

# **Survey-based approaches to measuring innovation: Two approaches**

**Wesley M. Cohen**  
**Duke University and NBER**

**NCSES/CNSTAT Workshop**  
**Advancing Concepts and Models of Innovative Activity**  
**and STI Indicator Systems**  
**Washington, D.C.**  
**May 19-20, 2016**

# 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.**

INDUSTRY (Number of respondents)	% NOSI · a	% NTM · b	%Imitator · a-b	% sales from NOSI	% sales from focal NTM innovation	% NTM patented
Food/Bev (362)	40%	13%	27%	16%	9%	24%
Textiles (210)	37%	15%	22%	19%	15%	51%
Wood (385)	33%	8%	25%	15%	7%	11%
Chemicals (365)	49%	24%	25%	17%	9%	42%
Pharma (128)	62%	28%	33%	23%	13%	61%
Plastics (340)	47%	16%	31%	14%	6%	42%
Minerals (323)	30%	9%	21%	21%	14%	35%
Metals (324)	38%	9%	29%	14%	5%	23%
Fab Metals (424)	38%	10%	28%	28%	8%	35%
Machinery (384)	44%	20%	24%	24%	14%	52%
Electronics (146)	76%	33%	43%	38%	9%	58%
Semicond (302)	60%	27%	33%	29%	18%	59%
Instruments (135)	59%	37%	22%	17%	7%	54%
Elec Equip (344)	54%	26%	28%	25%	13%	53%
Auto (339)	50%	27%	23%	25%	11%	34%
Med Equip (136)	55%	22%	33%	37%	31%	72%
Misc. (510)	47%	19%	29%	30%	10%	45%
All manuf. (5157)	42%	16%	27%	22%	11%	42%
Large firms (1268)	65%	38%	27%	24%	10%	63%
Med. firms(945)	54%	23%	31%	20%	15%	47%
Small firms (2944)	39%	13%	26%	19%	12%	36%

# 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

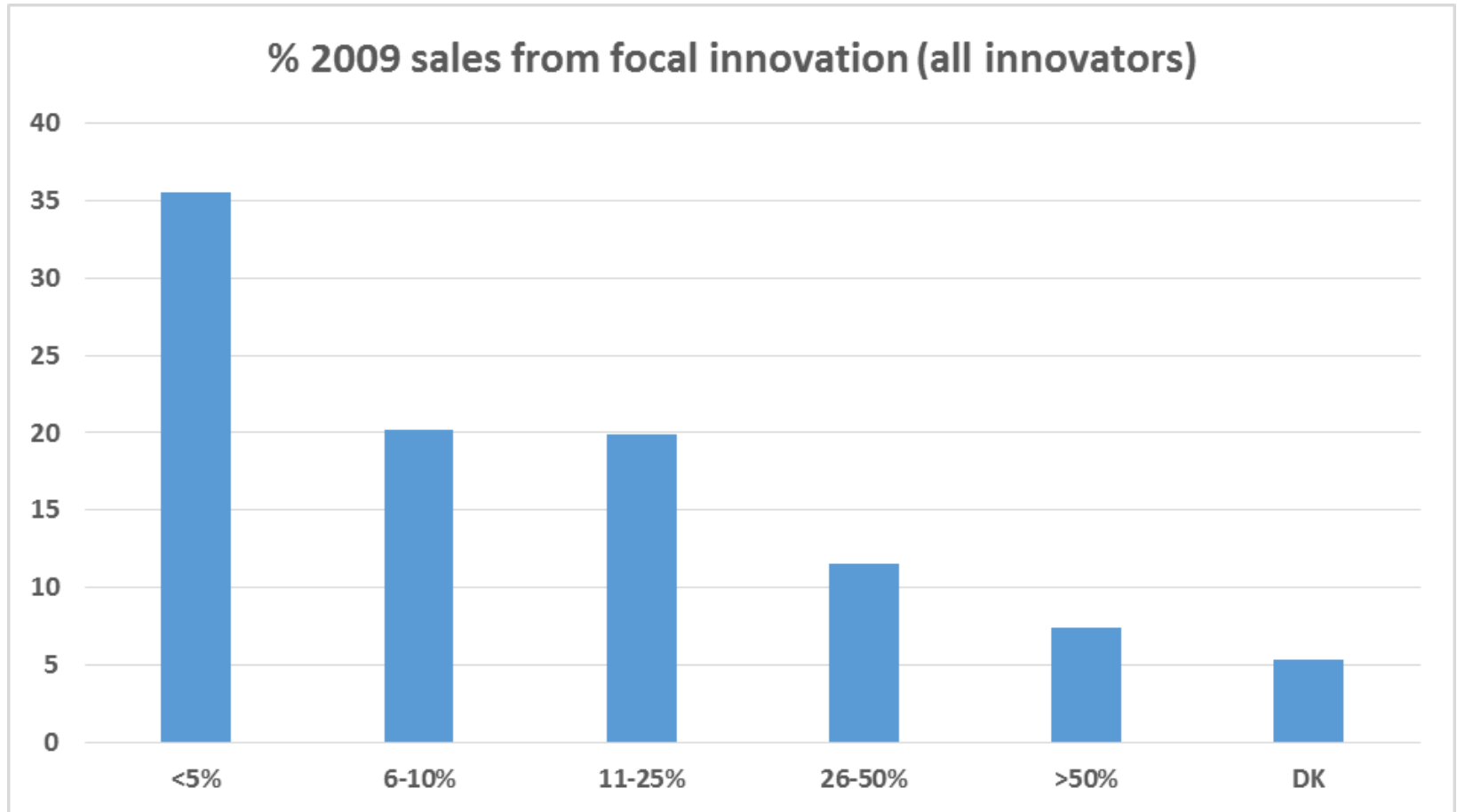
- Indicators of economic and technical importance of focal innovation mitigate concerns that the measure reflects trivial innovations
- Supplementary indicators of economic value and technical significance permit a an assessment of significance of the innovations reported by respondents.



