

Business Innovation Expert Panel for Task Order 19

NCSES V Task Order 19

Workshop Summary Report

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Table of Contents

Table of Contents	2
Executive Summary	4
Workshop Summary	7
<i>Continuing Examination of Innovation in the U.S. Business Sector by NCSSES</i>	7
Discussion - Continuing Examination of Innovation in the U.S. Business Sector by NCSSES	9
<i>Session 1: Business Innovation Activities</i>	10
Discussion - Business Innovation Activities.....	11
<i>Session 2: Business Capabilities for Innovation</i>	13
Discussion - Business Capabilities for Innovation	14
<i>Session 3: Business Innovation and Knowledge Flows</i>	15
Discussion - Business Innovation and Knowledge Flows	16
<i>Session 4: External Factors in Influencing Innovation in Firms</i>	17
Discussion - External Factors in Influencing Innovation in Firms.....	18
<i>Session 5: Objectives and Outcomes of Business Innovation</i>	19
Discussion - Objectives and Outcomes of Business Innovation	20
Detailed Notes	24
<i>Welcome, Introductions, and Discussion of Meeting Goals</i>	24
<i>Continuing Examination of Innovation in the U.S. Business Sector by NCSSES</i>	25
Discussion - Continuing Examination of Innovation in the U.S. Business Sector by NCSSES	28
<i>Session 1: Business Innovation Activities</i>	29
<i>Session 2: Business Capabilities for Innovation</i>	33
Discussion - Business Capabilities for Innovation	35
<i>Session 3: Business Innovation and Knowledge Flows</i>	37
Discussion - Business Innovation and Knowledge Flows	38
<i>Session 4: External Factors in Influencing Innovation in Firms</i>	40
Discussion - External Factors in Influencing Innovation in Firms.....	41
<i>Session 5: Objectives and Outcomes of Business Innovation</i>	44
Discussion - Objectives and Outcomes of Business Innovation	45
<i>Discussion Summary, Recommendations, and Conclusion</i>	47
Appendix: Presentation Slides	50

Note

Please note that this document was prepared by SRI International from the workshop on business innovation, convened by SRI. Any opinions, findings, and conclusions expressed in this material are those of the respective authors and do not necessarily reflect the views of the National Science Foundation or its staff. Because this report directly quotes individuals, it is not intended to be shared publicly.

Executive Summary

On behalf of the National Center for Science and Engineering Statistics (NCSES) within the National Science Foundation (NSF), SRI International (SRI) organized an Expert Panel on Business Innovation with stakeholders from academia, government, and industry. The *NCSES Business Innovation Workshop* was held on October 16, 2018, at SRI's offices in Arlington, Virginia.

The workshop focused on the following objectives:

- Prioritize the recommendations of the forthcoming new Oslo Manual edition regarding revised and/or new metrics and data collections on business innovation.
- Discuss how the recommendations from the forthcoming Oslo Manual should be incorporated into a module on innovation to be included in the Annual Business Survey (ABS).
- Identify the high-priority areas for future collections considering the needs for business innovation data and the interests of U.S. policy makers and academic researchers.

ABS is conducted in partnership by NSF/NCSES and the Census Bureau and includes a module on innovation. The module is currently based on the Community Innovation Survey (CIS). The Oslo Manual sets forth guidelines for collecting and interpreting innovation data. A revised version was published in October 2018. In the revised manual, numerous topics are presented for inclusion in future innovation surveys. However, there are too many topics to include in the ABS innovation module. During this workshop, participants discussed and recommended priorities on the topics for the future ABS. The outcome of the workshop will be used to assist in the development of the innovation module for the 2018 ABS.

In addition to the Oslo Manual, workshop panelists were invited to review and discuss several questionnaires that currently address innovation: ABS 2017 (innovation questions are in Section C, pages 16–22); the Microbusiness Research & Development (R&D) and Innovation Survey (BRDI-M) 2016 (innovation questions are in Section D, pages 3–4); the Business Research and Development and Innovation Survey (BRDIS) 2016 (innovation questions are in Section 1, pages 8–9); and CIS 2018 (innovation only).

The panelists included the following leading experts, who presented on various topics:

- **Jan Youtie**, Georgia Tech University, Workshop Chair, presented *Discussion 1: Business Innovation Activities*. Business Innovation Activities are activities that firms may undertake in pursuit of innovation, including R&D; engineering, design, and other creative work; marketing and brand equity activities; intellectual property (IP); employee training; software development and databases; investment in buildings, machinery, equipment and other tangible asset, and innovation management activities.
- **Wes Cohen**, Duke University, presented *Discussion 2: Business Capabilities for Innovation*. Business capabilities for innovation include the knowledge, competencies, and resources that a firm accumulates over time and draws upon in the pursuit of its innovation objectives. Collecting data on business capabilities is important to understand the effect of innovation on firm performance and why some firms innovate, and others do not.

- **Steve Landefeld**, Bureau of Economic Analysis (Retired), presented *Discussion 3: Business Innovation and Knowledge Flows*. Knowledge flows include how knowledge is accessed, how it is deployed, and how it is exchanged between firms and other actors engaged in the innovation system.
- **Stephen Ezell**, Information Technology and Innovation Foundation, presented *Discussion 4: External Factors in Influencing Innovation in Firms*. External factors can influence a firm's incentive to innovate, the types of innovation activities that it undertakes, and its innovation capabilities and outcomes. External factors may also be the object of a business strategy, public policy, or concerted social action by public interest groups.
- **E.J. Reedy**, University of Chicago, presented *Discussion 5: Objective and Outcomes of Business Innovation*. The planning and development stage for an innovation includes the identification of a set of one or more objectives that the innovation is expected to achieve. The objectives can concern the characteristics of the innovation itself, such as its specifications, and its market and economic objectives. The outcomes of an innovation are similar to the objectives but consist of the innovation's realized effects. These can include unexpected effects that were not identified among the firm's initial objectives.

Other participants present were:

- **Mohan Sawhney**, Director, Center for Research in Technology & Innovation, Kellogg School of Management, Northwestern University
- **Nico Thomas**, Performance Analyst, National Institute of Standards and Technology
- **Steve Campbell**, Economist, Manufacturing Research and Program Evaluation, National Institute of Standards and Technology
- **Adam Jaffe**, Professor, Economics, Brandeis University
- **Mark Crowell**, Executive Entrepreneur in Residence, Eshelman Institute for Innovation, UNC Eshelman School of Pharmacy
- **Stuart Graham**, Associate Professor, Scheller College of Business, Georgia Institute of Technology
- **Ann Xu**, Senior Technical Advisor for Impact and Assessment, ARPA-E
- **Kenneth Poole**, Executive Director of C2ER, The Council for Community and Economic Research

The meeting was also attended by Emilda Rivers, Division Director of NCSSES; Samson Adeshiyan, Acting Deputy Division Director of NCSSES; John Jankowski, R&D Statistics Program Director, NCSSES; Mark Boroush, Senior Analyst, NCSSES; and Audrey Kindlon, Survey Statistician, NCSSES. Additionally, several other NCSSES staff and Patrice Norman from the U.S. Census Bureau were present as observers.

The group recommended including most of the Oslo Manual topics reviewed during the discussion in the business survey module of the NCSSES survey. The only generally negative responses were towards the questions about the drivers of and barriers to innovation.

Several experts stressed that co-development and co-creation by firms working together need to be tracked, and the questions reviewed during the workshop may not capture adequately either legal or less formal relationships between firms.

Other points emphasized during the meeting included the following:

- Some information that the Oslo Manual suggests asking for may be available as administrative data; however, although linkages to other data sets are possible, they are still difficult and not an immediate option.
- Asking questions about regulations in the United States can be tricky as “regulation” has become a politically loaded term, and any questions of this type would have to be tested.
- Questions about objectives and outcomes would also need extensive testing.

The group did not agree on whether data collection should be entirely subject-based (as recommended by the Oslo Manual), or include an object-based component. The subject-based approach covers the full range of innovation and innovation activities of the firm, whereas the object-based approach collects data on a single most important innovation. Other unresolved disagreements included the ideal size of business to survey, and how to align the Oslo Manual’s three-year windows with product life cycles.

Workshop Summary

The NCSES Business Innovation Expert Panel convened various stakeholders and end users from academia, government, and industry in a workshop to identify and prioritize Oslo Manual recommendations to be incorporated into the Annual Business Survey (ABS). Through extensive conversation, SRI and NCSES developed a list of final panelists in academia, government, and industry. Although not all could attend, SRI secured the participation of outside experts and scheduled the panel meeting to take place at SRI International's office in Arlington, Virginia, on October 16, 2018. Prior to the meeting, several panelists were invited to present on the upcoming Oslo Manual chapters and review current NCSES survey questionnaires (ABS, BRDI-M, BRDIS, and CIS). The meeting was attended by thirteen panelists representing academia, industry, and U.S. government agencies; Emilda Rivers, Division Director of NCSES; Samson Adeshiyan, Acting Deputy Division Director of NCSES; John Jankowski, R&D Statistics Program Director, NCSES; Mark Boroush, Senior Analyst, NCSES; and Audrey Kindlon, Survey Statistician, NCSES; and eight observers from the U.S. Census Bureau and NCSES.

Jan Youtie, Georgia Tech University, served as the workshop chair. After welcomes by NCSES leadership, she presented an overview of the background and goals of the meeting. The meeting had been organized as part of the effort by NCSES to improve and revise the upcoming ABS. ABS is conducted in partnership by NCSES and the Census Bureau and includes a module on innovation. The workshop was organized to leverage the rich experience of participants' study of invention and innovation activities. The goal for the workshop was to discuss and recommend priorities on the topics for the innovation module of the future ABS. Question development was not a focus of discussion during this workshop.

Continuing Examination of Innovation in the U.S. Business Sector by NCSES

After introducing the Workshop Chair, Jan Youtie, **John Jankowski**, Program Director of NSF's Research and Development Statistics Program, began his presentation, *NCSES's Continuing Examination of Innovation in the U.S. Business Sector*. He provided an overview of the organizational background, NCSES innovation surveys, the Oslo Manual, and the purpose of the workshop.

NCSES is a division within the Directorate for Social, Behavioral, & Economic Sciences in the National Science Foundation, created by an act of Congress in 1950 to collect information on the science and engineering enterprise, including competitiveness. It is one of the U.S. Federal Government's 13 principal statistical agencies.

NCSES conducts three surveys of businesses in partnership with the Census Bureau: BRDIS, the Microbusiness R&D and Innovation Survey (Micro-BRDIS), and ABS. As of 2017, BRDIS no longer collects innovation data and has been renamed the Business R&D Survey (BRDS). Many of the innovation questions are derived from the Oslo Manual. Historically, the manual defined innovation in terms of various types of innovation achieved by the enterprise, specifically, **Product Innovation**, new or improved goods or services; **Process Innovation**, new or improved production processes, distribution methods, or support activities; **Organizational Innovation**, new business practices, new methods of organizing work and decision making, or new methods of organizing external relations; and **Marketing Innovation**, changes to the design or presentation packaging of goods or services, or new methods of pricing goods or services. However, the objective of the workshop was not to look at what has been

done, but to consider what data to collect in the future, based on guidance from the revised Oslo Manual.

Jankowski continued with an overview of BRDIS, for which data have been collected annually from 2009 to 2016. This survey had about an 80% survey response rate in the last cycle. Questions ask about product and process innovation as well as novelty (new to market or new to firm), but the survey does not define innovation.

In 2016, NCSSES distributed the Micro-BRDIS to 200,000 businesses that had up to nine employees. Some Oslo Manual elements were incorporated into the questions. Cognitive testing indicated that different wording worked better for small business respondents and, therefore, the original BRDIS questions were revised for the Micro-BRDIS. Micro-BRDIS asked small businesses about product innovation, process innovation, and organizational and marketing innovation. NCSSES partnered with the Census Bureau to include innovation modules on ABS. ABS combines the Survey of Business Owners, the Annual Survey of Entrepreneurs, Micro-BRDIS, and a standalone business innovation module with approximately 15 innovation questions based on the 2005 Oslo Manual and the CIS survey. The 2017 sample size was 850,000.

The ABS 2018 will feature fewer innovation questions when compared to ABS 2017. However, it is anticipated that the ABS 2019 will be closer to the ABS 2017 innovation module in terms of the number of questions asked.

Three years ago, the Organisation for Economic Co-operation and Development (OECD) and Eurostat began updating the Oslo Manual. The revisions are completed, after extensive review, and the new edition was released on October 22, 2018. The revision was guided by a steering group from many countries, including Japan, Germany, the United Kingdom, representatives from Eurostat, and the United States. Part of the effort was to align R&D terminology with the System of National Accounts (SNA) and other statistical manuals, such as the Frascati Manual. The review committee also looked at the role of digitization and globalization. The new Oslo Manual encourages a subject-based approach, but also recognizes the object-based approach. The subject-based approach covers the full range of innovation and innovation activities of the firm, whereas the object-based approach collects data on a single most important innovation. Each chapter ends with key indicator questions as well as supplementary indicators.

Jankowski noted that his presentation covers material from the Oslo Manual's Chapter 3, *Concepts and definitions for measuring business innovation*, and gave an overview of the chapters and topics that the remaining presenters would discuss:

- **Chapter 4.** Measuring business innovation activities (Jan Youtie, Workshop Chair)
- **Chapter 5.** Measuring business capabilities for innovation (Wes Cohen)
- **Chapter 6.** Business innovation and knowledge flows (Steven Landefeld)
- **Chapter 7.** Measuring external factors influencing firm innovation (Stephen Ezell)
- **Chapter 8.** Objectives and outcomes of business innovation (E.J. Reedy)

Jankowski explained that the workshop would review the topic areas, discuss how to interpret them in terms of U.S. business innovation, and then consider how to prioritize them in an innovation module for the 2019 ABS. The purpose of this workshop is to identify the most important topics on the next U.S. innovation survey, but not to write the questions themselves, which will be another step in the process.

Next, Jankowski presented the Manual's definition of innovation:

- An **innovation** is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process).

Jankowski noted that the product or process must be brought into use to count as innovation (it cannot be abandoned), though it may succeed or fail. Also, in the digital world, an innovation may contain intermixed products and processes.

A **business innovation** is a new or improved product or business process (or combination of the two) that the firm has brought into use and that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm. A business innovation may be either a product innovation or a business process innovation.

A **product innovation** is a new or improved good (a tangible object) or service (intangible activity). Digital knowledge-capturing products, used for data storage, security, and communication, may behave as either a goods or services.

A **business process innovation** is a new or improved business process and may concern any of six types of functions: (1) production of goods and services, (2) distribution and logistics, (3) marketing and sales, (4) information and communication systems, (5) administration and management activities, and (6) product and business process development.

Jankowski added that for countries that wish to maintain their time series from earlier surveys, these categories can be mapped to the previous types of innovation (i.e., product, process, organizational, and marketing innovation).

Discussion - Continuing Examination of Innovation in the U.S. Business Sector by NCSES

Youtie began the discussion by encouraging participants to offer their commentary and feedback on the presentations and methods to measure innovation. The goal of NCSES is to balance successfully collecting up-to-date innovation data with a reasonable respondent burden.

The participants raised the following points:

- Must an "innovation" be new to the market to count as innovation? Some studies focus on innovation imitators. But the important issue is whether a new idea is really important or impactful. For example, when it appeared, the first 3-D printer was more important than that season's new toothpaste formulas. There should be questions that speak to the importance of a new product. This suggests that NCSES should ask these types of object-oriented questions in addition to the firm-level questions.

- NCSES should add questions that measure impact (e.g., to address social welfare). These types of variables could be a foundation for subsequent innovation research and address several of the dimensions that change our understanding of social welfare and its impact. Jankowski commented that those variables will be addressed later in the Chapter 7 presentation.
- Could NCSES increase data quality by fielding targeted sampling modules? Jankowski responded that the ABS 2019 sample size will be around 300,000 for all businesses of one or more employees and cover all industries, as compared to this year's ABS with a sample size of around 850,000. Some observe that the nature of value-creating innovations has taken on significantly new characteristics. Now platforms are important; they create the ecosystem constructs upon which innovations are built. How will surveys designed to capture product, process, and business model innovation measure this? Jankowski responded that these variables are covered in the new Oslo Manual, which addresses product, process, the combination thereof, and new digital components. One takeaway could be to ensure that the survey captures something on value creation, captures something about platform-based innovation and how it creates value.
- Google, Uber, and other massively successful innovative companies are extremely rare. Can a broad-based survey capture these unusual cases of business model innovation? The high-impact factors are very rare, and that in itself is a policy issue.
- Those with a macroeconomics perspective would like to see more data on prices and transaction rather than yes/no responses. Valuations can be used to look at the relative importance of different innovations. What economic growth flows from the innovations? Researchers are scrambling for answers about U.S. and world economic growth and how innovation and technology are affecting it. What about the location of growth? What about offshore production? What do we expect to see from this new tax act? Two-way flow data are necessary for this research.

Session 1: Business Innovation Activities

Youtie defined business innovation activities as developmental, financial, and commercial activities that are intended to result in an innovation. They may be performed internally or externally. They may succeed or fail in their original purpose or may succeed in the sense that they do not meet their original goals but produce some other knowledge.

