

## The importance of measuring household sector innovation

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### Abstract

*Rather than businesses, individual end consumers may develop innovations for themselves. Innovating consumers generally do not protect their innovations with intellectual property rights and may be generally available. This paper presents stylized facts about household sector innovation, by summarizing the findings of a range of empirical studies that have been published in the past decade. Next, I present a survey procedure for future studies of consumer innovation. The survey procedure includes up to six steps which can be tailored to specific research purposes. The procedure will enable better international/cross-study comparisons and an efficient collection of data. Finally, I briefly explain how firm surveys can be modified to better capture household sector innovation.*

A range of recent studies show that innovation by individual end consumers is substantial, and that diffusion of their innovations advances social welfare. However, official innovation statistics for the household sector (HHS) are still missing. This paper reviews evidence on the empirical scope of household sector innovation (section 1) and explains how HHS innovation can be measured (section 2). The paper ends with recommendations (section 3).

### 1. Empirical scope

HHS innovation is widely present and important for social welfare. I here discuss six stylized facts.

#### *Fact 1: Consumers do innovate*

Qualitative evidence has shown for a long time that consumers can innovate as well as businesses (von Hippel, 2005). They may innovate for various reasons, including personal needs, but also for the benefits obtained from the innovation process itself – for fun, a desire to learn, or to help others (Raasch & von Hippel, 2013). Examples of everyday products that we owe to HHS innovators include dishwashers, kitesurfing equipment, baby buggies, jogging strollers, and Jacuzzis. Also, in the medical sector many treatments were created by patients or care-givers ([www.patient-innovation.com](http://www.patient-innovation.com)).

#### *Fact 2: There are millions of HHS innovators*

Nationally representative surveys have shown that many individual consumers innovate, not for profit, but rather to satisfy personal needs that they encountered in their everyday

lives (de Jong, 2016). See Table 1. At the population level millions of consumers across the globe can be considered innovators.

**Table 1. Percentage of household sector innovators in various countries**

| <i>Team</i>                                  | <i>Country</i> | <i>Year</i> | <i>Frequency</i> | <i>Estimated no of innovators</i> |
|--|----------------|-------------|------------------|-----------------------------------|
| Von Hippel, de Jong, Flowers                 | UK             | 2009        | 6.1%             | 2.9 million                       |
| De Jong                                      | Netherlands    | 2010        | 6.2%             | 0.772 million                     |
| Ogawa, Pongtalanert                          | USA            | 2010        | 5.2%             | 16.0 million                      |
| Ogawa, Pongtalanert                          | Japan          | 2011        | 3.7%             | 4.7 million                       |
| Kuusisto, de Jong, von Hippel, Gault, Raasch | Finland        | 2012        | 5.4%             | 0.172 million                     |
| De Jong                                      | Canada         | 2013        | 5.6%             | 1.6 million                       |

Notes: for full references of these studies, see de Jong (2016).

*Fact 3: HHS innovators spend considerable time and money*

HHS innovators invest limited time and money to solve problems in their everyday lives – typically a few person-days and a couple of hundred of Euros (von Hippel, 2016). Collectively, however, their investment is huge. Their total expenditures can match with corresponding innovation expenditures done by commercial enterprises. See Table 2 (Taken from von Hippel et al., 2011, table 1).

**Table 2. Total innovation expenditures per year on products for own use in three countries**

|   | <i>UK</i>     | <i>US</i>      | <i>Japan</i>   |
|---|---------------|----------------|----------------|
| Estimated total expenditures* by HHS innovators on product development per year | \$5.2 billion | \$20.2 billion | \$5.8 billion  |
| Estimated consumer product R&D expenditures funded by companies per year**      | \$3.6 billion | \$62.0 billion | \$43.4 billion |

Notes: \* Total expenditures include out-of-pocket expenditures and time investment evaluated at average wage rate for each nation. \*\* Calculated from national input-output tables.