# 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

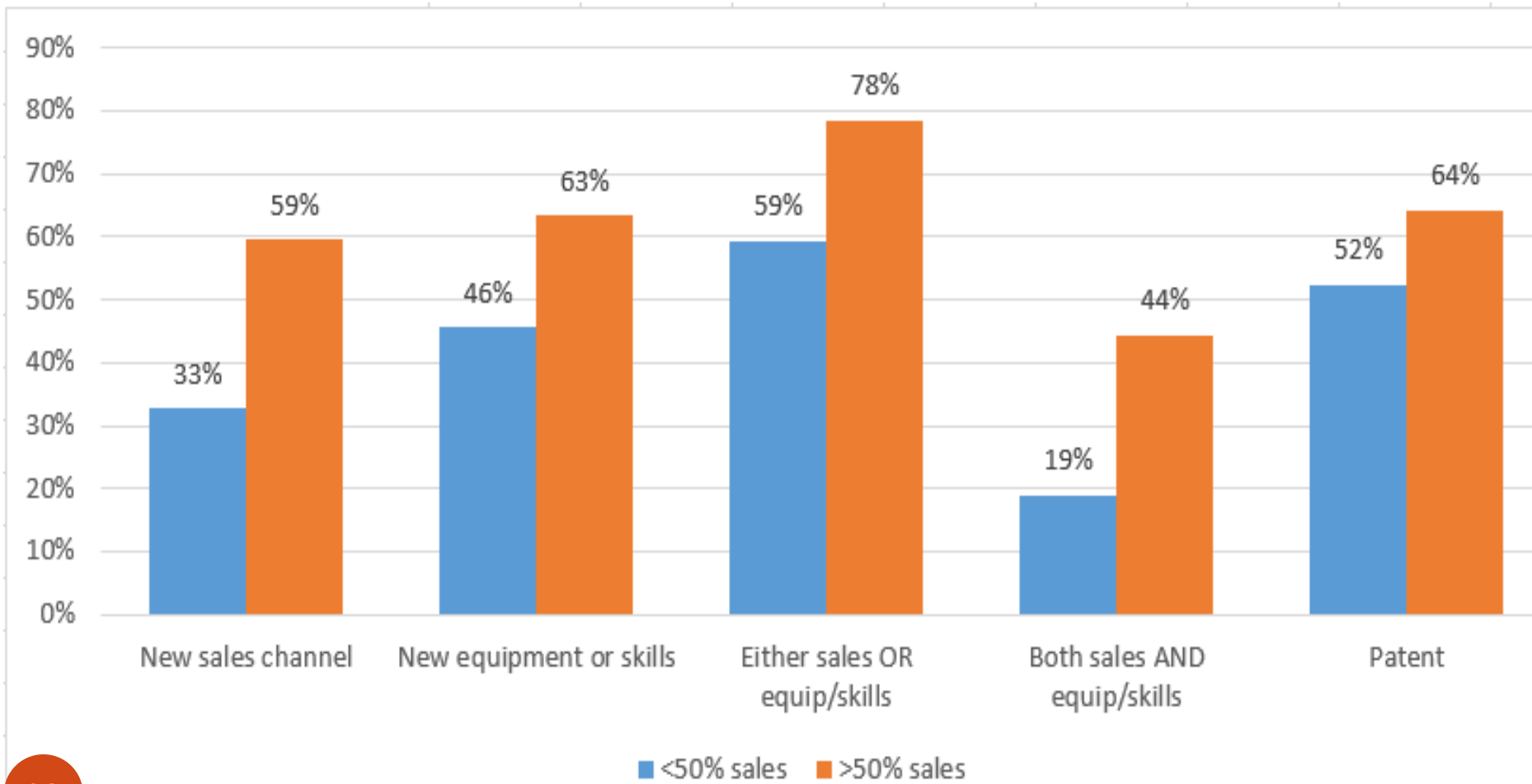
# % business unit sales from focal innovation (n=1,062 NTM innovators)