Youtie then discussed the eight types of business innovation activities:

- Research and experimental development activities – The five criteria of R&D specified by the Frascati Manual are novel, creative, uncertain outcome, systematic, and transferable/reproducible. Not all innovations meet all five of the R&D criteria.
- Engineering, design, and other creative work activities – Engineering and design activities that do not meet the five R&D criteria include testing, set-up, tooling, production, and quality testing. However, engineering may not always be innovative. Service firms may use design for appearance or ease of use. Reverse engineering is another example of non-innovative activity.
- Marketing and brand equity activities – Innovative marketing and branding activities include pricing, product placement, and advertising (often linked to a new or improved product).

- IP-related activities – IP activities include patents, utility patents, industrial designs, trademarks, copyright, integrated circuit designs, plants, and trade secrets for new products and processes.
- Employee training activities – Employee training would not be innovative if it is for existing products or general skills.
- Software development and database activities – Innovative software development and database innovation activities do not include maintaining the IT system, supporting existing systems, or conducting routine functions.
- Activities related to the acquisition or lease of tangible assets – These include buildings, instruments, equipment, machinery, and computer hardware
- Innovation management activities – These include funding, organization, external collaborations, and performance (for firms that innovate only).

The chapter's key questions for data collection are:

- Were the eight activities conducted, regardless of the reason, with innovation as the aim?
- Was each activity conducted in house or procured from external organizations?
- Of the total expenditures for each of the eight activities, was innovation management recommended?
- What were the funding sources for innovation?

Supplementary questions for data collection requested additional information about specific activities, such as whether R&D is continuous or occasional, innovation expenditures by funding source, follow-up activities, and planned innovation activities and expenditures. Questions about the number of innovation projects by activity may include innovation undertaken, completed, or ceased before completion during the period as well as projects that are still in progress at the end of the period. Follow-up activities are those that occur after implementation but within the period; they include marketing, training of employees or customers in the use of the product or business process innovations; and after-sales services, such as installation, update and repair services, guarantee and return support, and general information. Questions about planned activities may ask whether the firm plans to conduct any innovation activities in the one or two years after the reference year and whether total innovation expenditures compared to the reference year are expected to increase, decrease, or stay the same.

Discussion - Business Innovation Activities

The discussion centered around the following points:

- What was the thought process behind the prioritization of the list? Jankowski responded that it had been a collaborative consensus effort.
- Some participants did not like the use of the terms *procure* or *acquire*. Jankowski responded that the term *procure* was intentional on the part of the committee, but NCSES would take the comment into consideration.
- What is the unit of analysis? Jankowski explained that the Oslo Manual says to collect data from the lowest level legal entity with decision-making authority, that is, the business unit rather the firm as a whole. Some participants still favored using the innovation project as the unit of

analysis. Jankowski thanked his colleagues for bringing the object-based approach to the community's attention; he added that had it not been for the earlier research of some of the present participants, the object-based approach probably would not have been included in the manual at all. He stated that, nevertheless, the focus should be on the enterprise. Because this is the unit of analysis for all international statistics, NCSSES must concentrate on the subject-based approach. One participant noted that NCSSES could have both.

- Location is an important issue that may be overlooked. If a firm conducts training or deploys new technology, it could be in a different location from where the design is taking place. Data collection at the national level will not capture how multi-national organizations function.
- Some participants felt that co-development and co-creation were being left out. The world today is built upon partnerships, and a firm's boundaries are no longer rigid. Jankowski assured the group that the Oslo Manual addresses co-creation, and NCSSES will consider this point when developing the questions. One participant suggested a three-part question: Did you make it? Did you buy it? Did you partner with another firm?
- Many firms are engaged in work that meets the definition of R&D (e.g., it is novel and creative), but they would not label or identify their work as R&D. Perhaps more generic phrases, such as *new activities* would capture novel activities more successfully. Youtie responded that the Oslo Manual suggests more detailed questions beyond these, including should intramural and extramural activities be separated to try to get to the economics flows? However, she acknowledged that some firms do not use an accounting approach to track R&D. In these cases, the Oslo Manual suggests a full-time equivalent (FTE) approach.
- The group did not come to a consensus about the ideal size(s) of business that NCSSES should cover in a national innovation survey. Youtie's experience in Georgia has shown that companies with fewer than 10 employees generally do not do manufacturing primarily; they focus on distribution or sales. Companies with 10 or more employees should be the threshold. On the other hand, Xu noted that many performers with whom she has worked have only two or three employees. Jankowski commented that NCSSES might need to develop different standards for industries in different sectors.
- Several participants emphasized that small firms are involved in innovation, but they may be difficult to identify. How do we find small firms that conduct R&D? On the other hand, it cannot be assumed that R&D itself is a descriptor of innovation. People who work for especially small firms may have multiple roles, taking care of both traditional business activities and innovation activities. Another issue with small firms is that those who have not yet introduced an innovation into the market may not have any revenue, so tracking activity by accounts activity may not work.
- Some participants wished that the NCSSES survey would collect data at the state and local levels, at least for a few industries. Jankowski commented that NCSSES will be sensitive to those concerns, though the primary focus of the workshop was national level data.

Session 2: Business Capabilities for Innovation

Wes Cohen began the next discussion with a presentation on business capabilities for innovation, noting that he suspected, based on earlier clarifications by Jankowski, that some of the points he had planned to raise might be addressed by other chapters.

Cohen then discussed the types of business capabilities for innovation given by Chapter 5. As it pursues its objectives over time a firm accumulates knowledge, competencies, and resources. Other resources include the physical plant, human capital and experience, sources of finance, and access to outside resources. These would include cooperative venture, licensing deals, and other relationships, which NCSSES should try to capture. NCSSES should consider asking about cooperative ventures, licensing deals, and other relationships. The business strategy should include cost competitiveness or focus on quality features (e.g., functionality, durability, flexibility of use). Firms should also be surveyed on their organizational, managerial, and innovation management capabilities. NCSSES should also consider workforce qualifications, occupational structure, and competences. Regarding human resource management, an increasingly important source of information for innovation is the ability to use technological tools and digital resources. Lastly, NCSSES should consider the innovative capabilities related to digital technologies and data analytics (i.e. technical expertise and design capabilities).

Cohen recommended breaking out aggregate statistics from this category by industry. Then, he reviewed the key questions for data collection: What are the number of full-time employed persons by business unit (not the firm as a whole)? What are the total sales, business unit sales—the key correlate of R&D? What is the firm age by the year the firm began business activities (e.g., date of entry by market)? What is the firm ownership status (e.g., stand alone, part of a national group, part of a multinational group)? What is the geographical distribution of sales (e.g., local, national, international markets)? What are the export shares of sales by business unit? What is the importance of cost versus quality for the firm's competitive strategy (the suggested measures are: percentage of process versus product R&D, and, for the latter, percentage that is dedicated to developing new products versus product improvement)? What is the share of employed persons with a tertiary education? What is the business level of design capability and cash flow?

Having reviewed these, Cohen asked why the Oslo Manual needed supplementary questions and how had questions been sorted into the key and supplementary groups: by feasibility, or by vagueness? Jankowski responded that questions in the key groups were generally agreed on by the whole committee, or at least not strongly opposed by anyone. Supplementary questions were generally those that one or a few members thought were important (but none opposed).

Pursuing this line, Cohen asked, what approach could be used to determine whether these data are important or not? Can a method be developed to determine this, perhaps through working with others at NCSSES or organizations other than NSF? Jankowski responded that NCSSES would consider that in refinements of future innovation surveys. However, this workshop's focus is on guiding next year's survey, and NCSSES was relying on the stakeholders in the room because they had much more experience with these kinds of topics and issues than NCSSES' colleagues elsewhere.

Cohen gave an overview of supplementary questions for data collection: Is the firm family-owned? How many product lines does the firm manage? Who within the firm is responsible for innovation? How is innovation managed and how does the firm handle the internal exchange of knowledge? What emerging technologies does the firm have expertise in? What are the firm's digital competences?

Cohen wondered, who is the audience for these data, and would these topics address the needs of policymakers, business management, researchers, and others? He wondered if the Oslo Manual makes a clear statement about this. Also, he recommended that a vehicle be included within these surveys that will allow analysts to tease out cause and effect; this would allow researchers to answer the question, why should we care about these data? To do that, he suggested distinguishing between firms that innovate, firms that imitate, and firms that do neither. Rather than using Likert scale questions to assess that, he prefers to ask about behaviors; for instance, did a university suggest new products to a firm? In response, Jankowski noted that the scales help to provide a range of importance.

Discussion - Business Capabilities for Innovation

The discussion brought up the following points:

- Some recent work by Cohen's colleagues shows that an important driver for innovation performance at the systemic level is the relationships across nodes, not just the nodes themselves (e.g., individual firms, universities, and others). When asked from where the most important new products came, 49% of the respondents said that they were acquired from an external source, and many said they were acquired through co-development with other entities. It is reasonable to focus on the firm, but it is necessary to think about relationships and capabilities as well as how to find managers of co-operative ventures, licensing deals, etc.
- Perhaps a proxy measure for capabilities would be a measure of resources in the ecosystem. Relationship capital will not appear on the balance sheet. Where did you get the idea? Who built the prototype? What are the knowledge flows?
- At what level of the firm should these questions be asked? At what level do they reside? Who can respond knowledgeably? Upper management might be unaware of the innovative activity, and the department that undertakes it might have a different perspective from management. It may also vary across firms. NCSSES needs to think about how to get this information.
- One participant's research shows that different departments and levels within firms give different responses about innovation capabilities. Management and marketing are more optimistic, whereas sales and engineering are less optimistic. People in one function do not understand other functions, and few understand the picture as a whole. Capabilities may need to be distinguished across managerial, technical, and other divisions. Marketing, sales, and manufacturing are essential for data collection.
- Cohen stated that when measuring performance, he prefers to use financial performance data. Regarding products, he has in the past asked about incremental innovation versus new products and he has found that data on behaviors—even though self-reported—can be very useful.
- Questions about tertiary education could yield important data; however, it is worth remembering that some firms hire those with a tertiary education for the front office but not for the back office. Also, some firms make the decision to hire people without advanced skills, so it

becomes a matter of business strategy. In that case, it is necessary to know who in the firm understands the strategy.

- If tertiary education data are collected, it would be useful to separate out those with tertiary education in a technical field (as opposed to, say, individuals with master's degrees in business administration or social scientists).
- Digital capabilities and data analytics are becoming increasingly important, but researchers must be careful not to categorize design activities, such as user functionality and aesthetics, as R&D. However, the Oslo Manual recognizes that digitization is taking place across all sectors and aims to capture these types of innovation activity.
- Some of the key questions address things that researchers can already find out about firms. Perhaps many of these data can be imported from administrative record sources?
- A clear distinction needs to be made between business capabilities and individual employee capabilities. If the focus is on employees, the business (or firm) may not be the right unit of measurement.
- Looking at new products and financial performance gives a certain measure of success, but technology failure can also teach a great deal. Also, what about the lives affected? Did the firm learn anything from the experience? What about the firm's relationships with its customers and other firms?
- What are the incentives and what are the performance evaluation criteria for innovative project management? These trigger incentives and may vary across type of innovation, even within the same firm. These might yield a clue as to how firms prioritize projects. Could they be market performance or market share?
- Questions that capture institutional value at advancing stages of investment (as is often apparent in the pharmaceutical field) might help to quantify values around innovation.

Jankowski commented that knowing how businesses are organized at the functional level is critical for any survey that reports quantitative data on R&D. But what is the cut-off size? Businesses with nine or fewer people typically do not have super-specialized roles, so many staff members may have a good idea of what is going on, whereas large companies have people with specialized knowledge. Innovation statistics from BRDIS show that much business innovation activity did not have R&D.

Youtie asked Cohen whether he thought the business innovation capability questions should be included in the survey. Cohen responded that some should be included, but not the whole list from the Manual. He cautioned that it would probably take a year or two of research before the community could agree on two to four reasonable indicators.

Session 3: Business Innovation and Knowledge Flows

Steve Landefeld presented material from Chapter 6 of the Oslo Manual on business innovation and knowledge flows. He commented that IP is key to addressing these issues. Market transactions deliberately transfer from one knowledge area to another. Customers may suggest improvements that are incorporated into products or processes, but we will never see these in transaction records. Offshoring of resources and jobs may be technology transfer or tax avoidance. Trade regulations and tariffs also have an important effect on the flow of knowledge. Also, some flows are deliberate, whereas

others are accidental. Landefeld also encouraged NCSSES to strongly consider some of the more detailed questions presented in the chapter, such as geography.

He discussed the key questions for data collection.

- What inbound knowledge flows contribute to innovation? The Oslo Manual provides mainly a qualitative yes/no response; however, NCSSES has great experience in economic flows and can use BRDS and other surveys, as well as the Oslo Manual, as guides for this question.
- Where are the firm's collaborative partners in innovation located? If firms provide access to economic data, this would be very interesting in the Global Value Chain (GVC) context.
- What are the sources of ideas and knowledge for innovation? (Landefeld referred the group to Table 6.2, which includes internal and external sources of innovation.)
- What are the barriers to knowledge interactions? (Landefeld noted that Table 6.9 provides an interesting classification of barriers to transactions, many of which are amenable to increased or decreased policy action.)

Supplementary questions for data collection include: What are the locations of the sources of inbound knowledge flows? What are the firms' outbound knowledge flows? What channels for knowledge sharing exist between the firm and Higher Education Institutions and Public Research Institutions? Landefeld noted that the locations of inbound knowledge, though very important for GVCs, is very difficult to collect on surveys, and may only be possible with world input-output tables. Collecting data on outbound knowledge flows is also difficult, but both inbound and outbound flows are needed; perhaps NCSSES can approach these questions by build on existing economic data and surveys. Use of intellectual property rights for knowledge flows is also very difficult to collect due to tax and transfer pricing for IP, but it is extremely important.

Jankowski noted that NCSSES wanted to distinguish internal sources versus external sources but that the key recommendations are not always the easiest to collect nor even necessarily the sources of the most important information.

Discussion - Business Innovation and Knowledge Flows

The discussion touched on the following issues:

- One participant felt that the term *accidental* made the knowledge flow sound like a leak and preferred the term *unintentional*. Landefeld acknowledged the point but noted both that sometimes there are real leaks and that the language comes from the Oslo Manual.
- NCSSES could add trade secrets as an object that captures knowledge. Value chains are critically important today, but it is difficult to collect information on them; the only way researchers have been able to get at those data is through the world input-output model.
- Questions on barriers to innovation might be difficult for respondents to answer and increase item nonresponse. Youtie added that her work asking about barriers had rarely led to identifying new barriers; the same answers, usually time and money, appeared frequently. Jankowski mentioned the concerns listed in the manual, such as anti-trust policy enforcement, high coordination costs, cost of dispute settlements, and financial resources. He agreed that although time and resources are common barriers, these answers do not provide much insight.

- NCSES can use federal labs and clusters as test cases to see if they show innovation signals. These observations might help people develop better questions. This information would be useful for the National Institute of Standards and Technology, which focuses on industry questions about challenges; however, the issue with questions like these is that it is difficult to find one approach that is broad enough to address every industry.
- A significant challenge is tracking follow-up funding. It is difficult to know the full chain upstream and downstream but getting that information would dramatically improve the results. Outbound knowledge flows consider both sides (i.e., flows and asset transfers).
- Co-creation is more than a flow and more than transactional; it is persistent creation, not just an accidental leak; co-development should also be addressed.
- IP questions are very important; IP is observable in some areas of a firm, as it underpins royalties and tangible flows. Although IP provides some detailed information, it does not cover everything.

Landefeld cautioned that transaction data can be misleading (e.g., Apple has a much lower tax rate through maintaining a headquarters in Ireland).

Session 4: External Factors in Influencing Innovation in Firms

The fourth session leader, **Stephen Ezell**, held a discussion on the factors in the external environment that affect innovation. External factors define the firm's operating environment. A firm operating in the technology innovation sector may be in a different position than a firm elsewhere in the economy. An innovative firm must protect IP and manage R&D, design, innovation, and cloud computing services, all of which are affected by external factors. Likewise, the markets for the firms' products; society and the natural environment, including climate change; levels of societal trust; and innovation in society, are all important external factors.

Ezell reviewed the chapter's key questions: What is the firm's industry and main market? What is the firm's competition and what is their product market characteristics? What support does government provide for innovation? What are the drivers or barriers to innovation?

Ezell stated that government support for innovation should be a key component of the data collection and gave an overview of the main types of government policies supporting innovation: grants, equity finance, debt finance, guarantees for debt financing, payments for goods and services, tax incentives, and public infrastructure and services. Working capital and access to suppliers are also drivers to innovation.

The chapter's supplementary questions include: What are the locations of business activities and value chains? What is the firm's main customer's industry and share of sales? What is the effect of regulations on innovation? Ezell asked the group if it is worth investigating the firm's location and space domestically and globally in the survey. Ezell also encouraged the group to consider the value of questions about competition.

Ezell noted that the chapter also contains questions about consumer responsiveness to innovation and trust. However, he recommended not asking these questions, as the World Values Survey already

collects similar data. For the chapter overall, he concluded that he liked the questions but not the way they were approached.

