”
    • A “first” in your country, Europe or the world?”
Selected CIS estimates of innovation rates (~2007-2009) among mfg. firms, and DoIL survey estimates for U.S.

- **New-to-the-firm**
  - Germany: 49%
  - UK: 34%
  - France: 28%
  - DoIL for U.S.: 42%

- **New-to-the-market innovation**
  - Germany: 23%
  - UK: 17%
  - France: 19%
  - DoIL for U.S.: 16%
CIS framing

- CIS asks questions about innovation at the firm level
- Revenues and innovation
  - What percent of the firm’s total turnover in 2014 was from world-first product innovations intro’d between 2012 and 2014”?
- Examples of other questions
  - Types of partners
  - Licensing
  - Barriers to innovation
A concern

- What do respondents mean by “New or significantly improved goods”?
  - Trivial?
    - A new color toothpaste or the first 3-D printer?
- What respondents mean will affect interpretation of findings
Arora, Cohen and Walsh (2016) Survey on the Division of Innovative Labor
DoIL project objective

- More special purpose than the CIS
- Objective: To characterize contours of the “division of innovative labor” (DoIL)
  - Starting from distinction between invention and innovation, DoIL survey examines extent to which innovators acquire inventions from external sources and channels employed
    - Which sources? Which channels?
      - Allowed comparison of value of externally acquired inventions by source
      - Estimates importance of external sourcing for innovative performance
- First needed to identify innovating firms
Definitions of innovation

- **Innovators**
  - “In 2009, have you earned revenue from any new or significantly improved goods or services in [INDUSTRY] introduced since 2007, where “new” means new to your firm?”

- **FOCUS: Respondent’s most important innovation**
  - “Of all the new or significantly improved products or services you brought to market in [RESPONDENT INDUSTRY] during the three years, 2007-2009, think of the one that accounts for the most revenue.”
  - “Did you introduce this innovation in your industry before any other company?” =>

- **We identify these respondents as “new to the market” (NTM) innovators**
Comparison with CIS

- Both surveys start from similar definition of innovation

- **But** rather than focus on firm as a whole, DoIL survey focuses:
  - On single line of business
  - Single, most important innovation

- Follow-on questions concern this most important innovation.

- **Benefits**
  - Precision
  - Allows for calibration, mitigating concerns over interpretation of what “innovation” means, at least economically
Table 2. Rates of innovation and imitation, patenting and % sales for U.S. mfg. industries.

<table>
<thead>
<tr>
<th>INDUSTRY (Number of respondents)</th>
<th>% NOSI a</th>
<th>% NTM b</th>
<th>% Imitator a-b</th>
<th>% sales from NOSI</th>
<th>% sales from focal NTM innovation</th>
<th>% NTM patented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food/Bev (362)</td>
<td>40%</td>
<td>13%</td>
<td>27%</td>
<td>16%</td>
<td>9%</td>
<td>24%</td>
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<tr>
<td>Textiles (210)</td>
<td>37%</td>
<td>15%</td>
<td>22%</td>
<td>19%</td>
<td>15%</td>
<td>51%</td>
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<tr>
<td>Wood (385)</td>
<td>33%</td>
<td>8%</td>
<td>25%</td>
<td>15%</td>
<td>7%</td>
<td>11%</td>
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<tr>
<td>Chemicals (365)</td>
<td>49%</td>
<td>24%</td>
<td>25%</td>
<td>17%</td>
<td>9%</td>
<td>42%</td>
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<td>Pharma (128)</td>
<td>62%</td>
<td>28%</td>
<td>33%</td>
<td>23%</td>
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<td>61%</td>
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<td>Plastics (340)</td>
<td>47%</td>
<td>16%</td>
<td>31%</td>
<td>14%</td>
<td>6%</td>
<td>42%</td>
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<tr>
<td>Minerals (323)</td>
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<td>9%</td>
<td>21%</td>
<td>21%</td>
<td>14%</td>
<td>35%</td>
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<td>Metals (324)</td>
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<td>14%</td>
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<td>Fab Metals (424)</td>
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<td>28%</td>
<td>8%</td>
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<td>Machinery (384)</td>
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<td>20%</td>
<td>24%</td>
<td>24%</td>
<td>14%</td>
<td>52%</td>
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<td>Electronics (146)</td>
<td>76%</td>
<td>33%</td>
<td>43%</td>
<td>38%</td>
<td>9%</td>
<td>58%</td>
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<td>Semicond (302)</td>
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<td>27%</td>
<td>33%</td>
<td>29%</td>
<td>18%</td>
<td>59%</td>
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<td>Instruments (135)</td>
<td>59%</td>
<td>37%</td>
<td>22%</td>
<td>17%</td>
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<td>54%</td>
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<tr>
<td>Elec Equip (344)</td>
<td>54%</td>
<td>26%</td>
<td>28%</td>
<td>25%</td>
<td>13%</td>
<td>53%</td>
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<tr>
<td>Auto (339)</td>
<td>50%</td>
<td>27%</td>
<td>23%</td>
<td>25%</td>
<td>11%</td>
<td>34%</td>
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<tr>
<td>Med Equip (136)</td>
<td>55%</td>
<td>22%</td>
<td>33%</td>
<td>37%</td>
<td>31%</td>
<td>72%</td>
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<tr>
<td>Misc. (510)</td>
<td>47%</td>
<td>19%</td>
<td>29%</td>
<td>30%</td>
<td>10%</td>
<td>45%</td>
</tr>
<tr>
<td>All manuf. (5157)</td>
<td>42%</td>
<td>16%</td>
<td>27%</td>
<td><strong>22%</strong></td>
<td><strong>11%</strong></td>
<td><strong>42%</strong></td>
</tr>
<tr>
<td>Large firms (1268)</td>
<td>65%</td>
<td>38%</td>
<td>27%</td>
<td>24%</td>
<td>10%</td>
<td>63%</td>
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<td>Med. firms (945)</td>
<td>54%</td>
<td>23%</td>
<td>31%</td>
<td>20%</td>
<td>15%</td>
<td>47%</td>
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<tr>
<td>Small firms (2944)</td>
<td>39%</td>
<td>13%</td>
<td>26%</td>
<td>19%</td>
<td>12%</td>
<td>36%</td>
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</table>
Selected findings from DoIL survey