# 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

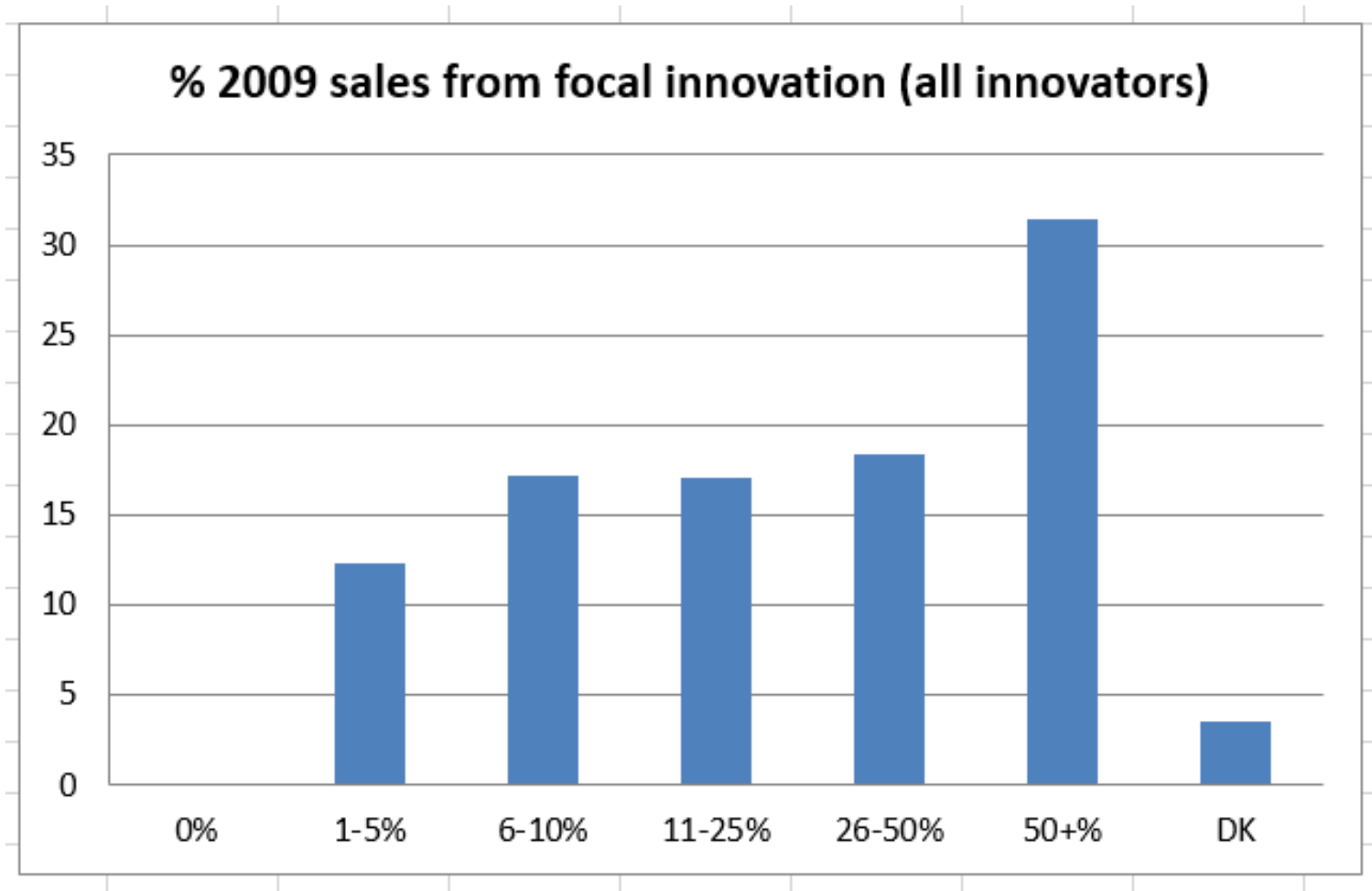


# Conclusions

- **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)

<b>Survey</b>	<b>NTF %</b>	<b>NTM/NTF %</b>
<b>DoIL (2010)</b>	<b>42</b>	<b>38</b>
<b>UK CIS (2009)</b>	<b>34</b>	<b>51</b>
<b>German CIS (2009)</b>	<b>49</b>	<b>45</b>

- \*NTF – New to the Firm
- \*\*NTM – New to the Market

# Validating Innovation Measures: Industry Correlations across Measures

<b>External Indicators</b>	<b>ACS NTF</b>	<b>ACS NTM</b>
BRDIS NTF	.72	.76
Europe-wide CIS NTM	.71	.72
BRDIS R&D Performers	.72	.72
CIS Innovative Activity	.70	.68
BRDIS RDI*	.59	.52
Rs' any patent application (PATSTAT)	.72	.74
Rs' patent count (PATSTAT)	.54	.47
Rs' forward citation count (PATSTAT)	.56	.49