Discussion - External Factors in Influencing Innovation in Firms

Points raised by the group during the discussion included the following:

- There are traditional competitors and disruptive competitors; the latter play a different game. Sometimes, the actions or identity of your next competitor cannot be predicted (e.g., Amazon getting into insurance).
- Defining *external* can be tricky. It requires a lot of attention to measurement. Aside from intensity of competition, there is demand, technological opportunity (i.e., technical performance value for dollar in R&D), and appropriability (i.e., the degree to which firms can hope to profit from their innovations).
- There are also demand-side externalities, including both direct and indirect externalities. Today, there are marketplaces mediated by platforms. The phenomenon of indirect externalities is new. Poole noted that the U.S. Bureau of Labor Statistics fields the Contingent Worker Survey that gets at some of the questions about how dependent firms are on external or platform technologies from the worker's perspective. Sawhney suggested asking, "Are you dependent on outside technology for how you do your work and how you are paid?"
- There are many all-digital platforms, such as small businesses that write software for Uber, for example. It is important to differentiate the digital platform from other types. Research should move to where the profit is going to be, because value is de-materializing. Data and digitalization will drive value in the future.
- Many groups have endorsed the concept of linkages to other data sets. Landefeld noted that there had been some very good work between the U.S. Economic Development Agency and the U.S. Census Bureau, and it may be helpful to link to that data.
- There are ways of linking non-Census data at a firm level with data from funding surveys. It may be possible to use linkages as substitutes for some questions. However, respondent burden must also be considered. Linking data is difficult but can be done.
- NCSSES should think about linkages ahead of time, as this will help researchers in their work. Ann Xu links self-reported data to two other data sets in her own research, but it is difficult.
- The traditional analysis of innovation has looked at the firm as the unit of analysis and the product as the output; but now the product is moving towards platform and the firm is moving towards ecosystem. The problem is how to measure a network in which the product is the output. Sawhney suggested researchers take an external view and consider it as an ecosystem.
- NCSSES should not only consider the federal level but collect state data as well. NCSSES should push the envelope on data linkage but not be overly optimistic about what the outcomes will be. This will rely in large part on data quality improvements.
- NCSSES could also consider cyclical survey components to add value to the data variables that are already available for linkages across time, which has been done with the U.S. Census Bureau's Annual Survey of Entrepreneurs. However, someone needs to go into the field to negotiate for linkages and data improvements to support linkage.

- In terms of external data, competition is not always a great measure. Past research (cited by participants) has shown that firms believed that there were fewer competitors than the actual number of businesses suggest. It is important to distinguish what researchers want to collect from what they want to infer.
- Several years ago, the U.S. Bureau of Labor Statistics tried to look at the issue of outsourcing. Either it was not successful, or the results were not reported. The outcomes of this work may be helpful for NCSSES if someone can find their results. One participant heard that the difficulties were more bureaucratic than technical. Budget resources in the statistical agencies are limiting this type of research.
- The underlying science and engineering base is a big external driver, but it does not appear in the Oslo Manual list. Is there a profitable way to ask something meaningful about regulatory effects on product innovation? NCSSES might have to ask particular questions for particular industries.
- The role of regulation is extremely important, but how does one obtain solid, objective data about its effect on innovation? And how deep should the questions go? One purpose of regulation is to keep people safe, but the social effects are far down the line, beyond NCSSES' remit.
- NCSSES should not use the term *regulation*; perhaps the survey could ask about specific *policies* for different industries instead.
- Rather than asking yes or no questions for many variables, it may be helpful for NCSSES to collect quantitative data to measure the external factors influencing innovation.
- Over 75% of federally funded R&D is conducted by multinational companies. A good chunk of multi-national data would be more valuable than that 300,000 U.S. respondents. NCSSES should ask questions about multi-national operations.
- Participants generally recommended including variables on topics such as the firm's industry, competition, and government support for innovation. They were not enthusiastic about questions regarding barriers to innovation. One participant suggested NCSSES collect data on barriers without asking explicitly if something is a barrier.

Session 5: Objectives and Outcomes of Business Innovation

For the final session, **E.J. Reedy** reviewed innovation outcomes, areas of influence, and strategies. He shared a casual conversation he had had with someone from the chemical manufacturing industry who makes products for agriculture. This industry representative discussed the difficulties of getting his products into the marketplace. His average customer is around 65 years old, and though consumers are becoming savvier, they do not always believe statistics. Even when his product offers a 10% increase in yield, he does not feel like he has a good value proposition to offer. In bad years, he must convince customers that their 50% lower yield would have been 60% lower yield without his product. His firm has developed other products with 1-2% yield increase rates that they have not brought to market. They do not believe they can sell them to their customer base because of the low yield rate. Reedy noted that this suggests that there may be patents for inventions that are not taken to market though they may still have tangential added value at the firm; however, that will not show up in the measurements. This

means that surveys do not capture the projects that fail. Those data are revealing about barriers and constraints. Some questions at the project level could address questions on projects that fail.

Reedy provided an overview of the definitions. Most of the chapter used similar terminology for objectives and outcomes, but Reedy was not convinced that the same structure could be used for both; in some cases, it might not be possible or feasible. Researchers often start with outcomes for innovative firms, for which the manual suggests a three-year period; then, these transition into the objectives. Reedy felt that the three-year period—around which the Oslo Manual is built— provides sufficient time to measure impact.

Next, he gave an overview of the questions for data collection.

- What are the firm’s innovation objectives and outcomes by area of influence (e.g., markets, production and delivery, business organization, economy and society)?
- What are the innovation objectives and outcomes for business strategies?
- What percentage of innovation sales share in total business sales?

Reedy then presented supplementary questions for data collection from the chapter: What is the count of product innovations? What are the major impacts of innovations for markets?

Discussion - Objectives and Outcomes of Business Innovation

The discussion continued with a debate on the three-year period. One year may not be enough time to measure impact. NCSSES can use impact as an outcome measure to determine how successful firms are. It could also describe market-level intensity around innovation.

The Manual can help NCSSES interpret outcomes. Although some effects would only be observable to customers, impact on society as a whole might be more visible.

In terms of objectives, it was not clear to what extent the focus should be on the last three years. Jankowski felt that for the revision steering group, objectives are probably linked to the three-year period, but it is probably not a tight timeline relationship.

The R&D lifecycle is likely longer than three years, and the time horizon for innovation is a function of objectives and outcomes. But this would require distinguishing different types of innovation. Some firms do not care about the next year. This is not just a large-firm issue, as even small companies may take 15 years to get something to market. NCSSES could ask about the distribution of projects across horizons or create a metric of product planning for product strategy that would measure the product life cycle. NCSSES can add a question that asks about lifecycle and another that asks about the types of innovation.

Reedy drew a diagram to illustrate the two types of taxonomies that apply to objectives and outcomes. The first is based on strategy and includes variables that assess positioning, internal capabilities, and positioning within the market. The second is based on area of influence and include variables that assess the markets for products; productivity and delivery; business organization; and economy, society, and environment (i.e., quality of life and well-being).

NCSES can also consider social impact by asking firms about their prioritization of those issues. Although it may be difficult to collect data about environmental and societal outcomes, many businesses cite them as part of their goals (i.e., objectives). Firms try to balance between being good corporate citizens (by having a societal impact) and making money.

Participants cautioned that adding questions on social impact to the ABS may lead to firms responding with what they think NCSES wants to hear. These types of questions will be difficult to write and will require extensive testing for bias. It might be more useful to conduct qualitative research on finances.

Another issue is that often respondents do not know the market or the demand and need to learn about them. This may require activities that do not bear directly on the objectives. Although the ultimate objective is to make money, these more intermediate objectives may be important. Additionally, how do researchers get to objectives other than strictly commercial ones (e.g., the malaria vaccine)? Many young entrepreneurs have a hybrid business vision, with a high level of intentionality about societal impact. NCSES is not inclined to include these on the first survey round. These sorts of goals are part of the European Union's Horizon 2020 plan, but they are not yet in the language of U.S. policy.

Xu suggested that the potential way for NCSES to confirm answers to social impact questions is to ask how firms measure their outcomes. Investments are measurable. Graham suggested NCSES find out what managers' bonuses are linked to.

Reedy concluded by saying that he was concerned about the granularity of the questions and would not recommend implementing all of them; he also suggested asking at the firm level rather than object level.

Summary and Recommendations

In the final session, Youtie reviewed the group's conclusions and recommendations for the topics by chapter. She noted that, overall, the group recommended including most of the questions, except those about drivers and barriers to innovation.

Chapter 5. Measuring Business Capabilities for Innovation

Youtie noted that the group appeared to have become more intense and probing as the day progressed and wondered if the discussion on capabilities had happened too soon. The general conclusion was that the questions in this section should probably be asked, especially if dollar figures can be collected. However, this chapter also had the least consensus among the group, and many concerns were voiced.

There was disagreement about the preferred unit of analysis. NCSES plans to collect data at the firm level, per the manual recommendations, but some participants felt that that without project-level data, the survey would miss business relationships and many functions of multi-national firms.

Sawhney felt that co-development and co-creation were not adequately addressed. He suggested a three-part question: Did you make it? Did you buy it? Did you partner with another firm?

Some firms are engaged in work that meets the definition of R&D but does not track it as such in the accounting systems. Perhaps NCSSES should consider more generic terminology (e.g., *new activities*). Youtie noted that the manual suggests an FTE approach in these cases.

The group did not come to a consensus about the ideal size(s) of businesses that NCSSES should cover in a national innovation survey. Some favored 10 or more employees, but others noted that small businesses also conducted innovative activity. One possibility is that NCSSES consider different standards for industries in different sectors.

Small businesses present particular challenges. They may have people who take care of both traditional business activities and innovation activities. Those that have not yet introduced an innovation into the market may not yet have any revenue.

Youtie doubted that the planned activities questions would yield useful data. (Many promise, but few follow up.)

Cohen liked supplementary questions that ask about the number of innovation projects by activity.

Poole suggested that it might be easier to get at capabilities by asking about occupations and human capital (e.g., how many people do this type of work?). Landefeld added that labor data can provide information on the mix of occupations.

Chapter 6. Business Innovation and Knowledge Flows

Youtie noted that the group had shown great interest in this chapter. Landefeld would prioritize anything that can be monetized. Sawhney felt that the topics got at some part of, but not all of, co-creation. Cohen suggested that researchers consider trying to capture spillovers, co-development activities, and upstream knowledge, in addition to the variables presented in the manual. Another suggestion was to track performance evaluation criteria for innovative project management, as these might show how firms prioritize projects.

One concern was identifying the correct persons in the firm of whom to ask the questions—who knows the operation? Who knows the company strategies? Do people in one unit understand what is happening in other units or in the firm overall?

Some wondered if administrative records could provide some of the information data this chapter discusses. Another point raised was that whereas new products and financial performance give a certain measure of success, failure is also a teacher. What did the firm learn? Also, how did an innovation affect people's lives? Did it affect the firm's relationships with its customers and other firms?

Chapter 7. Measuring External Factors Influencing Firm Innovation

The group liked most of the questions in this section. However, the questions about drivers of and barriers to innovation caused concern. Why ask about working capital and access to suppliers when secondary data can be used to control for how competitive a market is? Many firms have no idea how many competitors they have, and would not be able to answer questions about their domestic and global space. Also, data about consumer responsiveness to innovation and trust are already collected by the World Values Survey.

The discussion covered the possibility of linking to other data sources, while acknowledging the difficulty of doing this. Participants also acknowledged that regulation could be both a driver of and a barrier to innovation, but it is problematic to ask the question because the term “regulation” has become politically loaded in the United States. Some noted that external drivers to innovation were not on the list and should be added.

Chapter 8. Objectives and Outcomes of Business Innovation

Reedy was concerned about the granularity of these questions and would not recommend implementing all of them. Concerns raised by the group included the practical application of the three-year periods suggested by the manual. Do these apply to objectives as well as outcomes? More importantly, do they align with product life cycles? In many cases, the answer is no. Another concern was how to ask questions about outcomes and objectives in such a way that respondents would not simply choose an attractive sounding answer because there is no penalty for doing so. This line of questioning will likely need extensive testing, but many new businesses have a hybrid vision that includes social impact, and the group agreed that it is important to capture it. As a check on the outcome-related answers, Xu suggested asking how respondents measure their outcomes, and Stuart Graham suggested asking respondents what triggers bonuses.

Participants made several suggestions in closing. Poole stated that any increase in granularity in geography would increase the usage of the data dramatically. National data does not tell the story that researchers and policy makers need at the state and sub-state levels. Landefeld suggested that NCSSES interview government analysts directly for their feedback. Crowell noted that universities are becoming more like commercial firms in the way they manage their innovation assets and urged NCSSES to look more closely at this.

Cohen that the discussion missed the adoption and diffusion of platforms, and non-high-tech innovations that have a huge economic impact (e.g., the supermarket, containerization). Jankowski responded that the Oslo Manual explicitly states that the innovation does not have to be high-tech, while admitting that the last version was clearer about this.

Youtie thanked the stakeholders for their participation and wonderfully diverse comments. Jankowski told the participants that NCSSES would keep them updated on future developments and asked that they feel free to contact NCSSES with any questions or updates on any interesting developments in their work on innovation.

Next Steps

NCSSES will proceed with updates to the ABS and potentially schedule individual interviews with government agencies and other end users of the data for additional feedback. During these processes, NCSSES will consider the recommendations presented by each of the stakeholders. After this review, NCSSES will contact businesses about the topics it plans for the survey. NCSSES will be in touch with the workshop participants again to share its conclusions.

NCSSES plans to launch the survey module in about a year. NCSSES will also watch closely over the next two years as Eurostat, Japan, and Statistics Canada launch surveys based on the 2018 Oslo Manual.

Detailed Notes

Welcome, Introductions, and Discussion of Meeting Goals

John Benskin, Project Leader, Center for Innovation Strategy and Policy (CISP), SRI International

John Benskin opened the workshop by welcoming the assembly and provided an overview of the workshop logistics. Benskin introduced fellow workshop organizers, CISP Executive Director Christina Freyman and CISP Research Analyst Tina Davis. Benskin then introduced NCSES Division Director Emilda Rivers.

Emilda Rivers, Division Director, NCSES, NSF

Emilda Rivers welcomed everyone and thanked those in the room for participating in the workshop. Rivers summarized the objective of the Innovation Expert Panel and the goals for NCSES national and global innovation indicators. She stated that innovation is a very important topic that NCSES has heavily invested in to be able to have useful information not only on the United States, but in a global context. This workshop will engage stakeholders early on to determine the necessary measures and discuss the challenges and opportunities as NCSES moves forward to include more information in the business innovation survey. This is also an important topic for NCSES Directorate for Social, Behavioral, & Economic Sciences, as one of their grand challenges addresses innovation. She added that often when innovation is considered from a research perspective, measurement is not a part of the discussion. She would like to develop national and global ways of talking about innovation. Rivers closed by thanking everyone again for being a part of the workshop discussion.

Benskin suggested that each of the participants introduce themselves and provide their organizational background.

The participants who attended the workshop are as follows, in order of introduction:

- **Samson Adeshiyan**, Acting Deputy Division Director, NCSES, NSF
- **Audrey Kindlon**, Survey Statistician, NCSES, NSF
- **Stephen Ezell**, Vice President, Information Technology and Innovation Foundation
- **Mohan Sawhney**, Director, Center for Research in Technology & Innovation, Kellogg School of Management, Northwestern University
- **Nico Thomas**, Performance Analyst, National Institute of Standards and Technology
- **Steve Campbell**, Economist, Manufacturing Research and Program Evaluation, National Institute of Standards and Technology
- **Mark Boroush**, Senior Analyst, NCSES, NSF
- **Jan Youtie, Workshop Chair**, Principal Research Associate, Enterprise Innovation Institute, Georgia Tech
- **John Jankowski, R&D Statistics Program Director**, NCSES, NSF
- **Adam Jaffe**, Professor, Economics, Brandeis University
- **Mark Crowell**, Executive Entrepreneur in Residence, Eshelman Institute for Innovation, UNC Eshelman School of Pharmacy

- **Stuart Graham**, Associate Professor, Scheller College of Business, Georgia Institute of Technology
- **Ann Xu**, Senior Technical Advisor for Impact and Assessment, ARPA-E
- **E.J. Reedy**, Director, Polsky Center for Entrepreneurship and Innovation, The University of Chicago
- **Wes Cohen**, Professor, Fuqua School of Business, Duke University
- **Kenneth Poole**, Executive Director of C2ER, The Council for Community and Economic Research
- **Steve Landefeld**, Retired Director, U.S. Bureau of Economic Analysis

Next, the observers in the room introduced themselves and provided an overview of their organizational background.

- **Patrice Norman**, U.S. Census Bureau
- **Ray Wolfe**, NCSSES, NSF
- **Gary Anderson**, NCSSES, NSF
- **Dan Foley**, NCSSES, NSF
- **Francisco Moris**, NCSSES, NSF
- **Carol Robbins**, NCSSES, NSF

Continuing Examination of Innovation in the U.S. Business Sector¹ by NCSSES

John Jankowski, R&D Statistics Program Director, NCSSES, NSF

Jankowski began the discussion with an introduction of the Workshop Chair, Jan Youtie. Youtie will be guiding the conversation. Jankowski then began his presentation with an introduction to the work done by NCSSES in examining innovation in the U.S. business sector. He provided a presentation of the NCSSES organizational background, NCSSES innovation surveys, and the Oslo Manual and purpose of this workshop.

Jankowski continued his presentation with a brief overview of NCSSES's organizational background. He gave a brief history of the innovation surveys and then discussed the revisions to the Oslo Manual. NCSSES is a division within the Directorate for Social, Behavioral, & Economic Sciences. NCSSES is one of the 13 Federal Government's principal statistical agencies. NCSSES Legislative Mandate of 1950 outlines that NCSSES is an independent federal agency "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense" and one role is to collect information on the science and engineering enterprise.