- NTM innovation rate for manufacturing, 2007-2009: 16%
- 27% imitate
  - Imitation much more stable across industries than innovation rate
- Sales of new products highly skewed
  - For NTM innovators, the most important new to market innovation accounts for bulk of sales from all new to firm sales (about 70%)
Sources and channels for the underlying inventions

“Did any of the following originate this [most important] innovation, that is, create the overall design, develop the prototype or conceptualize the technology?”

- 49% externally source the invention
  - Most pervasive source: customers
  - Most valuable originate from tech specialists

How acquired?
- Market channels (e.g., lic’ing, contract, equity acquisition): 37%
  - Market only: 16%
- Non-market channels account for almost two thirds, with cooperative efforts at 61%
But is the product innovation “important”? 

Along what dimension(s)?

How can we tell?
Wheat from chaff

- Indicators of economic and technical importance of focal innovation mitigate concerns that the measure reflects trivial innovations.
- Supplementary indicators of economic value and technical significance permit an assessment of significance of the innovations reported by respondents.
Indicators of economic value and technical significance

- Percentage of business unit sales due to the focal innovation
- To commercialize focal innovation, did the innovator:
  - Develop new sales and distribution channels
  - Invest in new types of equipment or hired employees with skills different from existing employees
- Whether the focal innovation is patented
  - By the innovator
  - By an external source
% business unit sales from focal innovation (n=1,062 NTM innovators)
Investment in commercializing focal innovation and patenting

- Complementary investments to commercialize the innovation?
  - In new sales/distribution channels: 42%
  - In equipment or personnel: 47%
  - In equipment/personnel and sales/distn: 25%
  - In equipment/personnel or sales/distn: 64%
- Patent rate among (NTM) innovators in manufacturing: 42%
  - Patenting by source for externally acquired innovations: 24%
Correspondence between % of sales due to focal innovation and other indicators

- New sales channel: 33% <50% sales, 59% >50% sales
- New equipment or skills: 46% <50% sales, 63% >50% sales
- Either sales OR equip/skills: 59% <50% sales, 78% >50% sales
- Both sales AND equip/skills: 19% <50% sales, 44% >50% sales
- Patent: 52% <50% sales, 64% >50% sales
Conclusions

- Substantive
  - 49% innovator reliance on external sources for invention suggests that, to understand drivers of innovation, need to consider extent and implications of the “division of innovative labor.”

- Methodological
  - Innovation measures focusing on a specific innovation offer accuracy and interpretability
  - Multiple measures tied to a specific innovation can reflect dimensions of economic and technical importance, mitigating ambiguity surrounding term “innovation” or “new or significantly improved”
Thank you
Importance of innovation, SW: % of business unit sales from focal innovation
(n=75 innovators, of 274 SW firms, NAIC’s 5112, 5180, 5415)
Additional measures of importance of the focal innovation in SW

- Patent rate among (the 75 NTM) innovators (of 274 respondents) in SW: 32.3%
- Complementary investments to commercialize the innovation in SW?
  - In new sales/distribution channels: 63%
  - In equipment or personnel: 58%
  - In equipment/personnel and sales/distn: 42%
  - In equipment/personnel or sales/distn: 79%
Innovation rates across surveys: % of resps. introducing NTF or NTM innovs. (mfg only)

<table>
<thead>
<tr>
<th>Survey</th>
<th>NTF %</th>
<th>NTM/NTF %</th>
</tr>
</thead>
<tbody>
<tr>
<td>DoIL (2010)</td>
<td>42</td>
<td>38</td>
</tr>
<tr>
<td>UK CIS (2009)</td>
<td>34</td>
<td>51</td>
</tr>
<tr>
<td>German CIS (2009)</td>
<td>49</td>
<td>45</td>
</tr>
</tbody>
</table>

- *NTF – New to the Firm
- **NTM – New to the Market
Validating Innovation Measures: Industry Correlations across Measures

<table>
<thead>
<tr>
<th>External Indicators</th>
<th>ACS NTF</th>
<th>ACS NTM</th>
</tr>
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<tbody>
<tr>
<td>BRDIS NTF</td>
<td>.72</td>
<td>.76</td>
</tr>
<tr>
<td>Europe-wide CIS NTM</td>
<td>.71</td>
<td>.72</td>
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<tr>
<td>BRDIS R&amp;D Performers</td>
<td>.72</td>
<td>.72</td>
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<tr>
<td>CIS Innovative Activity</td>
<td>.70</td>
<td>.68</td>
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<td>BRDIS RDI*</td>
<td>.59</td>
<td>.52</td>
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<tr>
<td>Rs’ any patent application (PATSTAT)</td>
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<td>.74</td>
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<td>Rs’ patent count (PATSTAT)</td>
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<tr>
<td>Rs’ forward citation count (PATSTAT)</td>
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