*Fact 4: HHS innovations can be substantial projects*

HHS innovators may operate either solo or collaboratively. In the aforementioned national surveys, it was found that 10 to 28% of all HHS innovations were collaborative efforts. When innovations are developed in an ‘open collaborative mode’, they can be substantial and be alternatives to large-scale commercial products (Baldwin & von Hippel, 2011). This is most evident in open-source software projects like Linux (being an alternative to Microsoft Windows), but also in open design projects like the RepRap in 3D printing (vs the products offered by commercial suppliers like Stratasys). Collaborative HHS innovations can also fill a space that commercial suppliers cannot adequately serve (e.g., Wikipedia is more up-to-date and reliable than any commercial encyclopedia). Finally, due to increasingly available low-cost innovations tools (like

CAD software) and the Internet (which lowers transaction costs to HHS innovators) open collaborative innovation is expected to grow (Baldwin & von Hippel, 2011).

*Fact 5: Diffusion of HHS innovations advances social welfare*

Some HHS sector innovations are highly valuable to other consumers. For social welfare it is important that these innovations diffuse, or consumers with similar needs would have to independently develop the same innovation. Gambardella et al. (2016) showed that HHS innovators enhance social welfare by developing innovations which can substitute commercial producers' products (imposing price pressure, or driving producers to improve their quality), or alternatively, by developing innovations which complement producer offerings (so that the aggregated use value increases). Also, if producers adopt HHS innovations, the commercial value of their products beats traditional product development projects (e.g., Lilien et al., 2002). HHS innovations are commonly found at the edge of new, emerging industries, and associated with venture creation and employment growth (Shah & Tripsas, 2007).

*Fact 6: HHS innovations are even more relevant to developing countries*

Household sector innovations are part of the 'informal economy', which is especially prevalent in developing countries. Recent contributions on reverse innovation (von Zedtwitz et al., 2015) and bottom-of-the-pyramid innovation (Prahalad, 2012) show that many innovations in developing countries were developed initially in the household sector. Absent the presence of HHS innovations in official statistics, developing countries will perform poorly in international benchmarks.

## **2. Measurement of household sector innovation**

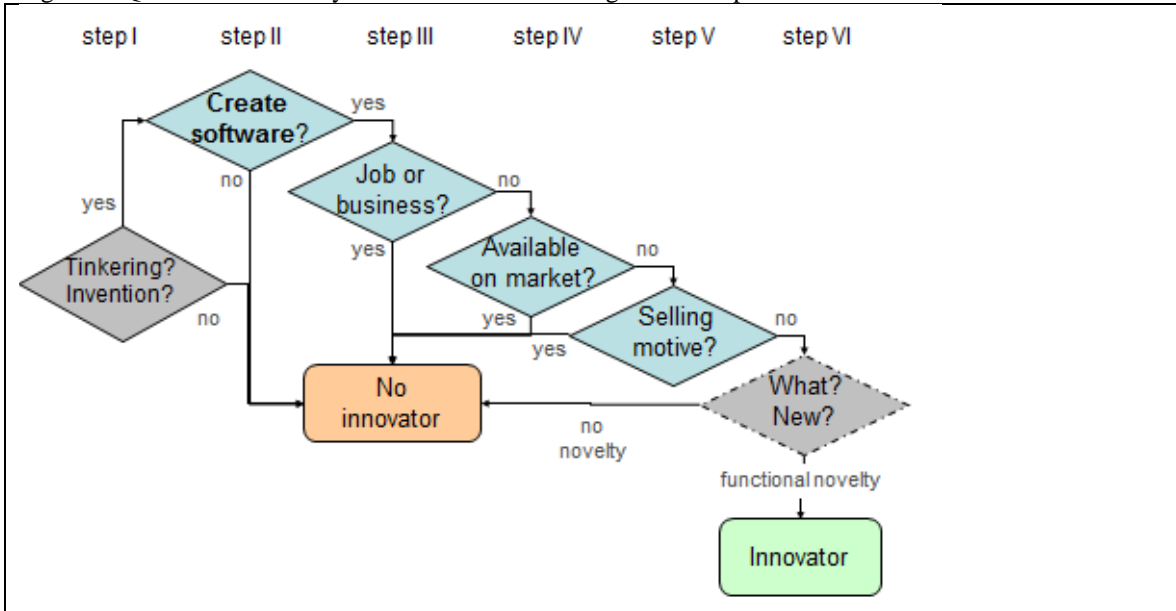
HHS innovation can be measured in two ways:

- Social surveys. New surveys can be developed to directly measure if individual consumers are innovators.
- Firm surveys. Existing surveys can be modified to measure if commercial firms absorb and/or influence HHS innovation.