All the BRDIS and Micro-BRDIS innovation questions have derived from the Oslo Manual. Jankowski asked if anyone in the room did not know of the Oslo Manual. As all participants were aware of the manual, Jankowski proceeded. The Oslo Manual itself defines innovation historically in terms of what the enterprise did. It discusses various types of innovation: product innovation, process innovation, organizational innovation, and marketing innovation.

¹ See Appendix for presentation slides.

- **Product Innovation** – New or significantly improved goods or services with respect to their capabilities, user friendliness, components, or sub-systems.
- **Process Innovation** – New or significantly improved production processes, distribution methods, or support activities for goods or services.
- **Organizational Innovation** – New business practices; new methods of organizing work responsibilities and decision making; or new methods of organizing external relations with other firms or public institutions.
- **Marketing Innovation** – Significant changes to the design or packaging of a good or service; new media or techniques for product promotion; new methods for product placement; or new methods of pricing goods or services.

These factors govern what type of data are collected. Although historically the Oslo Manual itself defines innovation based on what enterprises do, the objective of the workshop today is not to look back but to continue looking forward.

Jankowski gave an overview of the BRDIS questions. Innovation data on BRDIS have been collected annually from 2008 to 2016. BRDIS had about an 83% response rate last year. NCSSES introduced questions about product and process innovation as well as novelty, new-to-market sales, and more to the survey instrument. Internationally, this is the focus for innovation. In 2016, NCSSES developed the micro-BRDIS survey that went out to 200,000 businesses with up to 9 employees. The survey asked these micro-businesses about product, process, organizational, and marketing innovation, and those data have been delivered to NCSSES from the U.S. Census Bureau. NCSSES has now partnered with Census to include innovation modules on the new ABS.

With the development of the ABS, where businesses of all sizes are asked questions about innovation, BRDIS then became the Business Research and Development Survey (BRDS). The 2017 BRDS contains no questions on innovation. The ABS combines the Survey of Business Owners, Annual Survey of Entrepreneurs, Micro-BRDIS, and a stand-alone business innovation module. This will collect business innovation statistics with a sample of 850,000. NCSSES has considered various business strategies and the results of those activities. The module will ask approximately 15 questions looking at innovation.

In June 2019, NCSSES will scale back the innovation module on the ABS to ask approximately eight questions. This transition will mirror the transition from the old Oslo Manual to the new Oslo Manual and ask new innovation questions (e.g., types of innovation activities, total cost). Three years ago, the OECD and Eurostat began an effort to review and revise the Oslo Manual. The manual is completed, having gone through extensive review. It will be released on October 22, 2018. The revision was guided by a steering group from multiple countries, including Japan, Germany, Norway, representatives from Eurostat, and the United States. There was an extensive effort to review each chapter in terms of measuring innovation so that it is consistent with other manuals. NCSSES also looked at the role of digitization and globalization in terms of the economy and the role of innovation. The manual encourages companies to focus on the subject-based approach as the primary collection source for innovation statistics, although it also recognizes the object-based approach. Each Oslo Manual chapter ends with key indicator questions as well as supplementary indicators.

Jankowski commented that five presenters will introduce the discussions in each of the topic areas of interest. Jankowski provided an overview of Chapter 3, *Concepts and definitions of measuring business innovation*, and the basic definitions of the Oslo Manual; the remaining presenters focus on Oslo Manual Chapters 4 through 8, as follows:

- **Chapter 4.** Measuring business innovation activities (Jan Youtie, Chair)
- **Chapter 5.** Measuring business capabilities for innovation (Wes Cohen)
- **Chapter 6.** Business innovation and knowledge flows (Steve Landefeld)
- **Chapter 7.** Measuring external factors influencing firm innovation (Stephen Ezell)
- **Chapter 8.** Objectives and outcomes of business innovation (E.J. Reedy)

Jankowski explained that the workshop would review the basic topic areas and then hold a discussion regarding how to understand them in terms of U.S. business innovation and how to prioritize them to create an innovation module for the 2019 ABS. He added that the purpose of this workshop will identify the most important topics on the next U.S. innovation survey based on the guidance in the Oslo Manual—not to write the questions themselves, which will be another step in the process.

Jankowski introduced the survey definition of innovation:

- An **innovation** is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process).
 - This definition is to be the basis for measuring innovation in all sectors of the economy.

Jankowski added that the product or process must be used to count as innovation, though it may succeed or fail. Also, in this digital world, products and processes can intermix.

- A **business innovation** is a new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm.
 - A **product innovation** is a new or improved good or service that differs significantly from the firm's previous goods or services and that has been introduced on the market.
 - A **business process innovation** is a new or improved business process for one or more business functions that differs significantly from the firm's previous business processes and that has been brought into use by the firm.
- There are two major types of innovation by object: innovations that change the firm's products (product innovations), and innovations that change the firm's business processes (business process innovations):
 - **Product innovations** can involve two generic types of products: goods (tangible objects) and services (intangible activities). Knowledge-capturing products, as identified in SNA, can have the characteristics of either a good or service and concern the provision, storage, safekeeping, communication, and dissemination of digital information that users can access repeatedly.

- There are six types of **business process functions**: (1) methods for producing goods or providing services; (2) distribution and logistics; (3) marketing and sales; (4) information and communication systems; (5) administration and management activities; and (6) product and business process development, including activities to identify, develop, or adapt products or a firm's processes.

Jankowski added that for countries that wish to maintain their time series, these functions will crosswalk to the previous other types of innovation (i.e., organizational, marketing, and process innovation). He added that this is where things stand after much work that has gone into the Oslo Manual. He suggested that the same amount of work will have to be put into a good survey on business innovation in the United States. Jankowski concluded his presentation and thanked the participants.

Discussion - Continuing Examination of Innovation in the U.S. Business Sector by NCSES

Jan Youtie, Chair, Principal Research Associate, Enterprise Innovation Institute, Georgia Tech

Youtie introduced herself as the Workshop Chair and noted that she would welcome feedback for methods to measure innovation. Youtie added that she does not want to overburden firms by asking everything in the Oslo Manual, but NCSES would like to collect up-to-date information to measure innovation. She encouraged commentary and updates from the stakeholders in the room. Youtie then opened the floor for discussion.

Wes Cohen, Professor, Fuqua School of Business, Duke University

Cohen discussed his ideas on the importance of copycat innovation and asked if an innovation must be new to the market; he doubts this factor is important to the discussion today. His last survey identified those who were innovation imitators. Cohen asked participants how to decide when to pay attention to new innovative products—is it a new toothpaste or the first 3-D printer? Which is more significant? There should be questions that summarize the importance of a new product. This will also speak to the importance of object-oriented questions. NCSES should ask these questions in addition to the firm-level questions. He added that if NCSES wants respondents to answer meaningfully, specific questions and measures should be kept in mind (e.g., to address social welfare). Cohen recently co-authored a paper that discussed those variables. This could be a foundation for subsequent innovation research and address several of the dimensions that change the understanding of social welfare and its impact.

Jankowski commented that those variables will be addressed in the presentation on Chapter 7. He added that each of the five presenters has seen the individual chapter that pertains to his or her presentation; however, no one else in the room has seen it or the whole manual yet. Many the issues that Cohen has identified will be covered in later discussions. (The 2018 Oslo Manual will be launched next week.)

Stuart Graham, Associate Professor, Scheller College of Business, Georgia Institute of Technology

Graham asked how much space would be available on the survey for questions and how many questions could realistically be included for businesses? Graham suggested that it might be helpful to make comments on those questions today to get an informal, internal ranking on the first-order, high-priority issues. Jankowski responded that the goal, at this point, is to include 15 to 20 questions.

Reedy asked about the sample size and industry focus. Jankowski responded that the 2019 sample size will be approximately 300,000 for all businesses of one or more employees and cover all industries. One question is whether it is possible to have targeted sampling modules. ABS, which is in the field now, has a sample size of approximately 800,000, and the only oversampling is on the Micro-BRDIS portion. Sampling modules will not be realistic for the business innovation survey.

Mohan Sawhney, Director, Center for Research in Technology & Innovation, Kellogg School of Management, Northwestern University

Sawhney noted that the end users provide use cases for what happens in the data. He asked, what do we do with all these data? Jankowski responded that the workshop participants are the end users or represent a particular interest in these data. One of the problems with BRDIS is that the questions have not changed much and are not granular enough; they have not kept up with end users' interests. Sawhney feels that the nature of value-creating innovations has transformed. He asked, how do surveys capture that in product, process, and business model innovation? Sawhney added that everyone may be using industrial viewpoints to measure ecosystem constructs. Now, platforms have become very important; iOS and Android create the foundation.

Jankowski responded that all these variables that Sawhney mentioned (addressing product, process, and the combination thereof) are covered in the new Oslo Manual. The new survey includes the digital components that could overlap. One of the takeaways could be to ensure that the survey captures something on value creation or platform-based innovation; NCSES should be aware of those variables and include questions that will help to capture those topics.

Youtie invited one final question. Cohen added that Google and Uber are trillion-dollar companies, and he is worried about the ability of a broad-based survey to capture these rare cases of massively successful business model innovation. The real high-impact factors are very rare, and that in itself is a policy issue.

Steve Landefeld, Retired Director, U.S. Bureau of Economic Analysis

Landefeld stated that he comes from a macroeconomics perspective. The relative importance for macroeconomics is huge; he would like to see more data on prices and dollars instead of yes/no responses to observe valuations and put a relative importance on it. What is the residual and the impact on economic growth? In terms of U.S. and world growth, everyone is scrambling for answers on what's happening in innovation and technology and how that is impacting growth. What about the location of growth and offshore production? What is expected from this new tax act? He would like to see two-way flows. Data on both sides of the flow is critical.

Session 1: Business Innovation Activities²

Youtie closed the discussion points and began her presentation. This discussion captures Business Innovation Activities. Youtie introduced the definition for this chapter.

² See Appendix for presentation slides.

- All developmental, financial, and commercial activities that are intended to result in an innovation.

She gave an overview of the eight activities and reviewed the manual definitions and criteria, as follows:

Eight Types of Business Innovation Activities:

- Research and experimental development activities
- Engineering, design, and other creative work activities
- Marketing and brand equity activities
- IP-related activities
- Employee training activities
- Software development and database activities
- Activities related to the acquisition or lease of tangible assets (e.g., buildings, equipment, machinery, and other tangible assets)
- Innovation management activities

Youtie briefly discussed how each activity must meet five criteria of R&D: novel, creative, uncertain outcome, systematic, and transferable/reproducible. Software and new-economy companies are where these R&D often activities take place. Not all innovations meet all five of the R&D criteria.

- Engineering and design activities which do not meet the five R&D criteria include testing, set-up, tooling, production, and quality testing; service firms use design for look and use. (Engineering need not always be for innovation and can even be reverse engineering.)
- Marketing and brand equity activities include pricing, placement, and promotion advertising (usually if linked to a new, improved product).
- IP activities include patents, utility patents, industrial designs, trademarks, copyright, IC designs, plants, and trade secrets for new products and processes.
- Employee training is not for existing products or general skills.
- Software development and database innovation activities would not include maintaining the IT system, supporting existing systems, or routine functions.
- Tangible assets are buildings, instruments, equipment, and computer hardware.
- Innovation management includes funding, organization, external collaborations, and performance (applicable only to firms that innovate).

Youtie asked participants, do all eight activities need to be covered in the questions?

Cohen asked what the unit of analysis was? From what is the data collected? Jankowski stated that the Oslo Manual says to collect it at the enterprise level, not at the establishment level. Collect from the lowest legal entity with decision-making authority. Cohen suggested that the unit of analysis should be the innovation project. Jankowski thanked Cohen and his colleagues for bringing the object-based approach to the community's attention. He added that had it not been for the earlier research of Cohen et al., the object-based approach would not be included in the manual but added that the focus should be the subject-based approach; because the enterprise is the unit of analysis for all the international

statistics. Cohen clarified that he was not suggesting object-based *instead* of subject based collection. Youtie noted that the next slides cover detailed questions about the eight activities.

Poole added that if one is doing training or deployment of new technology or innovation, it could be in an entirely different location from where the design is taking place. Typically, data collection is done at a national level, but we must consider how multi-national organizations function as well.

Youtie noted that the rest of the slides contained more detailed questions about the eight activities conducted in-house, as well as funding sources. She continued with her presentation.

Key Questions for Data Collection:

- Were the eight activities conducted, regardless of the reason, with innovation as the aim? Was each activity conducted in house or procured from external organizations?
- What was the total expenditure for each of the seven activities, excluding innovation management (not recommended by the Manual)?
- What were the funding sources for innovation?

Sawhney mentioned the need to address co-development and co-creation. Everything in the world today is built upon partnerships. The boundaries of a firm are no longer rigid. The Oslo Manual considers the source(s) as a core question. Sawhney noted that there is a binary question on make or buy; he asked, what about the co-developed or co-created partnerships? Youtie responded that there may be other chapters that address co-development and cocreation in the manual.

Jankowski responded that when organizing the workshop, NCSSES deliberately did not send the Oslo manual to all the participants because of its length and density, so they have not been able to review it. However, the manual does address co-creation, and he assured Sawhney that NCSSES would consider it when developing the questions. Sawhney suggested a three-part question: did you make it, did you buy it, and/or did you partner?

Next, Youtie noted that although it is difficult to assign a dollar figure to innovation management activities, it is important to capture general total expenditures and expenditures on R&D.

A participant asked if it was really necessary to ask for the total expenditures.

Adam Jaffe, Professor, Economics, Brandeis University

Jaffe noted that many firms are engaged in activities that meet the definition of R&D (e.g., novel and creative), but they would not label or identify their work as R&D. Jaffe suggested using different, perhaps more generic phrases, such as *new activities*, to capture novel activities. Youtie responded that the Oslo Manual suggests more detailed questions beyond these, including separating intramural and extramural activities, to try to get to the economics flows, but it acknowledges that some firms (especially small firms) cannot use an accounting approach, in which cases it suggests using an FTE approach.

Jankowski asked if there was a consensus about the size of the business NCSSES should cover in a national innovation survey. Youtie responded that her experience suggested 10 or more employees

should be the standard. Her experience in the state of Georgia showed that most companies with fewer than 10 employees do not primarily do manufacturing, but rather distribution or sales.

Ann Xu, Senior Technical Advisor for Impact and Assessment, ARPA-E

Xu stated that many of the performers with which she works at ARPA-E are businesses with only two or three people.

Jankowski commented that there may be different standards for different sectors (and added parenthetically that it may require the survey to reveal how many employees a company actually employs, as opposed to what the business register says).

Landefeld added that it is better to collect information from them once every five years rather than not collect at all. Small firms are involved in innovation.

Poole added that there is a numbers problem with a large quantity of smaller firms. Below a certain size, some firms focus on R&D and some do not. It is necessary to focus on those that conduct R&D, but how do we find them? Jankowski responded that the assumption is that R&D itself is not necessarily a good descriptor for businesses engaged with innovation. Some small firms have people with multiple roles who take care of traditional business activities as well as new things.

E.J. Reedy, Director, Polsky Center for Entrepreneurship and Innovation, The University of Chicago

Reedy noted that many of the small firms have no revenue yet; therefore, looking at small firms only through innovations introduced into the market could be problematic. Industries in different areas have huge differences in culture and response rates. Reedy also noted that he would want to know, at least for a few industries, what is happening at the state and local level, and what the microdata show.

Jankowski commented that they will be sensitive to those issues, but asked that for today the participants focus on what is most important at the national level.

Youtie added that those are all considered to be core questions. Should they ask about marketing and other follow-up activities? Youtie addressed the supplementary questions for human resources by activity, data collection, number of innovation projects by activity, follow-up activities after implementation, (but within the period), and planned activities. She asked about planned activities. In her experience in Georgia, there are many promises but little follow-up activity, so she does not think this category will yield much useful data.

Supplementary Questions for Data Collection:

- R&D continuous or occasional
- Innovation expenditures by funding source
- Follow-up activities
- Planned innovation activities and expenditures

Youtie concluded with a summary for prioritization and asked participants what they thought about these questions:

- Qualitative data on whether or not each of the eight activities were conducted

- Whether the activity was conducted for innovation
- Whether or not each activity was conducted in house or procured from external organizations
- Total expenditures for each of seven activities
- Total innovation expenditures using the accounting method (shown for R&D)
- Funding sources for R&D

Stuart Graham, Associate Professor, Scheller College of Business, Georgia Institute of Technology

Graham asked about the thought process behind the prioritization of the list. Jankowski responded that it was a collaborative consensus effort. There was no systematic approach to determine which questions to add to the core list. Cohen added that he would not use the terms *procure* or *acquire* in prioritization. Jankowski responded that the term *procure* was intentional, but he would take that into consideration.

The participants took a brief break and reconvened for Wes Cohen's discussion.

Session 2: Business Capabilities for Innovation³

Cohen began the next discussion with a presentation on business capabilities. He stated that some of the points are being addressed by other chapters. He gave an overview of resources contributed by the firm. Cohen added that the recent work from his colleagues shows that an important driver for innovation performance at the macro level is the relationships across nodes, not just the nodes themselves (e.g., individual firms, universities). They had asked where the most important new products came from; 49% of respondents said that it was acquired from an external source, and many said it was acquired through co-development with other entities. It is reasonable to focus on the firm, but it is important to think about relationships and capabilities, and how to find managers of cooperative ventures, licensing deals, and other relationships. He and his colleagues have also collected data on the relevance of those channels over time.

