A SURVEY OF INNOVATION SURVEYS: TAKING STOCK OF A GROWING LITERATURE

Jacques Mairesse
and
Pierre Mohnen

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Outline

- History of innovation surveys
- Content of innovation surveys
- Characteristics of the data
- What have we learned?
- Pitfalls
- Improvements

History

- Oslo Manual (1992, 1996, 2005)
- Community Innovation Surveys (CIS)
- 5 waves: 90-92, 94-96, 98-00, 02-04,04-06
- Surveys prior to CIS 1 in France, Germany, Italy, the Netherlands, Norway and Sweden
- Exploratory survey in the U.S. (1985)
- SPRU data on innovation

History (2)

- Annual surveys (Germany), bi-annual surveys (Netherlands)

- Surveys on particular sectors

  (e.g. Canadian survey in construction industry)

- Surveys on particular issues

  (e.g. organizational innovation in France)

Countries with innovation surveys

- EU countries (CIS surveys)
- Canada
- Norway, Switzerland, Russia, Turkey
- Australia, New Zealand
- Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay, Venezuela
- South Korea, Taiwan, Singapore, Malaysia, Thailand, Japan, China
- South Africa

Related surveys

- Ifo survey in Germany, annual since 1982
- ESEE in Spain: 10 years of data
- commercialized innovation data such as from US Small Business Administration
- Yale survey, Carnegie-Mellon Survey, Patval Survey

Content

- **I. General information**
  - Independent or part of a group?
  - Domestic or foreign group?
  - Country of location
  - Main industry affiliation
  - Number of employees (level and growth)
  - Turnover (level and growth)
  - Exports (level and growth)
  - Mother, daughter or sister enterprise (CIS 1)
  - Significant changes in turnover (CIS 2 and 3)
  - Newly established (CIS 2 and 3)
  - Merger affected turnover for more than 10% (CIS 2 and 3)
  - Closure affected turnover for more than 10% (CIS 2 and 3)
  - Most significant market: national or international, nearby or distant (CIS 3)
  - Gross investment in tangible goods (CIS 3)
  - Number of employees with higher education, female, expected increase (CIS 3)

Identifying an innovator

- **II. Innovator (yes/no)**
  - Introduced new to the firm product in the last 3 years?
  - Is yes: share of innovative sales
  - Who developed the new products ? (CIS 2 onward)
  - Introduced new to the market product in the last 3 years?
  - Is yes: share of innovative sales
  - Introduced new process in the last 3 years?
  - Unfinished or abandoned innovative project?

Questions to innovators

- **III. Categorical data**
  - Sources of information for innovation
  - Objectives of innovation (CIS 1 and 2)
  - Effects of innovation (CIS 3 and 4)
  - Means of transferring technology (CIS 1)
  - Effectiveness of appropriation mechanisms (CIS 1)

- **IV. Dichotomous data**
  - R&D
  - R&D continuously
  - R&D cooperation with partners
  - Government support for innovation from various sources (CIS 3 and 4)
  - Applied for a patent? (CIS 2)

- **V. Continuous data**
  - R&D expenditures (intra- & extramural)
  - R&D personnel (CIS 2 and 3)
  - Innovation expenditures (+ sub-items)
  - Estimated share of products in different phases of life-cycle (CIS 1)
  - Share of innovative products new to enterprise
  - Share of products new to market

Questions to all respondents

- **VI. Data on all firms (innovators or not)**
  - Factors hampering innovations (after a filtering question from CIS 2 on)
  - Applied for a patent? (CIS 3 and 4)
  - Possession of valid patents (CIS 3)
  - If yes: number of valid patents
    share of patent protected sales
  - Use of any other IP protection methods? (CIS3 and 4)
  - Organizational changes? (CIS 3 and 4)
  - Importance of organizational changes (CIS 4)
  - Marketing innovations (CIS 4)

Characteristics of the data

- Qualitative data
- Censored data (some only for innovators)
- Subjective data (“new”, “new to the market”)
- Quality of variable (innov. expenditures, share of innov. sales)
- Cross sectional