*Social surveys*

Recent surveys have measured the frequency of HHS innovation in broad consumer samples (de Jong, 2016). A revolving challenge is that consumers do not understand what innovation entails. Thus, the word 'innovation' is avoided, and researchers rather offer specific cues to trigger respondents' recall. For example, researchers first ask for 'computer software' i.e. if the consumer created computer software in the past three years. If yes, a series of screening questions is asked to explore if the respondent is a HHS innovator with regard to computer software. If not, a next cue is offered ('household fixtures and furnishing'). De Jong (2016) recently suggested the screening procedure in Figure 1.

Figure 1. Questions to identify HHS innovators with regard to computer software



Notes: Steps II to VI are repeated for each cue.

The suggested procedure includes up to six steps:

- I Two advance screening questions, i.e. if respondents ever tinker in their leisure time, and if they ever spend their time on inventions or developing new products, applications or concepts. If not, the survey may be ended.
- II Next, respondents are offered eight cues (computer software; household fixtures or furnishing; transport or vehicle-related; tools or equipment; sports-, hobby- or entertainment; children- or education-related; help-, care- or medical; and other). For each cue respondents indicate if they have created it (e.g., computer software) in the past three years. If yes, up to four additional questions are asked to screen out false positives:
- III Respondents indicate if they created it (e.g., computer software) for their job or business – to screen out job-related innovations;
- IV They then indicate if they could have bought a similar application on the market if they had wanted to – to screen out homebuilt versions of existing products;
- V They indicate if their primary motive was commercial, or rather personal use of any other motive – commercially-driven innovations are discarded;
- VI Finally, respondents may be asked to describe their innovation and what was new about it – to exclude any false positives with no functional novelty.

Similar procedures were used in the studies mentioned in Table 1. Depending on the researcher’s interests, different versions can be applied. If, for example, survey resources are minimal and the purpose is not to provide population estimates, but rather to obtain a sample of innovators for further analyses, researchers could discard step VI (avoiding expensive open-ended questions). After it has been established if a respondent is a HHS

innovator or not, typically a range of follow-up questions is asked to collect data on innovation expenditures, protection, collaboration, and diffusion.

More details regarding the suggested procedure can be found in the *Appendix* at the end of this paper. For details we refer to de Jong (2016).

### *Modifying firm surveys*

HHS innovation does not exist in isolation. Rather, commercial firms may adopt HHS innovations to further develop them and offer them to the market for general sale. They may also engage in behaviors to influence and trigger HHS innovations (von Hippel, 2016).

Gault (2012) launched the idea of modifying existing firm surveys to better reflect to what extent firms take advantage of HHS innovations. A pilot was done in Finland by Niemi and Kuusisto (2015) who added detailed questions to the CIS 2010 survey. Specifically, they asked firms to report on the role of end users as a source of new product development projects. Three types of end user involvement were recorded: classical user involvement in new product development (user feedback, need surveys and market studies), co-creation efforts with users (development forums, platforms, and crowdsourcing projects) and the adoption of ‘true’ HHS innovations (commercializing products created and/or modified by users).

Niemi and Kuusisto (2015) found that a significant fraction of firms’ innovation activities were based on the innovations that end users had created or modified. A drawback is that their definition of end users also included businesses, but in a next pilot their questions could be modified to target only HHS innovators.

### **3. Recommendations**

Many consumers innovate and some of their innovations are valuable to others. Diffusion of HHS innovation advances social welfare. In the official statistics, however, HHS innovation is still lacking. Until the actual levels of HHS innovation are made clear it will be difficult to inform innovation policymaking, and also to get a good grasp of innovation levels across countries. Recent studies have shown that HHS can be measured. Two recommendations are formulated:

- Expand the measurement of HHS innovation to official surveys. The obvious next step would be to find one or few governments or national statistical offices willing to pilot with HHS innovation questions in a social survey. A related challenge would be to draft a manual, comparable to the Oslo and Frascati Manuals, to guide the development of official HHS statistics.
- Modify existing firm innovation statistics to better reflect if firms absorb, and what they do to influence HHS innovation. For this purpose the initial work done in Finland can be developed further.

I hope that many will follow in pursuing these important challenges.