Sawhney commented that there may be a way to capture a proxy through a measure of resources in the ecosystem. Youtie commented that the next presentation will address knowledge flows. Sawhney mentioned that he has written an article on the concept of relationship capital and argues that the most important factors will not appear on the balance sheet. He called this "relation capital." Cohen added related aspects to think about: Where did you get the idea? Who built the prototype? What are the knowledge flows? Invention is much more tangible downstream.

Cohen mentioned the definition:

- Knowledge, competencies, and resources that a firm accumulates over time and draws upon in the pursuit of its objectives.

Cohen asked the participants, where do these capabilities/resources reside? At what level should these types of questions be asked, and who can respond knowledgeably to these things? Upper management might be clueless, and the innovative department might have a different perspective from management. It is also complicated because it varies across firms. Does anyone have ideas of how to get at this?

³ See Appendix for presentation slides.

Cohen presented the last two components of the definition, workforce skills and how a firm manages its human capital; and the ability to use technological tools and digital resources, with the latter providing an increasingly important source of information for innovation.

The aggregate statistics should be broken down by industry. Cohen began reviewing the key questions for data collection. He asked: why is there a need for supplementary questions and how were they sorted? By feasibility? Vagueness? Jankowski responded that questions that made it into the key groups were generally agreed on by the whole steering group, or at least were not strongly opposed by anyone. Supplementary questions were generally those that one or a few members thought were important (but none opposed).

Cohen continued by asking if there is a vehicle that can be used to determine if those data are important. Can we develop a method to address the question, “So what?” Perhaps this is achievable by working with others at or organizations external to NSF? Jankowski responded that he will consider that in the refinements and advancements of future innovation survey collections; however, today’s focus is to guide the next survey because many of the stakeholders in the room have had much more experience with these kinds of topics and issues than NCSES’s colleagues elsewhere.

Cohen discussed the following key questions for data collection:

- Number of full-time employed persons
 - Also, by business unit (not the firm as a whole)
- Total sales
 - Also, business unit sales—the key correlate of R&D
- Firm age by year the firm began business activities
 - Date of entry by market
- Firm ownership status (e.g., stand-alone, part of a national group, part of a multinational group)
- Geographical distribution of sales (e.g., local, national, international markets)
- Export share of sales
 - By business unit
- Importance of cost versus quality for the firm’s competitive strategy
 - Suggested measures: percentage of process versus product R&D, and, for latter, percentage dedicated to developing altogether new products versus product improvement
- Share of employed persons with a tertiary education
- Business level of design capability
- Cash flow

Cohen then gave an overview of supplementary questions for data collection, as follows:

- Family-owned firm status
- Number of product lines
- Innovation management: responsibility for innovation within the firm
- Innovation management: methods to support internal knowledge exchange

- Number of employed persons by major field of education
- Technical expertise in emerging technologies
- Digital competences

Cohen asked who is the audience, and does this address policymakers, management, and other stakeholders? Is there a clear statement on that in the Oslo Manual? Why are we doing this? Also, there should be a vehicle within these surveys that allows analysts to tease out cause and effect, because this will allow researchers to answer the question, “So what?” To do that, distinguish between innovating, imitating, and firms that do neither. Cohen suggested that he is a bit worried about using Likert scale questions to assess that. He would prefer to ask concrete questions about behaviors; for instance, did a university suggest new products to a firm? Jankowski responded that there is a scale to provide a range of importance.

Discussion - Business Capabilities for Innovation

Cohen asked, what capability should be identified? Is it the capacity to invent or to take a product to the next step of commercialization, manufacturing, marketing, or sales? Pfizer does some R&D, but mostly acquires inventions from others. Cohen did not see any discussion of commercialization or sales in the business capabilities chapter. He noted that firms with weak inventive capability benefit from being around other firms, which provide them with inventions; firms with strong inventive capability do not benefit from non-inventive firms but do benefit from being near universities. The capabilities should be distinguished across managerial, technical, and other divisions. Marketing, sales, and manufacturing are essential.

Sawhney suggested looking for the capability to innovate. Cohen asked, but are firms’ inventions exclusively originating from R&D? Sawhney asked, why do we care?

Youtie added that collecting data about secondary education would be nice for some companies. Cohen added that advanced degrees are covered elsewhere under workforce, and Jankowski confirmed that the manual addresses this.

Cohen stated that when measuring performance, he prefers financial performance. Regarding products, Cohen asked about incremental versus altogether new products. He has found data—even self-reported data—on behaviors to be very useful. Youtie confirmed that strategy is important, but that many firms hire those with a tertiary education for the front office, but the back office is mostly those without a tertiary education. Youtie added that it could be helpful if those individuals with a tertiary education in a technical field (as opposed to, for instance, individuals with master’s degrees in business administration or social scientists) could be separated out. Xu talked about the importance of digital capabilities. She said that she did not see any questions or data on that; she then asked about collecting information on data analytics. Cohen responded that this was a good question, as they are constrained in terms of the number of questions that can be asked. Jankowski read a brief paragraph from the Oslo Manual in response to the earlier questions. Jankowski added that many design activities, including user functionality and aesthetics, could be categorized as R&D, but they shouldn’t be in that category. In the manual, digital technologies and data analytics are specifically singled out. There are more definitional aspects there; digitization is taking place across all sectors and they want to capture it along those lines.

Ken Poole, Executive Director of C2ER, The Council for Community and Economic Research

Poole stated that the key questions address things that people know about firms. How much of this can be imported from administrative record sources (e.g., business demographic questions)? Poole added that there is much muddling between business capabilities and individual capabilities. If asking about people, then business may not be the right unit of measurement. Cohen continued that looking at new products and financial performance gives a certain measure of success. But what about tech failures? What about the lives affected? Did the firm learn anything from the experience? Cohen added that relationships are important as well.

Youtie noted that Poole's point was very important. In some regions, firms make a business decision to hire people with no skills, so that is also a business-level issue. Poole added that the fundamental issue is who understands that strategy. Who in the firm knows this? In terms of skills, try to get that information by proxy. But some of the strategic decisions should be in the list of questions.

Stephen Ezell asked about innovation project management. Cohen wondered, what are the incentives and what are the criteria of performance evaluation for individuals and projects? These trigger incentives and may vary across type of innovation, even within the same firm. Reporting structure can be like a matrix. Cohen offered that the key might be the basis for prioritizing projects. But economists make many assumptions that may not hold in the real world. Is the key market performance or market share?

Crowell works in life sciences and noted that great value was created at advancing stages of investment; he asked about questions to capture that value (e.g. institutional value). The ability to quantify the additional values around innovation is important. Cohen responded that others may be able to answer those questions more concretely. There is an assumption-based approach, based on the notion that innovation capabilities are not observable. They have used a finite mixture model⁴—which is new and to be deployed in marketing and healthcare—that allows the ability to develop a measure of inventive (not innovative) capabilities.

Stephen Ezell, Vice President, Information Technology and Innovation Foundation

Ezell added that in the book *Ten Types of Innovation: The Discipline of Building Breakthroughs*, author Larry Keeley and others suggest 10 essential questions to be asked. Those might be helpful as well. Sawhney added that different levels across firms garner different responses. Across functions, management and marketing are more optimistic, and sales and engineering are less optimistic. There is a lot of respondent bias because the whole thing is subjective. Crowell agreed. Sawhney added that his

⁴ In Sept. 2018, Cohen and his co-authors published a NBER paper applying a finite mixture model approach to treat inventive capability as an unobserved, latent variable. This is in contrast to trying to directly measure inventive capability using empirical proxies such as prior patents, R&D, innovation, or sales. Finite mixture model models are similar to some types of unsupervised machine learning. A multinomial logit relates characteristics to outcomes, and the coefficients can differ for firms of different capabilities (latent types). Cohen et al. state that they leverage theory to identify the latent class associated with higher inventive capability, and use the predicted firm-specific probability of belonging to that latent class as a measure of the firm's inventive capability. <https://www.nber.org/papers/w25051>

work measures innovation in what, why, and how as well as relationships across 12 dimensions divided into four quadrants. His data show that people who perform one function do not understand other functions or the picture as a whole. For example, the functional head in sales does not necessarily understand the logistics.

Cohen added that one study he worked on was conducted by phone precisely because they had to talk to many people in different roles within a firm to find the right people to address the questions and to minimize bias.

Jankowski added that knowing how businesses are organized at the functional level is critical for any survey that reports quantitative data on R&D. Much R&D is performed by very large businesses, so what is the cut-off size? Business with nine or fewer people typically do not have super-specialized roles, so many of the staff may have a good idea of what's going on. Large companies will have people with specialized knowledge. National innovation statistics question capabilities and outcomes. Overall business innovation activity might not be as important. The innovation statistics that come out of BRDIS show that much business innovation activity did not have R&D.

Youtie asked Cohen a closing question about whether the business capability questions should be in or out. Cohen responded, should they be in? Yes. Should they all be in? No. But a couple of years of research is needed before settling on what two to four reasonable indicators would be.

Session 3: Business Innovation and Knowledge Flows⁵

Landefeld began his discussion of business innovation and knowledge flows. IP is key to addressing these issues. Chapter 6 of the Oslo Manual provides definitions on knowledge flows, knowledge exchange, and innovation diffusion.

Market transactions deliberately transfer from one knowledge area to another; and customers may suggest improvements that are incorporated into products or processes; these will never be included in transaction records. Offshoring of resources and jobs may be tech transfer or tax avoidance. Trade regulations and tariffs are also very important to the flow of knowledge. Also, some flows are deliberate whereas others are accidental. Sawhney felt that the term *accidental* sounded like a leak; *unintentional* might be better. Landefeld acknowledged the point but noted that sometimes there are real leaks; additionally, the language comes from the Oslo Manual. It is not necessary to agree with it, but that's why Landefeld is using it in the discussion.

Ezell suggested adding trade secrets as an object that captures knowledge. Value chains are critically important today. It is difficult to collect information on value chains; the only way researchers have been able to get those data is through the world input-output model.

Key questions for data collection address inbound knowledge flows to innovation. Landefeld added that in this chapter, there are some more interesting distinctions about knowledge being collected (e.g., geography). He urged NCSSES to consider those variables. Cohen asked about respondents considering

⁵ See Appendix for presentation slides.

in-bound knowledge flows to innovation. He considered universities as a source of knowledge flows to be important.

Landefeld discussed key questions for data collection:

- What inbound knowledge flows contribute to innovation? (The Oslo Manual provides mainly a qualitative yes/no response; however, NCSSES has great experience in economic flows and can use BRDS and other surveys as well as the Oslo Manual as a launching platform.)
- Where are the firm's collaborative partners for innovation by location? If firms provide access to economic data, this would be very interesting in the GVC context.
- What are the sources of ideas and information for innovation (excluding details on internal sources)? Landefeld does not understand this: see Table 6.2, which includes internal and external sources of innovation. Or, is this problem with the firm perceptions/bias?
- What are the barriers to knowledge interactions? Landefeld noted that Table 6.9 provides an interesting classification of barriers to transactions, many of which are amenable to policy action (including less action).

Next, Landefeld discussed supplementary questions for data collection:

- What are the sources of inbound knowledge flows by location? Landefeld notes that this provides important GVCs, but it is hard to collect on surveys; it may only be possible with world input-output tables.
- What are the outbound knowledge flows? Landefeld notes that this is hard, but both sides of flow and asset transfers are needed; build on existing economic data and surveys.
- What are the channels for knowledge-based interactions between firms and Higher Education Institutions and Public Research Institutions?
- What are key uses of IPR for knowledge flows? Landefeld notes that tax and transfer pricing for IP make this very hard but extremely important.

Jankowski added that they wanted to distinguish internal sources versus external sources. He added that the key recommendations do not always reflect the ease of collection or the importance of the information.

Landefeld added that he worries that NCSSES will have an item response problem. The U.S. Census Bureau surveys have those issues. There are various barriers, (e.g. regulatory, financing). The innovative activities should be collected to address those areas. Youtie added that they had barriers to knowledge interactions in her earlier survey; there were always barriers, such as time and money. They did not learn many new things from the survey of manufacturers, and it did not always get to the new barriers.

Discussion - Business Innovation and Knowledge Flows

Jankowski mentioned the concerns listed in the manual, such as anti-trust policy enforcement, high coordination costs, cost of dispute settlements, and financial resources. He added that time and resources are the common barriers; however, time and money will not provide insight on much of anything.

Cohen asked if the barriers were something best left to inference. Tangible measures are needed. He asked if ties with universities, reportable behaviors, and other aspects should be considered? Jankowski noted that, by design, the manual does not specify actual questions, but high-level coordination of national statistical agencies ensures comparability of data.

Poole added that from a user and policy perspective, the value is in asking what the influencers of innovation are. Landefeld added that there are other unintended outcomes, such as IP infringement, counterfeiting a firm's products, and patent trolls. Is this a serious barrier to innovation? It would be helpful to find out what businesses think. Jankowski responded that NCSSES staff would talk to some potential respondents before designing the instrument.

Poole added that the source ideas should be labs and clusters. If these are not showing up as sources of innovation, why is money being spent on them? Cohen responded that providing a measure and tying it into policy can be subtle and difficult, even if the measurement problem is solved. If only observing, how does one know if it is too little or too much? Poole added that the observations might help determine better questions to ask.

Nico Thomas, Performance Analyst, National Institute of Standards and Technology

Nico Thomas added that this information is useful for the National Institute of Standards and Technology because it focuses on industry questions about challenges; the issue with a question like this is that it is hard to ask one question that is broad enough to address each industry. Some of the other questions may not be as applicable.

Landefeld asked if the microdata would be available and if there would be access at Research Data Centers (RDCs). Jankowski confirmed that researchers would have access to BRDIS data at RDCs.

Xu added that a significant challenge is tracking the follow-up funding. She asked if anyone else has had success on that. In general, they do not know what happens to those projects. Ezell said that they may not know the full chain, and it can be hard to collect those upstream and downstream pieces of information; getting that information would dramatically improve the results. Outbound knowledge flows consider both sides (i.e., flows and asset transfers), which he would rank as high priorities. Ezell added that he may not believe the surveys, but he can look at the results.

Youtie added that the takeaway is that they are all important, but there are many barriers. She asked Sawhney how he feels about these slides. Sawhney responded that co-creation is more than a flow; it is more than transactional, it is persistent creation rather than an accidental leak. Landefeld added that the rental payments and shared agreements are not mentioned in this chapter.

Cohen commented that it is not just co-creation; it is also co-development. He was surprised that they found in his work that of the 49% of firms that report cooperative outside relationships, 60% do not involve a license. There are other methods of invention and acquisition. Cohen noted that these data were about the acquisition underpinning the respondent's most important new product.

Jankowski asked Graham if he thought that information/IP rights flow should be included in the survey. Graham responded that he does not know how to think about that. Is it a supplementary question from the Oslo Manual? What does it mean? Jankowski responded that he would not focus on supplemental

versus key questions; instead focus on chapter items of higher interest and value. Is this the type of information we should bother to try to include in a survey with only around 15 core questions? Graham responded that IP is observable in some places, as it underpins royalties and tangible flows. It teaches something, but not everything. Crowell agreed that IP would be very important.

Graham added that this is a backdoor way to get at Landefeld's concerns. Landefeld noted that transaction data can be misleading (e.g., Apple has much lower tax rate through maintaining a headquarters in Ireland).

The group broke for lunch and the Oslo Manual Revisions Briefing.

Session 4: External Factors in Influencing Innovation in Firms⁶

Youtie reconvened the discussion and introduced Stephen Ezell.

Ezell began his presentation on external factors, with the goal of presenting the content of the chapter and soliciting the input of participants on the most critically important factors about the external environment. The systems view of innovation includes a number of external factors. They are often beyond the immediate control of the firm and may be either drivers or inhibitors of innovation. He added that it is important to understand that external factors define the firm's operating environment. The external environment also defines the operating domain. A firm operating in the technology innovation sector may be in a different position than a firm elsewhere in the economy. Innovation must protect IP and manage R&D, design, innovation, and cloud computing services.

This chapter shows the main elements of external factors in the environment. The core content of the chapter talks about the various components of human resources and other economic policies. Moreover, spatial and locational factors define the locations. Markets include the markets for the firms' products. Society and the natural environment include climate change, levels of trust, and innovation in a society. The Oslo Manual suggests these questions for data collection:

Key questions for data collection include the following:

- What is the firm's industry and main market?
- What is the firm's competition and product market characteristics?
- What government support is there for innovation?
- What are the drivers or barriers to innovation?

Supplementary questions for data collection include the following:

- What are the locations of business activities and value chains?
- What is the main customer's share of sales and the industry of the main customer?
- What is the effect of regulations on innovation?

⁶ See Appendix for presentation slides.

One factor the chapter does not seem to address is if firms can sell their innovations in foreign markets. Ezell asked the room, what is the nature of the broad type of business that firms engage in? Who are the competitors? There is a set of qualitative measures about potential intensity. Ezell's boss has said that the most important thing to ask for is new products introduced in the past 12 months. He focused on intermediaries and digital platforms as focus of value creation.

Discussion - External Factors in Influencing Innovation in Firms

Ezell asked for comments on those proposed items. Graham asked if the respondents will be known. Jankowski said, yes, but only to the collecting agency. Linking with other data sets is a goal within the federal statistical system. Graham wondered about selecting a sample frame from Census or some other source, making collection of some administrative data automatic.