Summary of content

- Innovation outputs
  - Commercialization as opposed to invention (to compare with patents and bibliometrics)
  - Different types (product, process, organis., marketing)
  - Levels of novelty
- Innovation inputs
  - Besides R&D, other innovation expenditures
- Innovation modalities
  - Cooperation, sources of information, use of IPR, objectives of innovation, public support, obstacles

Use of innovation surveys

- Policy guidance:
  - monitoring, benchmarking
  - Effectiveness of public support
- Understanding innovation
  - Determinants
  - Complementarities
  - Effects
  - Dynamics

Use for policy guidance

- Examples
  - European innovation scoreboard
  - Global summary innovation index
- Questions
  - Are some countries lagging behind?
  - Are new member states catching up?
  - Comparison of R&D, innovative sales, cooperation, government support

Difficulties

- Which indicators to include in the index?
- Weights ?
- Intertemporal comparison when components change?
- International comparisons when questions differ?
- How to aggregate qualitative variables?
- Importance of complementarities
- Correlation between individual components
- Pairwise analysis does not explain

Questions investigated

- determinants of and complementarities in:
  - innovation
  - sources of information for innovation
  - cooperation for innovation
  - obstacles to innovation
- effects of innovation on
  - productivity level or growth
  - exports
  - patenting
  - employment
- persistence and dynamics of innovation
- additionality or crowding out of government support for innovation

What have we learned?

- On determinants of innovation
  - probability to innovate increases with firm size
  - intensity of innovation is unaffected or even decreases with firm size
  - Incumbents tend to innovate more
  - demand pull often significant and positive
  - technology push >0, less often significant
  - R&D, especially continuous R&D, matters

What have we learned? (2)

- Industry taxonomy for innovation
  - Pavitt's taxonomy, based on regularities in the sources of technology, the requirements of users, and the possibilities for appropriation
  - Based on principal components analysis (Hollenstein, Baldwin and Gellatly)
  - Based on poolability tests of model of innovation determination (Raymond et al.)

What have we learned? (3)

- “Innovation accounting framework” (Mairesse and Mohnen)

$$y^A = y^E + f_C^E \beta_2 (w_2^A - w_2^E) + f_Z^E (Z^A - Z^E) + f_C^E (-\alpha_2 / 2) + e^A$$

$$y^B = y^E + f_C^E \beta_2 (w_2^B - w_2^E) + f_Z^E (Z^B - Z^E) + f_C^E (\alpha_2 / 2) + e^B$$

Intensity of Innovation Unconditionally on Being Innovative

Source:	European intensity	Industry effects	Size and Group effects	R&D effects	Environ-ment effects	Sum of structural effects	Expected intensity	Innovativity	Observed intensity
				High-tech Industries					
Belgium	34.7	-1.2	2.6	0.9	0.7	3.0	37.7	0.2	37.9
Denmark	34.7	1.3	-0.7	0.4	0.4	1.4	36.1	0.7	36.8
Germany	**34.7**	**1.3**	**0.6**	**0.9**	**1.7**	**4.5**	**39.2**	**4.6**	**43.8**
Ireland	34.7	-0.6	-2.2	0.1	-0.1	-2.6	32.1	3.1	35.2
Italy	**34.7**	**0.4**	**1.1**	**-0.9**	**-1.6**	**-1.0**	**33.7**	**-8.1**	**25.6**
Netherlands	34.7	-0.8	-1.1	-0.6	0.1	-2.4	32.3	1.0	33.3
Norway	34.7	-0.5	-0.2	-0.7	-1.5	-2.9	31.8	-1.6	30.2
Average	34.7	0.0	0.0	0.0	0.0	0.0	34.7	0.0	34.7

What have we learned? (4)

- Complementarities (supermodularity: the whole is more than the sum of its parts)
  - different types of innovation, e.g. product and process innovation (Miravete and Pernías, 2006)
  - internal and external technology sourcing (Cassiman and Veugelers, 2002)
  - different types of cooperation strategies (Lokshin, Belderbos, Carree, 2005)
  - internal skills and cooperation (Leiponen, 2003)
- results are mixed and heavily dependent on the appropriate correction for unobserved heterogeneity

What have we learned? (5)

- R&D-productivity revisited
  - Crepon-Duguet-Mairesse (CDM) model
  - estimated for at least 12 countries
  - R&D $\Rightarrow$ Innovation $\Rightarrow$ Productivity
  - confirmation of rates of return to R&D found in earlier studies
  - innovation output statistics are noisier than R&D statistics: need to be instrumented