**Appendix: survey script**

De Jong (2016) provides a ready-to-go survey script optimized for computer assisted telephone interviewing. In overview, the script provides data on the following indicators:

Table A1. Indicators for the incidence and nature of consumer innovation

| <i>Indicator</i>  | <i>Description</i>   | <i>Values</i>        |
|---|--|----------------------|
| <i>(based on part A: screening of consumer innovators)</i>  |  |                      |
| Innovator   | Respondent created an innovation in past three years                 | 0 (no); 1 (yes)      |
| Innovation object   | Innovation was concerned with...                                     |                      |
|   | ...computer software   | 0 (no); 1 (yes)      |
|   | ...household fixtures or furnishing                                  | 0 (no); 1 (yes)      |
|   | ...transport or vehicles   | 0 (no); 1 (yes)      |
|   | ...tools or equipment  | 0 (no); 1 (yes)      |
|   | ...sports, hobby or entertainment                                    | 0 (no); 1 (yes)      |
|   | ...children or education   | 0 (no); 1 (yes)      |
|   | ...help, care or medical products                                    | 0 (no); 1 (yes)      |
|   | ...other products or applications                                    | 0 (no); 1 (yes)      |
| <i>(based on part B: innovation and diffusion variables related to specific innovation cases)</i> |  |                      |
| Motives   | Innovation was created for...  |                      |
|   | ...personal need   | 0-100 points         |
|   | ...to sell or make money   | 0-100 points         |
|   | ...to learn or develop own skills                                    | 0-100 points         |
|   | ...to help other people  | 0-100 points         |
|   | ...the fun of doing it   | 0-100 points         |
| Collaboration   | Innovation was developed in collaboration with others                | 0 (no); 1 (yes)      |
|   | Average number of collaborators                                      | No. of collaborators |
| Investment  | Estimated time investment to develop the innovation                  | No. of person-days   |
|   | Estimated money investment to develop the innovation                 | Amount of money      |
| Protection  | Innovation was protected with any intellectual property right        | 0 (no); 1 (yes)      |
| Revealing   | Respondent willing to freely reveal the innovation...                |                      |
|   | ...to all  | 0 (no); 1 (yes)      |
|   | ...selectively   | 0 (no); 1 (yes)      |
|   | Respondent willing to reveal for compensation...                     |                      |
|   | ...to all  | 0 (no); 1 (yes)      |
|   | ...selectively   | 0 (no); 1 (yes)      |
|   | Respondent employed activities to inform others about the innovation | 0 (no); 1 (yes)      |
| Diffusion   | Innovation commercialized via new venture creation                   | 0 (no); 1 (yes)      |
|   | Innovation transferred to commercial producer                        | 0 (no); 1 (yes)      |
|   | Innovation adopted by others via peer-to-peer sharing                | 0 (no); 1 (yes)      |
|   | No diffusion of the innovation                                       | 0 (no); 1 (yes)      |
| Diffusion intentions  | Respondent has intentions to...                                      |                      |
|   | ...commercialize the innovation via new venture creation             | 0 (no); 1 (yes)      |
|   | ...transfer the innovation to a commercial producer                  | 0 (no); 1 (yes)      |
|   | ...have others adopt the innovation via peer-to-peer sharing         | 0 (no); 1 (yes)      |
|   | ...not diffuse the innovation  | 0 (no); 1 (yes)      |

(Step I)

**A01a.** In your leisure time, do you ever tinker with machines, cars, computers or any other devices, or do you ever program software? 1: yes, 2: no

**A01b.** Do you ever spend your leisure time on inventions or developing new products, applications or concepts? 1: yes, 2: no

*If A01a > 2 and A01b > 2 Go to End*

(Steps II-VI for 'computer software')

My next questions relate to any creative activities in your leisure time. You may have created any products or applications for personal use, to help other people, to learn or just for fun. I will provide some examples.

**A02.** First, creating computer software by programming original code. In the past three years, did you ever use your leisure time to create your own computer software? 1: yes 2: no

*if A02>1 Go to A12*

**A03.** Did you do this primarily for your employer or business? 1: yes 2: no

*if A03=1 Go to A12*

**A04.** At the time you developed it, could you have bought ready-made similar software on the market? 1: yes 2: no

*if A04=1 Go to A12*

**A05.** Did you primarily create it to sell, to use yourself, or for some other reason? 1: to sell 2: to use myself 3: other, please specify.....