Sawhney wondered how to most elegantly capture disruption. There are traditional competitors and disruptive competitors; the latter play a different game. Sometimes, the actions or identity of your next competitor cannot be predicted (e.g., Amazon getting into insurance).

Cohen added that the applied R&D provides three classes of variables that have different dimensions. Everything is modular. Defining *external* can be pretty dicey. It requires a lot of attention to measurement. It has only been in the past 15 years that it has been estimated in any rigorous fashion. Aside from intensity of competition, there is demand, technological opportunity (i.e., technical performance value for dollar in R&D), and finally, appropriability (i.e., the degree to which firms can hope to profit from their innovations).

Cohen also brought up the issue of data linkages to other data sets. Many groups have endorsed this, and he felt it was a positive recommendation this meeting should make to NSF. Landefeld noted that there had been some very good work between the U.S. Bureau of Economic Analysis and the U.S. Census Bureau, and it may be helpful to link to that data.

Cohen added that this is something that has been studied for decades; there are measures that are out there. For example, one can ask how many firms can come up with a substitute to hurt profit. There are other questions that could be framed. Ezell added that there are valuable questions around competition. The master chart in the Oslo Manual provides more details on intermediaries and digital platforms.

Sawhney added that the traditional analysis of innovation has looked at the firm as the unit of analysis and the product as the output; but now the product is moving towards platform and the firm is moving towards ecosystem. The problem is how to measure a network in which the product is the output. It would be best to take the external view, considering it an ecosystem. Cohen asked, if the platform enables markets where markets had not existed, how is that really different from the situation before? The speed of information is faster, of course. But is this an evolution in the form of markets? Is this a difference of degree or a difference of kind?

Sawhney responded that it is a difference of kind, if you are a marketplace operator; it is a two-sided market with network externalities. Cohen suggested that there are also demand-side externalities.

Sawhney responded that there are both direct and indirect externalities. Today, there are marketplaces mediated by platforms. The phenomenon of indirect externalities is new.

Jankowski responded that the Oslo steering group had discussed the idea of platforms but did not feel that they had enough knowledge or actual experience to address it in the Manual. He asked, is it important enough to pursue in the next survey, or should we wait to gain more knowledge from other sources? Sawhney argued that it was not a binary question. Questions can be added today, even if they are not as precise as we'd like. For example, are you dependent on other technology for how you work and how you are paid?

Poole added that the Bureau of Labor Statistics created the Contingent Worker Survey that gets at some of those questions from the worker's perspective. Sawhney noted that someone may say, I am a one-person company, but they write software for Uber, so actually they are involved in the platform. There are many all-digital platforms like this. Cohen added that it is important to differentiate the digital platform from other types. Sawhney suggested that it is necessary to move to where the profit is going to be because value is de-materializing. Data and digitalization are capturing many things going forward.

Ezell continued, stating that government support for innovation should be a key component of the data collection. He gave an overview of the main types of government policies supporting innovation: grants, equity finance, debt finance, guarantees for debt financing, payments for goods and services, tax incentives, and public infrastructure and services. It is helpful to tap into support for government innovation activities.

Jankowski agreed that there are always those possibilities. There are other ways of linking those surveys to bring in external non-Census data at a firm level to match survey answers with funding levels from non-statistical agencies. It may be possible to use linkages as substitutes for some questions, but he is not quite as optimistic about data linking activities becoming a reality soon. He would like for the important items to include valuable real estate. Jankowski continued that most data linking has been on the demographic surveys, rather than the establishment surveys.

Xu agreed. She added that this is important and from a grants agency perspective; she would like to see these data, but having designed surveys, she knows that respondent burden must be considered. Linking data is difficult, but can be done. The data community is affected by the same forces of disruption as everyone else. She encourages NCSSES to think about linkages ahead of time, as this will help researchers in their work. She links self-reported data to two other data sets in her own research, but it is difficult.

Poole added that he is not delusional about what the issues are; unique identifiers are necessary. He asked what variables are available to be linked? He does not just think of the federal level, there are state data as well. Push the envelope on data linkage, but do not be misled about what the outcomes will be. A big piece of this will be data quality improvements. This survey element is important, but a yes or no is more important than a weighted number.

Reedy suggested that NCSSES consider cycling survey components to add value to the data variables that are already available for linkages across time, as has been done with the U.S. Census Bureau's Annual Survey of Entrepreneurs. He noted, however, that someone needs to go into the field to negotiate for linkages and data improvements to support linkage.

Ezell continued, stating that there are various drivers across innovation, including working capital and access to suppliers. Youtie asked, do we really need to ask for this information? When she has used CIS in models, she has been okay using secondary data to control for how competitive a market is. Some of the firms that she's interviewed have had no idea of the number of competitors they have. In Georgia, they think of the local market, not the global market.

Cohen asked, what are the impediments to knowledge flows? He does not want to ask firms, "Why do they not innovate?" and "Is this a barrier?" Those questions are not valuable. In terms of external data, competition is not always a great measure. In his work from the 1990s, it became clear that firms believed that there were far more competitors than the actual number of businesses would suggest. The broad question is to distinguish what to collect from what to infer.

Ezell added that there are several supplementary questions. The question is, is it worth investigating the firm's location and space domestically and globally in the survey? Youtie asked, could a firm answer this question?

Poole said that some years ago the BLS tried to look at the issue of outsourcing. Either they were not successful or did not report on it. It would be great to know the outcome of this work. Cohen asked, what were the difficulties? Poole said that there were more bureaucratic issues than whether the data was capturable. Budget resources in the statistical agencies are limiting this type of research.

Ezell continued, noting that there are questions about consumer responsiveness to innovation and trust. He recommended not asking these questions, as the World Values Survey already collects similar data. For the chapter overall, he noted that he liked the questions but not the way they were approached.

When Ezell asked about the importance of drivers, Cohen stated that the underlying science and engineering base is a big driver not appearing on the list "Main elements of the external environment for business innovation" or in the following presentation slides. Is there a profitable way to ask something meaningful about the regulatory effects of product innovation? Youtie suggested asking particular questions for particular industries. Asking it in a way that would be relevant to a particular industry may enable them to answer yes. Graham felt that there would be no easy way to do this, and it would lead back to inference.

Jankowski added that the chapter assumes that regulations can both inhibit or foster innovation. The clean energy industry came about because of regulations. Graham asked but can that disinterestedness be conveyed in a survey? He suspected not. Jankowski responded, let's first look at the types of questions to ask. Then, after the workshop, the cognitive folks can determine if there are questions that cannot be asked without leading the respondent one way or the other. The question is, what should be on the U.S. innovation survey? Do not worry about the other stuff yet. Ending up with 15 questions after today may later change to only five after review and consideration; if that's the case, everyone will accept that.

Cohen added that, given that the role of regulation is extremely important, obtaining solid, objective data on the effects is all the more important. Then, the question is, how is that achieved? There may be an effect on innovation, but should it be left there? Folks should be careful and safe, but the social

effects are far down the line, beyond NCSES's remit. Also, he suggests not using the word *regulation*, as it is a political hot potato. Perhaps talk about specific *policies* for different industries.

Landefeld added that yes/no questions are being asked for many variables, and it is necessary to think about hard numbers. Over 75% of federally funded R&D is conducted by multinational companies. A good chunk of multi-national data would be more valuable than 300,000 U.S. respondents. Ask them these questions.

Youtie asked Landefeld what he recommends should be included and not included.

Landefeld responded, yes to firm's industry, competition, and government support for innovation. He is iffy about barriers. Data should be collected on barriers, but it is best not to ask explicitly if something is a barrier.

Reedy added that a Kaufmann survey tried to assess competition from a regional versus a national perspective and discovered that 25% of the economy will now say that Amazon is competition.

Session 5: Objectives and Outcomes of Business Innovation⁷

Reedy began the discussion by noting that he thought he'd answered many of the questions that had come up while he reviewed the chapter, but after the day's discussions, he was no longer so sure. He gave an overview of the questions in the chapter. He added that this is much less prescriptive than the previous version of the Oslo manual.

He reflected on a conversation he had with someone at the airport who works in the chemical manufacturing industry. Reedy later inferred that this person was probably in charge of chemical products. He talked about a product in the agricultural space that gave a 10% increase yield rate for farms. Reedy noticed that the chemical industry employee jumped straight to what the Oslo Manual describes as the object perspective. The industry employee then discussed difficulties getting his products into the marketplace.

The average customer is around 65 years old, and, though they are becoming savvier, they do not always believe statistics. Even with a 10% increase the industry employee doesn't feel like he has a good value proposition. In bad years, he must convince customers that their 50% lower yield would have been 60% lower without his product. He has some products with a 1-2% yield increase rate but does not feel his customers will buy them because of the low increase rate, so they sit on the shelf. Reedy notes that in this case there may be patents for inventions not taken to market that may still have tangential added value at the firm but will not show up in measurements.

Cohen added, what this means is that no one sees the projects that fail. They will not be reflected at all through the survey. They are very revealing about barriers and constraints. Some questions at a project level could address those types of questions.

Jankowski added that the manual does address innovation activities, acknowledging that their result could be ongoing or abandoned. Failure is an acceptable outcome. But comparing an innovative and a

⁷ See Appendix for presentation slides.

non-innovative firm is different from comparing an innovative firm with innovative success and an innovative firm with innovative failure. The ABS tries to capture the failed innovation activities as well as non-innovative firm characteristics.

Reedy began going over the slides, starting with an overview of the definitions. Most of the chapter used a similar terminology for objectives and outcomes, but Reedy was not convinced that the same structure could be used for both; in some cases, it may not be possible or feasible. People often start with outcomes for innovative firms, for which the manual suggests a three-year time period, then transition into the objectives.

Jankowski added that the manual committee had left open the question of whether or not the three-year time period was most appropriate, but the entire manual is built around a three-year time period. Reedy agreed that three years seemed to be a good period to measure impact. Reedy then gave an overview of the questions for data collection.

Key questions for data collection are as follows:

- Innovation objectives and outcomes by area of influence (e.g., markets, production/delivery, business organization, economy/society)
- Innovation objectives and outcomes for business strategies
- Innovation sales share in total business sales

Supplementary questions for data collection are as follows:

- Counts of product innovations
- Major impacts of innovations for markets

Discussion - Objectives and Outcomes of Business Innovation

Youtie asked about the three-year reporting period. Reedy responded that the three-year period allows a good-sized window to measure impact. One year may not be enough time to measure impact. Cohen asked about using impact as an outcome measure to determine how successful firms are at doing this? It could also describe market-level intensity around innovation. Jankowski agreed with that characterization. Sawhney added that they also perform three-year testing.

Reedy added that the manual can be applied to how outcomes are interpreted. Reedy cautioned that some effects would only be observable to customers. Another area is the impact on society.

In terms of objectives, it was not clear to what extent the focus should be on the last three years.

Jankowski added that the manual committee was silent on that issue, but the starting point of measurement is the original ideas that went into innovation activities. So, objectives are probably linked to the three-year period, but it is probably not a tight timeline relationship. Reedy said that is how he'd originally read the chapter, but now wonders, what if people want to look forward? What do are the x, y, z objectives leading to in three years? The R&D lifecycle is likely longer than three years.

Cohen asked, what about the objectives today? Reedy said that the manual should be clearer. Overall, this chapter talks generally about those variables. Sawhney added that the time horizon for innovation is

a function of objectives and outcomes. The questions are, what are your time horizons, and how do you allocate effort across different time horizons? Boeing might have a 60-year time horizon for an aircraft. A small biotech firm might have tiny timelines.

Cohen added that this would require distinguishing different types of innovation. Some firms do not care about the next year. This is not just a large-firm issue, even small companies may take 15 years to get something to market. Ask about the distribution of projects across horizons or a metric of product planning for product strategy. It should measure the life cycle. He suggested that having one question that asks about lifecycle and another that asks about the types of innovation.

Reedy drew a diagram to illustrate that there are two types of taxonomies that apply to objectives and outcomes, as follows:

- By area of influence. These variables assess how much is it related to markets for products, productivity and delivery, business organization, and economy, society, and environment (quality of life and well-being).
- By strategy. These variables assess, positioning, internal capabilities, and positioning firms within the market.

Youtie mentioned that this is the first group of questions that she cannot relate to because they are squishy, except for innovation sales as a percent of total business, and counts of product innovation.

Xu added that social impact is still a factor. Some nonprofits have both economic and social goals (double or triple bottom line). Even if all these questions are not covered, consider asking, which do you prioritize?

Jankowski cautioned against making presumptions about what the Manual steering group wanted. The Manual's questions were distilled from activities seen in surveys, Eurostat, and the literature. It is not so much a hierarchy as a general list. The committee discussed combining outputs and outcomes, but Jankowski did not like the idea. Environmental and societal outcomes may be squishy, but many businesses cite these as part of their goals (objectives). They want to be good corporate citizens; make money, but also have a societal impact. But it is a big basket; there was no assumption that all these questions would be asked.

Poole felt that if this is added in the survey, people will say what they think others want to hear. It would be useful as qualitative research. Unless someone can write questions that address those topics appropriately (without respondents telling you what to hear), issues will have biases. Friends in the corporate world talk about these things, but he does not know the cost of public relations.

Cohen asked if it worth inquiring about intermediate objectives? Often respondents do not know the market or the demand and need to learn about these things. Ultimately the objective is to make money. But it may be useful to inquire about more intermediate objectives. Moreover, how does one get to objectives other than strictly commercial ones (e.g., the malaria vaccine). Jankowski responded that the Oslo Manual addresses both response biases and non-market aspects of innovation.

Reedy added that he works with many students, mainly undergrads, and most have a hybrid business vision, with a high level of intentionality about societal impact. Jankowski was not inclined to include these on the first survey round. Youtie noted that these goals come from the European Union's Horizon 2020 plan, but they are not yet really in the language of U.S. policy. Perhaps, it will happen in a few years.

Cohen added that there may be a way to find out if they actually spend money on these things. Dollars dedicated to these objectives may be more concrete below the public relations level. How much funding do you dedicate to these objectives? Poole asked if that would require forcing a choice? People will pick an attractive sounding answer because there is no cost for doing so. He suspects this would need a lot of testing.

Xu suggested a potential way to check: ask how they measure their outcomes. Investments are measurable. Graham suggested finding out what managers bonuses are linked to.

Reedy concluded by saying he was concerned about the granularity of the questions and would not recommend implementing all of them; he also suggested asking at the firm rather than object level.

Discussion Summary, Recommendations, and Conclusion

In reviewing and summarizing the day's discussions, Youtie said that the group appeared to have become more intense and probing as the day progressed and that the business innovation activities discussion might have happened too soon. However, generally, people are on board with asking the questions in this section, especially if there are dollar signs associated with the expenditures and funds.

Cohen liked the idea of supplementary questions asking about number of innovation projects by activity, especially innovation management activities. There were some issues about innovation management activities. Poole suggested asking some human capital questions to get at capacity in management. For example, ask how many people are doing this kind of work?

The business capabilities section had the second lowest ranking with the whole group. Because people felt that the results were not at the firm level, it would be better to have another level to get new information. Overall, the participants felt that several of the indicators would be useful. Youtie finds some of the questions useful and has used them in the past herself (e.g., tertiary education).

Youtie added that there could be some questions in the CIS that are useful. The first demographic questions will be asked anyway; tertiary education is a standard variable for innovation capability. The design capability that Xu and Sawhney mentioned seemed vague, and participants could not get their minds around them in a practical way. This was the chapter with the least amount of consensus. Poole added that it might be easier to better understand a firm's capabilities by looking at the occupations of its employees. Youtie added that everything is on the table, so yes, this would provide a better sense of what they are doing. Cohen added that experience and years of experience might cut a couple of different directions. There is no standard CIS question about this. Landefeld added that labor data can also provide information on the mix of occupation, rather than education.

Youtie noted everyone's great interest in the chapter about *Business Innovation and Knowledge Flows* section. She summarized that Landefeld's priority is anything that can be monetized. Sawhney felt it got

some but not all of co-creation. Of the suggested questions, the participants only excluded barriers to knowledge interaction. Cohen suggested that researchers should not confine themselves solely to those variables and consider spillovers, co-development activities, and upstream knowledge as well.

Youtie continued by summarizing the discussion of external factors presented by Ezell. The group liked most of the questions, except for drivers and barriers to innovation. The group discussed linking to other data sources. But it is also more difficult if local and national sources are preferred. (There is no magic identification number to link everything). The group is still on the fence about drivers and barriers to innovation. Participants understood that regulation could be positive as well as negative for innovation, but it is problematic to ask. External drivers to innovation was not on the list and it should be added. NCSSES should also consider the Yale survey.

Lastly, the group discussed the societal benefits in addition to the standard sales share. Youtie confirmed that the group felt that questions in these areas should be asked, and they should figure out a way to ask them.

Youtie asked for any final questions or feedback for Jankowski.

Sawhney asked about any next steps and the outcomes of this workshop. Jankowski said that they are not well planned out yet. They are awaiting the manual release, which will be a major input on the variables that NCSSES will take into consideration. They will review the discussion feedback and contact businesses about the topics that NCSSES asks about. There are questions that NCSSES will ultimately set out to test with businesses. Next year, their colleagues at Eurostat will launch a survey that will include Oslo 2018 input. They are doing the testing now. Moreover, Japan is launching a survey this winter that addresses some of these concepts. Stats Canada will also be launching a survey in a year and a half. In about a year, NCSSES will have an instrument with Oslo 2018 questions; that survey will be launched in 2020, with a 2021 or 2022 data release.