Table 4: Different direct and indirect estimates of productivity elasticities (in %) with respect to R&D,

	High-Tech Industries				Low-Tech Industries			
Estimates of productivity elasticities with respect to R&D*:	R&D per employee	Through Products new to the firm	Through Products new to the market	Through Patent holdings	R&D per employee	Through products new to the firm	Through Products new to the market	Through Patent holdings
Correcting only for selectivity	3.40 (0.52)	0.02 (0.56)	0.00 (0.31)	0.04 (0.36)	1.05 (0.57)	0.07 (0.62)	-0.02 (0.32)	0.19 (1.21)
Correcting only for endogeneity	4.50 (1.44)	3.80 (1.57)	3.73 (1.39)	4.44 (1.59)	6.75 (1.96)	4.34 (1.91)	6.74 (2.18)	7.31 (2.19)
Correcting for selectivity and endogeneity	4.28 (0.93)	4.55 (1.13)	4.37 (0.99)	4.88 (1.14)	2.79 (0.82)	3.06 (0.88)	3.60 (0.98)	2.80 (0.91)

What have we learned? (6)

- Few studies so far have estimated dynamic models using panel data from successive innovation surveys
  - Persistence of innovation found by Peters (2005), Duguet and Monjon (2001), Cefis (1996), Raymond et al (2007).

What have we learned? (7)

- Crowding-out or additionality of government support for innovation

  (Czarnitski, Duguet, Arvanitis,…)
  - Matching estimator or simultaneous modeling of government support and firm performance
  - Most studies find additionality

What have we learned? (8)

- Complementarity of innovation policies (Mohnen-Röller)

- Idea of considering binding obstacles to innovation as signs of deficient government policies
- Complementarity in innovation policies calls for a policy mix
- Different signs of complementarity depending on
  - the pair of obstacles (access to finance, lack of qualified personnel,…)
  - stage of innovation (getting firms to innovate or getting firms to innovate more)

Testing for complementarities

$$I(10\,XX\,,\theta_{ij})+I(01\,XX\,,\theta_{ij})\leq I(00\,XX\,,\theta_{ij})+I(11\,XX\,,\theta_{ij})$$

$$H_0: h_0 < 0 \text{ and } h_1 < 0 \text{ and } h_2 < 0 \text{ and } h_3 < 0$$

$$H_1: h_0 \geq 0 \text{ or } h_1 \geq 0 \text{ or } h_2 \geq 0 \text{ or } h_3 \geq 0$$

COMPLEMENTARITY/SUBSTITUTABILITY TETS IN INNOVATION POLICY

Wald test of inequality restrictions based on generalized Tobit estimates
(at 10% significance level: lower bound=1.642, upper bound=7.094*)

	Probability to innovate						Intensity of innovation					
Obstacle Pairs	1-2	1-3	1-4	2-3	2-4	3-4	1-2	1-3	1-4	2-3	2-4	3-4
Supermodularity Test												
	13.443	7.908	10.998	6.752	11.952	3.028	0.00	0.00	1.529	3.341	3.730	14.09
Submodularity Test												
	2.690	0.000	2.215	0.353	0.772	0.871	18.653	9.984	5.215	0.335	8.156	0.403

Obstacle definitions: 1= Lack of appropriate sources of finance, 2= Lack of skilled personnel, 3= Lack of opportunities for cooperation with other firms and technological institutions, 4= Legislation, norms, regulations, standards, taxation.
* see Kodde and Palm (1986)

Pitfalls

- Difficulty of comparing across studies because of different definitions of innovation
- Difficulty of international comparisons
- R&D typically higher in innovation than in R&D surveys
- Few variables to explain innovation from innovation surveys

Suggestions of improvement

- Harmonization of surveys across countries
- Stability of questionnaire over time, at least for core questions
- More information about non-innovators
- Follow a core of firms survey after survey
- Experiment with order of questions, sensitivity to respondent

How to progress?

- Merge innovation survey data with other data
- Create longitudinal datasets
- Harmonize surveys across countries
- Ease access to data
- Collect data on groups and especially on multinationals