*If A05=1 Go to A12*

**A06a.** What kind of software did you create? [open]

**A06b.** What was new about this software? [open]

(Steps II-VI for other cues)

**A12.** The second example is household fixtures and furnishing, such as kitchen- and cookware, cleaning devices, lighting, furniture, and more. In the past three years, did you ever use your leisure time to create your own household fixtures or furnishing? 1: yes 2: no

**A22.** Next, you may have developed transport or vehicle-related products, such as cars, bicycles, scooters or anything related. In the past three years, did you ever use your leisure time to create your own transport or vehicle-related products or parts? 1: yes 2: no

**A32.** Tools and equipment, such as utensils, molds, gardening tools, mechanical or electrical devices, and so on. In the past three years, did you ever use your leisure time to create your own tools or equipment? 1: yes 2: no

**A42.** Sports-, hobby- and entertainment products, such as sports devices or games. In the past three years, did you ever use your leisure time to create your own sports-, hobby- or entertainment products? 1: yes 2: no

**A52.** Children- and education-related products, such as toys and tutorials. In the past three years, did you ever use your leisure time to create your own children- or education-related products? 1: yes 2: no

**A62.** Help-, care- or medical-related products. In the past three years, did you ever use your leisure time to create your own help-, care- or medical-related products? 1: yes 2: no

**A72.** Finally, in the past three years, did you ever use your leisure time to create any other products or applications? 1: yes 2: no

(follow-up questions and routing A13-A16b, A23-A26b, etc. see A03-A06b)

*If number of valid innovations (A05, A15, ..., A75 > 1) = 0 Go to End*

*If number of valid innovation = 1 Go to B01*

**A99.** You just mentioned a number of creations. Which one do you consider most significant? 1: computer software 2: household of furnishing product 3: transport or vehicle-related product 4: tool or piece of equipment 5: sports-, hobby- or entertainment product 6: children- or education-related product 7: help-, care- or medical-related product 8: other product or application

My next questions are concerned with this specific ... that you created. I will refer to it as the 'innovation'.

**B01.** Why did you develop this innovation? I will give you a list of reasons. Please indicate their importance by assigning zero to 100 points. **B01a:** I personally needed it ...points **B01b:** I wanted to sell it/make money ...points **B01c:** I wanted to learn/develop my skills ...points **B01d:** I was helping other people ...points **B01e:** I did it for the fun of doing it ...points

**B02a.** Did you work with other people to develop this innovation? 1: yes 2: no

*If B02a = 2 Go to B03*

**B02b.** How many others contributed to developing this innovation? ...persons

**B03.** Can you estimate how much time you invested developing this specific innovation?

...hours/days/weeks during ...days/weeks/months

**B04a.** Did you spend any money on this innovation? 1: yes 2: no

*If B04a=2 Go to B05*

**B04b.** Can you estimate how much? ....Euros

**B05.** Did you use any methods to protect this innovation? (For example patents, trade marks, copyrights, confidentiality agreements) 1: yes 2: no

**B06.** Suppose that other people would be interested, would you be willing to FREELY share what you know about your innovation? 1: yes, with anyone 2: yes, but only selectively 3: no

**B07.** Suppose that other people would offer some kind of COMPENSATION, would you be willing to share your innovation? 1: yes, with anyone 2: yes, but only selectively 3: no

**B08.** Did you do anything to inform other people or businesses about your innovation? (For example: Showing it off, communicating about it, posting its design on the Web) 1: yes 2: no

**B09a.** To the best of your knowledge, have any other people adopted your innovation for personal use? 1: yes 2: no

*If B09a=1 Go to B10a*

**B09b.** Do you intend to contact other people who may adopt your innovation for personal use? 1: yes 2: no

**B10a.** Do you, alone or with others, currently own a business you help manage, or are you self-employed? 1: yes 2: no

*If B10a=2 Go to B11a*

**B10b.** Did you commercialize your innovation via your business? Or do you intend to do this? 1: yes, I commercialized it 2: yes, I intend to do so 3: no

*Go to B12*

**B11a.** Are you currently, alone or with others, trying to start a new business? 1: yes 2: no

*If B11a=2 Go to B12*



**B11b.** Do you intend to commercialize your innovation with this start-up? 1: yes 2: no

**B12a.** Finally, commercial businesses like your employer or any other organization may be interested in your innovation. Did any commercial business adopt your innovation for general sale? 1: yes 2: no

*If B12a=1 Go to End*

**B12b.** Do you intend to contact commercial businesses to adopt your innovation for general sale? 1: yes 2:

no

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