Sawhney acknowledged that the following question would be unfair. Noting that in the past, when Microsoft sold Office, they would release the product, not see what customers were doing with it, and not release an update for another three years. But now, telemetry is built into the software and Microsoft sees what customers are doing as they use the product. The software is now a service. That is an analogy. Participants spent the day talking about the questions, but what is now known about the return on investment for the questions in the survey, and what are the use cases? What will users do with this information? That should be the focus of the survey questions; end users should be the key focus of the survey adjustments.

Jankowski stated that NCSSES would interact with the workshop participants again, and share NCSSES's conclusions. He added that one of the biggest disappointments is that the workshop did not include more people from the Federal Government to whom organizers would have reached out. This should serve policy stakeholders as well.

Poole added that any increase in granularity in geography would increase the usage dramatically. There is a lot of interest in these data at the state and sub-state level, but the national data does not tell the story that they need.

Landefeld added that NCSSES might need to talk one-on-one with analysts. At the analyst level, there is a lot of good feedback (in the government sector).

Cohen added that missing from the discussion was the adoption and diffusion of platforms, and non-high-tech innovations that have a huge economic impact (e.g., the supermarket, containerization). He is concerned about that being captured, though this may be beyond what the Oslo Manual covers.

Jankowski responded that the Oslo Manual explicitly states that the innovation does not have to be high tech, though the last version was clearer about this. The manual is meant not to have a bias toward technology.

Youtie added that there was a technology use survey by Census in the 1990s that addressed that issue as well, but they do not field it anymore.

Jaffe noted that on his own surveys, when he had asked respondents to answer questions with subcategories, he would usually roll them back up for the analysis. However, this would be useful for geographic breakouts. The subcategories take a lot of real estate and time.

Youtie asked for any final closing comments and suggestions for NCSSES.

Mark Crowell, Executive Entrepreneur in Residence, Eshelman Institute for Innovation, UNC Eshelman School of Pharmacy

Crowell stated the ways universities manage their innovation assets is shifting. The UNC Pharma school is becoming much more like companies in developing partnerships and investments and taking products almost all the way to market. There's a need to capture that value as well.

Sawhney noted that Google came out of Stanford.

Youtie addressed all participants and thanked the stakeholders for their participation and comments. She added that there had been wonderful diversity in the responses today. Youtie asked that the stakeholders keep the group informed on any interesting developments in their work on innovation. Jankowski will keep the group informed as NCSSES makes future developments.

Appendix: Presentation Slides

Continuing Examination of Innovation in the U.S. Business Sector by NCSES

John E. Jankowski, Program Director of NSF's Research and Development Statistics Program, presented *NCSES's Continuing Examination of Innovation in the U.S. Business Sector*. He provided an overview of the organizational background, NCSES innovation surveys, the Oslo Manual, and the purpose of the workshop.

Session 1: Business Innovation Activities

Jan Youtie, Georgia Tech University, Workshop Chair, presented *Discussion 1: Business Innovation Activities*. Business Innovation Activities are activities that firms may undertake in pursuit of innovation, including R&D; engineering, design, and other creative work; marketing and brand equity activities; intellectual property (IP); employee training; software development and databases; investment in buildings, machinery, equipment and other tangible asset, and innovation management activities.

Session 2: Business Capabilities for Innovation

Wes Cohen, Duke University, presented *Discussion 2: Business Capabilities for Innovation*. Business capabilities for innovation include the knowledge, competencies, and resources that a firm accumulates over time and draws upon in the pursuit of its innovation objectives. Collecting data on business capabilities is important to understand the effect of innovation on firm performance and why some firms innovate, and others do not.

Session 3: Business Innovation and Knowledge Flows

Steve Landefeld, Bureau of Economic Analysis (Retired), presented *Discussion 3: Business Innovation and Knowledge Flows*. Knowledge flows include how knowledge is accessed, how it is deployed, and how it is exchanged between firms and other actors engaged in the innovation system.

Session 4: External Factors in Influencing Innovation in Firms

Stephen Ezell, Information Technology and Innovation Foundation, presented *Discussion 4: External Factors in Influencing Innovation in Firms*. External factors can influence a firm's incentive to innovate, the types of innovation activities that it undertakes, and its innovation capabilities and outcomes. External factors may also be the object of a business strategy, public policy, or concerted social action by public interest groups.

Session 5: Objectives and Outcomes of Business Innovation

E.J. Reedy, University of Chicago, presented *Discussion 5: Objective and Outcomes of Business Innovation*. The planning and development stage for an innovation includes the identification of a set of one or more objectives that the innovation is expected to achieve. The objectives can concern the characteristics of the innovation itself, such as its specifications, and its market and economic objectives. The outcomes of an innovation are similar to the objectives but consist of the innovation's realized effects. These can include unexpected effects that were not identified among the firm's initial objectives.



NCSES's Continuing Examination of Innovation in the U.S. Business Sector

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Innovation Workshop
October 16, 2018

National Science Foundation
National Center for Science and Engineering Statistics
www.nsf.gov/statistics/



Structure of Presentation

- NCSES Organizational Background
- NCSES Innovation Surveys (brief history)
- Oslo Manual Revisions and Purpose of this Innovation Workshop



National Center for Science and Engineering Statistics (NCSES)

- NCSES is a Division within the Directorate for Social, Behavioral and Economic Sciences within the National Science Foundation.
- NCSES is one of the 13 Federal Government's principal statistical agencies.
- Created by Congress in 1950, NSF is an independent federal agency *“to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense...”*
 - NSF is mandated *“...to provide a central clearinghouse for the collection, interpretation, and analysis of data on scientific and engineering resources and to provide a source of information for policy formulation by other agencies of the Federal Government...”*
 - This mandate has been fulfilled by NCSES and predecessor agencies.
- Our role to collect information on the science and engineering enterprise, including on competitiveness, was further codified in the America Competes Reauthorization Act of 2010 (December 6, 2010) which “created” NCSES.



NCSES Innovation Surveys

- Surveys conducted in partnership with the Census Bureau
- Mandatory survey; item nonresponse for innovation questions historically ~10%-20%
- Business R&D and Innovation Survey (BRDIS) (Reference years: 2008-2016)
 - All industries with 5 or more employees; primarily a survey for R&D activities;
 - Sample size =~42,000; 2016 Response rate =~80%
 - Innovation data collected 2008-2016
 - Starting with 2017 data collection, innovation data no longer collected
 - All industries with 9 or more employees; remains primarily an R&D survey
 - Survey now called the Business R&D Survey (BRDS)
- Microbusiness R&D and Innovation Survey (MicroBRDIS) (Reference year 2016)
 - All industries with 1-9 employees with a focus on 1-4; small business owner survey with questions on R&D and innovation and owner characteristics
 - Sample size =~200,000; 2016 Response rate =~76% for 1-4 and ~78% for 5-9
- Annual Business Survey (ABS) (Reference years 2017-2021 or longer)
 - All industries with 1 or more employees
 - Sample size in 2017 = 850,000; non benchmark year samples = 350,000
 - Rotating module approach combining previously stand-alone surveys
 - Collects R&D data for businesses with 1-9 employees (previously Micro-BRDIS)
 - Collects data on business owner characteristics (Survey of Business Owners), financing, technology and intellectual property and (for 2017-2019) innovation

What **was** Innovation per the **old** Oslo Manual (2005) / European Community Innovation Survey?

During [the recent 3-year period], did your enterprise introduce...

- new or significantly improved goods or services with respect to their capabilities, user friendliness, components or sub-systems?
(Product innovation)
- a new or significantly improved production process, distribution method, or support activity for your goods or service?
(Process innovation)
- new business practices; new methods of organizing work responsibilities and decision making; or new methods of organizing external relations with other firms or public institutions?
(Organizational innovation)
- significant changes to the design or packaging of a good or service; new media or techniques for product promotion; new methods for product placement; or new methods of pricing goods or services?
(Marketing innovation)



2009-16 BRDIS Innovation Questions

- BRDIS was to be a platform for innovation (including CIS-like) questions
- Measures only product and process innovation
 - Yes/No questions: During 2007-2009, did you introduce...
 - New or significantly improved goods? ...services?
 - New or significantly improved methods of manufacturing or producing goods or services? ...logistics, delivery or distribution methods? ...support activities?
- No specific guidance on defining innovation
- Does not define innovative activity per se
(for example, does not include performance of R&D as an innovation activity)
- Degree of novelty: Innovation sales as a percentage of total sales
 - that were new to one of your markets
 - that were only new to your firm
 - that were unchanged or only marginally modified



Revised Approach to 2016 Micro-BRDIS

- Respondents to this survey were very small businesses (1-9 employees) and cognitive testing found that wording different from that used in BRDIS worked better for them.
- Specific elements of innovation from the Oslo Manual definitions were incorporated into the question items.
- Included questions on product, process, organizational and marketing innovation. (BRDIS asked only about product and process innovation)
- Each aspect of innovation (for each form of product, process, marketing, and organization) was broken into individual yes/no questions.



Expanded Approach to reference year 2017 ABS (based substantially on 2016 CIS)

- First NCSES stand-alone innovation survey, which still did not stand-alone
- Launched in mid-2018 and currently being fielded
- Specific innovation topics from the 2005 Oslo Manual were asked.
- Definitions were incorporated into the yes/no question items on product, process, organizational and marketing innovation
- Included questions on
 - Novelty of innovation (new to firm vs new to market)
 - Percentage of innovation sales in total sales
 - Importance of various business strategies
 - Types of innovation activities engaged in
 - Results of innovation activities (abandonment, successful, ongoing)
 - Type and location of cooperation partner
 - Factors interfering with business innovation



Reference year 2018 Annual Business Survey (based somewhat on 2018 CIS)

- To be launched mid-2019 with reference year 2018
- Extremely scaled back version – in order to incorporate findings from this workshop and methodological testing
- Incorporates new 2018 Oslo Manual definitions of innovation (upcoming slides)
- Includes questions on
 - Percentage of innovation sales in total sales
 - Types of innovation activities engaged in
 - Total costs of innovation activities



2018 Oslo Manual Revision Process

- Three year international effort, led by the OECD's Working Party of National Experts on Science and Technology Indicators (NESTI) and the European Union. Resulted in the 4th edition of the Oslo Manual (2018), to be formally launched in Paris on October 22nd.
- Provides general definition of innovation and revised concepts for measuring business innovation (upcoming slide)
- Adaptation of terminology to be consistent with the System of National Accounts (SNA) and with other statistical manuals such as the Frascati Manual (for collecting R&D information)
- Acknowledges cross-cutting issues: Digitalization and Globalization
- Specific provision for experimentation in terms of types of questions and types of data (e.g., administrative data)
- Includes expanded methodological guidance
- Recognizes the object-based approach for measuring innovation (focal innovation), but emphasizes subject-based approach
- **Broad expansion of topic areas—basis for the 5 sessions of our Workshop**

Contents of 2018 Oslo Manual (What to Prioritize in the U.S. 2019 ABS Collection?)

- Chapter 1. Introduction to innovation statistics
- Chapter 2. Concepts for measuring innovation
- Chapter 3. Concepts and definitions for measuring business innovation (John)
- Chapter 4. Measuring business innovation activities (Jan)
- Chapter 5. Measuring business capabilities for innovation (Wes)
- Chapter 6. Business innovation and knowledge flows (Steve L)
- Chapter 7. Measuring external factors influencing firm innovation (Stephen E)
- Chapter 8. Objectives and outcomes of business innovation (E.J.)
- Chapter 9. Methods for collecting data on business innovation
- Chapter 10. The object method for innovation measurement
- Chapter 11. Use of innovation data for statistical indicators and analysis

Each chapter has recommendations for key indicators and supplementary indicators

General Definition(s) of Innovation (1)

- An **Innovation** is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process).
 - This definition is to be the basis for measuring innovation in all sectors of the economy.
- A **business innovation** is a new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm.
 - A **product innovation** is a new or improved good or service that differs significantly from the firm's previous goods or services and that has been introduced on the market.
 - A **business process innovation** is a new or improved business process for one or more business functions that differs significantly from the firm's previous business processes and that has been brought into use by the firm.

General Definition(s) of Innovation (2)

- There are two major types of innovation by object: innovations that change the firm's products (product innovations), and innovations that change the firm's business processes (business process innovations)
 - **Product innovations** can involve two generic types of products: goods (tangible objects) and services (intangible activities). (Note: Knowledge-capturing products, as identified in the SNA, can have the characteristics of either a good or service and concern the provision, storage, safekeeping, communication and dissemination of digital information that users can access repeatedly.)
 - There are six types of **business process functions**: (1) methods for producing goods or providing services; (2) distribution and logistics; (3) marketing and sales; (4) information and communication systems; (5) administration and management activities; and (6) product and business process development (including activities to identify, develop or adapt products or a firm's processes).
- The 2018 Oslo Manual cross-walks this revised set of innovation types to the 2005 Oslo Manual's four types of innovation.



Thank you and let's have at it!

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Discussion 1 – Business Innovation Activities

National Center for Science and Engineering Statistics
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Definition

- All developmental, financial and commercial activities that are intended to result in an innovation
 - Can be performed in-house or obtained from external organizations
 - May be postponed or abandoned during the observation period due to multiple reasons
 - Can create knowledge or information that is not used to introduce an innovation during the observation period. This includes knowledge from activities that fail to meet their primary innovation goals



8 Types of Business Innovation Activities

- Research and experimental development (R&D) activities
- Engineering, design and other creative work activities
- Marketing and brand equity activities
- Intellectual property (IP) related activities
- Employee training activities
- Software development and database activities
- Activities related to the acquisition or lease of tangible assets (buildings, equipment, machinery and other tangible assets)
- Innovation management activities



Innovation Activity	Includes
R&D	<ul style="list-style-type: none"> *1) novel, 2) creative, 3) uncertain outcome, 4) systematic, 5) transferable, reproducible *Basic, applied, development
Engineering, design, other creative work	<ul style="list-style-type: none"> *5 R&D criteria not met *Testing, set-up, tooling, production, quality *Service firms use design for look, use *Engineering may not be for innovation
Marketing, brand equity	<ul style="list-style-type: none"> *Pricing, placement, promotion advertising *Usually if linked to a new, improved product
IP	<ul style="list-style-type: none"> *Patents, utility patents, industrial designs, trademarks, copyright, IC designs, plants, trade secrets for new products, process
Employee training	<ul style="list-style-type: none"> *Not for existing products, general skills
Software development, databases	<ul style="list-style-type: none"> *Not to maintain IT system, supporting existing systems, routine functions
Tangible assets	<ul style="list-style-type: none"> *Buildings, instruments, equipment, computer hardware (not replacement)
Innovation management	<ul style="list-style-type: none"> *Funding, organization, external collaborations, performance *For innovation active firms

Key questions for data collection

- Qualitative data on whether or not each of the 8 activities were conducted, regardless of the reason, identifying whether innovation was the aim
- Whether or not each activity was conducted in-house or procured from external organizations
- Total expenditures for each of seven activities
 - expenditures for innovation management not recommended
- Funding sources for innovation



Source specifically relevant to innovation

Innovation Activity	Any activity, in-house or procured	Activity conducted in-house for innovation	Activity procured from external source for innovation
R&D			
Engineering, design, other creative work			
Marketing, brand equity			
IP			
Employee training			
Software development, databases			
Tangible assets			
Innovation management			

Expenditure data on activities & specifically relevant to innovation

Innovation Activity	Total expenditures (all firms)	Expenditures for innovation (innovation-active firms only)
R&D	\$	\$
Engineering, design, other creative work	\$	\$
Marketing, brand equity	\$	\$
IP	\$	\$
Employee training	\$	\$
Software development, databases	\$	\$
Tangible assets	\$	\$

Firms that perform R&D as a service to other firms include under "Total expenditures" and their own innovations under "Expenditures for innovation"



Accounting method for collecting data specifically related to innovation

	Expenditure on	Total expenditures for innovation (innovation-active firms only)
1	R&D	
1a	Intramural R&D <i>(include personnel cost, materials and other supplies, purchase of capital goods for R&D activities)</i>	
1b	Extramural R&D <i>(purchase of R&D from other parties)</i>	
2	Innovation activities other than R&D	
2a	Own personnel <i>(excl. cost of R&D personnel)</i>	
2b	Services purchased from other parties <i>(excl. purchase of R&D services)</i>	
2c	Materials and supplies <i>(excl. materials/supplies for R&D)</i>	
2d	Capital goods <i>(purchased tangible, intangible assets)</i>	



Supplementary: Human Resources by Activity (FTE)

- Person-months for each activity
 - Activities most likely to involve labor costs
 - Small firms in service industries
- Can combine with monthly salary data

Disaggregation by Sources of Funds

- Own funds (retained profits or income from asset disposal)
- Transfers from affiliated firms (holding, subsidiary or associated companies located in the domestic country or abroad)
- Customer orders (including procurement contracts from governments or international organizations)
- Shareholder loans
- Debt funding from commercial loans (banks, credit cards etc.), overdraft facilities, suppliers' credit
- Loans from governments
- Loans from international organizations
- Equity from private equity or venture capital firms, business angels or other individuals (family and friends)
- Grants or subsidies from governments, international organizations, NGOs, etc.
- Bonds and obligations
- Other sources (e.g. Crowdfunding)



Supplementary questions for data collection

Additional information for specific activities, such

- as whether R&D activities are conducted continuously or on an occasional basis
- Follow-on activities
- Planned innovation activities and expenditures



Supplementary: Number of innovation projects by activity

- Undertaken during period
- Completed during period
- Ceased before completion during period
- Ongoing projects by the end of period



Supplementary: Follow on activities after implementation, but within the period

- Marketing: promote the sale of a product innovation in the market
- Training: training of employees, customers in the use of product or business process innovations
- After-sales services: installation, updating and repair services, guarantee and return, information



Supplementary: Planned activities

~Firm plans to conduct any innovation activities in the one or two years after the reference year?

- Yes
- No
- Don't know

~Total innovation expenditures compared to the reference year (if any) are expected to

- Increase
- stay the same
- decrease



Summary for Prioritization

- Qualitative data on whether or not each of the eight activities were conducted
 - Whether the activity was conducted for innovation
- Whether or not each activity was conducted in-house or procured from external organizations
- Total expenditures for each of seven activities
- Total innovation expenditures using the accounting method (shown for R&D)
- Funding sources for R&D
- Supplementary questions
 - R&D continuous or occasional
 - Innovation expenditures by funding source
 - Follow-on activities
 - Planned innovation activities and expenditures



Discussion 2 – Business Capabilities for Innovation

National Center for Science and Engineering Statistics
National Science Foundation

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Definition

- Knowledge, competencies and resources that a firm accumulates over time and draws upon in the pursuit of its objectives
 - Resources controlled by a firm
 - Human, physical and intangible capital, accumulated experience, internal sources of finance, ownership status, and access to outside resources
 - General management capabilities of a firm, including capabilities related to managing innovation activities
 - Business strategy, for example, cost competitiveness or focus on quality features (e.g. functionality, durability, flexibility of use, etc.)
 - Organizational and managerial capabilities
 - Characteristics of the business owner and top management
 - Innovation management capabilities
 - IP management and appropriation
- Where do these capabilities/resources reside?
=>Who can respond knowledgeably to questions—Upper management?
Innovation project managers? R&D managers?

Definition (continued)

- Workforce skills and how a firm manages its human capital
 - Workforce qualifications, occupational structure and competences
 - Human resource management
- Ability to use technological tools and digital resources, with the latter providing an increasingly important source of information for innovation
 - Technical expertise
 - Design capabilities
 - Capabilities related to digital technologies and data analytics

Key questions for data collection

- Number of employed persons (FTEs)
 - Also by business unit
- Total sales
 - Also business unit sales—THE key correlate of R&D
- Firm age by year the firm began business activities
 - Date of entry by market
- Firm ownership status (stand alone, part of a national group, part of a multinational group)
- Geographical distribution of sales (local, national, international markets)
- Export share of sales
 - By business unit
- Importance of cost versus quality for the firm's competitive strategy
 - Suggested measures: % process vs. product R&D, and, for latter, % dedicated to developing altogether new products vs. product improvement
- Share of employed persons with a tertiary education
- Business level of design capability
 - ?
- Cash flow?

Supplementary questions for data collection

- Family owned firm status
- Number of product lines
- Innovation management: responsibility for innovation within the firm
- Innovation management: methods to support internal knowledge exchange
- Number of employed persons by major field of education
- Technical expertise in emerging technologies
 - Only?
- Digital competences

Issues/questions?

- Questions bearing on “business capabilities” relegated to “supplementary questions?—Why?
- To understand drivers of innovation and innovative performance, do not focus exclusively on innovating firms—Surveying imitators and firms that do neither?
- What question do we want to answer with measures of capabilities?
 - **Why are we doing this?**
 - If it’s the role of capabilities in driving firms’ innovative performance, very difficult due to endogeneity
 - Per above, to analyze effect of capabilities, need to identify not only (N-t-M) innovators, but also imitators (i.e., N-t-F “innovators”), as well as firms that do neither

- More questions
 - Capability to do what?
 - Starting with the coarse distinction between invention and innovation (i.e., commercialization of new products)=>
 - Invent? Develop?
 - Commercialize?
 - » By bringing manufacturing, marketing and sales capabilities to bear
 - Example (Arora, Cohen and Cunningham, 2018)
 - Firms with weak “inventive” (i.e., upstream) capability, benefit from proximity to others’ **inventions**, while those with strong inventive capability do not, though they benefit from proximity to universities
 - May want to distinguish capabilities by classes of activity
 - Managerial
 - Technical (invention and/or development)
 - Commercialization (Mfg./Sales/Mkting)

- How to measure performance? And what kind?
 - Financial performance?
 - At what level? B.U.? Firm?
 - Technological success?
 - Commercial success?
 - Learning?
 - Coarsely distinguishing between invention and innovation, move away from assumption that firms are self-sufficient in innovation
 - In U.S. mfg, 2010, 49% of innovating manufacturing firms acquired the invention (i.e., overall concept, prototype) underlying their most important new or significantly improved product from an external source (Arora, Cohen and Walsh, 2016)
- => Highlights importance of firms' ability to search for and manage external relationships

- Sample questions for “managerial capabilities” at upper level of mgt
 - Objectives?
 - Incentives? Of what form?
 - Pay, promotion, nonpecuniary, etc.?
 - Criteria for personnel and project performance evaluation?
 - Reporting structures?
 - To whom do innovation project managers report?
 - Delegation of decision rights to project managers?
 - Basis for prioritizing projects
 - Typical timelines?
 - And for many of the above, would want to know variation across business units and projects
- Also useful to distinguish across types of innovation?
 - E.g., Incremental versus altogether new products, perhaps for new markets
- Questions at level of innovation project managers?

A different approach: Assume innovation capabilities are unobservable (Arora, Cohen and Cunningham, 2018)

- Latent variable, discrete choice model
 - Employs a finite mixture model employed in marketing and health care literatures
- Assumes the data generated reflect mixture of two or more distributions.
 - Each data point has unknown probability of belonging to one of the distributions.
 - The unknown probabilities and the set of coefficients from the model predicting innovation outcomes for each distribution are jointly estimated.

- We distinguished firm types by their underlying capability, allowing firm characteristics (e.g., size) and supply of external inventions and knowledge, respectively, to relate differently to innovation outcomes (i.e., innovation, imitation, neither) for two classes of firms distinguished by inventive capability
- => Simultaneous estimation of
- Probability that firm belongs to high (v. low) capability class
 - Class-conditional probabilities of innovation outcomes (innovate, imitate, neither)
 - Class-specific coefficients
- Method provided a measure of “inventive capability” (i.e., the probability of high inventive capability) that can be used in subsequent analyses.



Discussion 3 – Business Innovation and Knowledge Flows

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Definition (*from Oslo Manual*)

- Knowledge flows encompass the deliberate or accidental transmission of knowledge
 - *Deliberate: asset purchase or payment for services such as rental, royalty, or profit)*
 - *Accidental: Spillovers, externalities, public goods*
- Knowledge exchange (sometimes referred to as knowledge transfer) is the deliberate transmission of knowledge from one entity to another
 - *Economic analysis needs prices and sales (weights)*
- Innovation Diffusion
 - The process and the outcomes of innovation diffusion are of policy and research interest because diffusion amplifies the economic and social impacts of ideas and technology (*Social vs. private rates of return*)
 - Innovation diffusion can also create knowledge flows that lead to further innovations (*spillovers/public goods*)
 - The expected speed and nature of innovation diffusion also shape the incentives to innovate. (*payback and ownership*)

Definition (continued)

- Knowledge Flows (OSLO Manual - Ch
 - Knowledge can be captured by “objects” such as databases, software routines, patents, publications, public presentations and know-how (*embodied technical change*)
 - All organizations, agents or individuals can be involved in knowledge flows (*market transactions, GVC/MNE, World I-O*)
 - “Firms (*internal/external, customers, universities, investors, experts and other potential sources of knowledge*)” OSLO

Key questions for data collection

- Contribution of inbound knowledge flows to innovation (*OSLO mainly qualitative yes/no; NSF has lots of experience economic flows, use BRDS other surveys and OSLO as launching platform*)
- Collaboration partners for innovation by location
 - *Really interesting in GVC context if can get economic data*
- Sources of ideas and information for innovation, but excluding details on internal sources
 - *Don't understand: see Table 6.2, which includes internal/external sources of innovation; or is this problem with own firm perceptions/bias*
- Barriers to knowledge interactions
 - *Table 6.9: Interesting classification of barriers to transactions, many amenable to policy action (including less action)*

Supplementary questions for data collection

- Sources of inbound knowledge flows by location (*Very important GVCs, but hard to collect on surveys, may only be possible with World I-O Tables*)
- Outbound knowledge flows (*Hard, but need both sides of flows and asset transfers; build on existing economic data and surveys*)
- Channels for knowledge-based interactions between firms and Higher Education Institutions (HEI) and Public Research Institutions (PRI) (*Yes!*)
- Use of Intellectual Property Rights (IPR) for knowledge flows (*Tax, transfer pricing for IP make this very hard, but extremely important*)



Discussion 4 – External Factors Influencing Innovation in Firms

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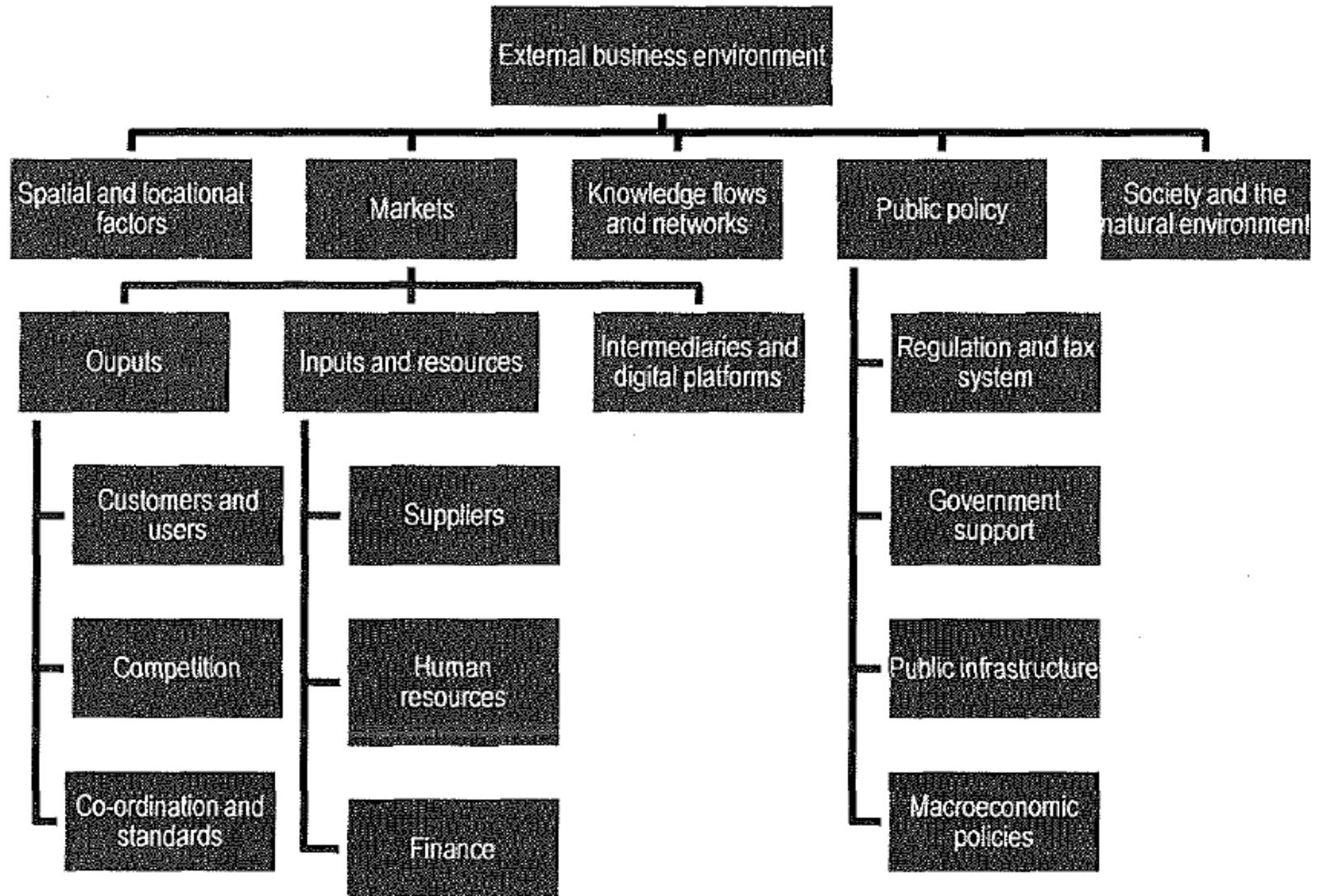
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Definition

- External factors can:
 - influence a firm's incentives to innovate and its innovation activities, capabilities and outcomes
 - be the object of a business strategy, public policy or concerted social action by public interest groups
 - are often beyond the immediate control of management
 - be drivers or barriers to innovation
 - define the firm's innovation operating environment
 - depend on proximity to universities/clusters
 - can we really sell our innovations into foreign markets?

Figure 7.1. Main elements of the external environment for business innovation



Definition (continued)

- External factors may include:
 - Spatial and locational factors that define the firm's location and its distance to product and labor markets which can influence costs and consumer awareness
 - Markets for the firm's products; types of customers; the influences of customers on innovation; competition and collaboration in markets; coordination and standards in markets
 - Public Policy including regulations, government support, public infrastructure
 - Society and the natural environment



Questions for data collection

Key Questions

- **Firm's industry and main market**
- **Competition and product market characteristics**
- **Government support for innovation**
- **Drivers or barriers to innovation**

Proposed Items for Inclusion in Questions on Competition

Basic measures

Number of competitors¹

Characteristics of main competitor – e.g. whether a multinational enterprise, a digital platform²

Qualitative measures of potential competition intensity

Your firm's goods / services need to be quickly upgraded to remain relevant

Technological developments in your firm's main markets are difficult to predict

Your firm's goods / services are easily substituted by your competitors' offerings

The entry of new competitors is a major threat to your firm's market position

The actions of your competitors are difficult to predict

Your firm faces strong competition in its markets

Price increases in your markets tend to lead to an immediate loss of clients

Customers in your markets find it difficult to assess the quality of products before purchasing them

Main Types of Government Policy Instruments to Support Innovation

Grants	Government grants or other transfers for innovation activities. These are often related to specific innovation projects and help meet part of their related costs
Equity finance	Government investment in business equity
Debt finance	Government loans for innovation
Guarantees for debt financing	Government guarantees to facilitate third-party financial investment in the firm's innovation activities
Payment for goods and services	Buying goods or services from firms, implicitly or explicitly requiring firms to innovate as part of the agreement
Tax incentives	Tax relief for innovation activities and related outcomes, such as incentives for R&D expenditures or favourable IP regimes
Use of infrastructure and services	Direct or indirect provision of infrastructure and services for business innovation activities, such as subsidised access to R&D, testing or prototyping facilities, or allowing access to relevant data, networking or advisory resources This may include allocating vouchers to firms to allow them to acquire certain types of specialised services from approved providers, such as universities, research centres or design consultants

Questions for data collection

Key Questions

- Firm's industry and main market
- Competition and product market characteristics
- Government support for innovation
- Drivers or barriers to innovation

Supplemental Questions???

- **Location of business activities and value chains**
- **The main customer's share of sales and the industry of the main customer**
- **Effect of regulations on innovation**

Table 7.1. Business activities by location

Business activities	Within the firm or the firm's group		Outside the firm and firm's group	
	Domestic	Rest of the world	Domestic	Rest of the world
a) Production of goods and services				
b) Distribution and logistics				
c) Marketing and sales				
d) Information and communication				
e) Administration and management				
f) Product and business process development				



“Proposal for Integrated Collection of Data on External Innovation Drivers”

General area	Specific area	Importance as a driver of innovation (low, medium, high, not relevant)
Markets	Domestic customers	
	Access to international markets	
	Suppliers and value chains	
	Availability/cost of skills	
	Availability/cost of finance	
	Competitors	
	Standards	
	Markets for knowledge	
Digital platforms		
Public policy	Regulations	
	Functioning of courts and rules enforcement	
	Taxation	
	Public spending (level and priorities)	
	Government support for innovation	
	Government demand for innovations	
	Public infrastructure	
General policy stability		
Society	Consumer responsiveness to innovation	
	Favourable public opinion towards innovation	
	Level of trust among economic actors	



Discussion 5 – Objectives and Outcomes of Business Innovation

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Definition

- Planning and development for an innovation includes the identification of one or more objectives that the innovation is expected to achieve
 - Objectives can concern the characteristics of the innovation itself, such as its specifications, and its market and economic objectives
- The outcomes of an innovation are similar to the objectives, but consist of the innovation's realized effects.
 - Outcomes can include unexpected effects that were not identified among the firm's initial objectives

Definition (continued)

- Objectives may include the following:
 - Profit generation, cost savings, or improvements in productivity
 - an increase in sales or brand awareness from product innovation
 - changes to the firm's capabilities, markets, or the types of customers
 - establishment of new external linkages
- Outcomes may include the following:
 - extent to which a firm's objectives are met
 - broader effects of innovation on other organizations, the economy, society, and the environment
- Compared with product innovations, respondents have more difficulties in providing quantitative outcome data for business process innovations



Questions for data collection

Key Questions

- Innovation objectives and outcomes by area of influence (e.g., markets, production/delivery, business organization, economy/society)
- Innovation objectives and outcomes for business strategies
- Innovation sales share in total business sales

Supplemental Questions

- Counts of product innovations
- Major impacts of innovations for markets