



Defining and measuring innovation in all sectors of the economy

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ABSTRACT

This paper combines general definitions of innovation applicable in all economic sectors with a systems approach, to develop a conceptual framework for the statistical measurement of innovation. The resulting indicators can be used for monitoring and evaluation of innovation policies that have been implemented, as well as for international comparisons. The extension of harmonised innovation measurement to all economic sectors has implications for innovation research and for policy learning.

1. Introduction

“Innovation drives growth and helps address social challenges” (OECD, 2010a). Innovation mitigates climate change, advances sustainable development, and promotes social cohesion. To support these claims, to inform policy development, and to monitor and evaluate implemented policy, innovation must be measured. For innovation to be measured, it must be defined.

For the last twenty-five years, the Oslo Manual (OECD/Eurostat, 2005) has provided definitions of innovation, but only for use in statistical measurement in the business sector. There have been innovation surveys in the public sector and the households sector but there is no international standard providing definitions that apply in these sectors. This is a significant gap which prevents the analysis and understanding of innovation in the whole economy and how innovation in one sector is influenced by activities in others.

To address this gap, a systems approach is used for classification and as a basis for the construction of a conceptual framework which could lead to a theoretical framework. The definitions of the economic sectors used in the System of National Accounts 2008 Manual (EC et al., 2009) are adopted and the present definition of innovation used in the business sector is reviewed, along with work on measuring innovation in other sectors. This leads to the introduction of a general definition of

innovation, applicable in all sectors.

The benefit of using a general definition of innovation is that innovation can be measured in a consistent way in all sectors and new indicators developed that describe the interactions between actors in sectors and between sectors. These indicators can be used to inform policy development and for monitoring and evaluation of existing policy. This approach to a system wide understanding of innovation is the principal contribution of the general definition.

2. Building a conceptual framework

The characteristics that are present in the existing definition of innovation that are used in the general definition are identified, the sector definitions and a systems approach are introduced.

2.1. The current definition of innovation

The definition used since 2005 for the statistical measurement of innovation in the business sector consists of paragraphs 146 and 150 of the Oslo Manual (OECD/Eurostat, 2005).

146. An *innovation* is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices,

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workplace organization or external relations.

150. A common feature of an innovation is that it must have been *implemented*. A new or improved product is implemented when it is introduced on the market. New processes, marketing methods or organizational methods are implemented when they are brought into actual use in the firm's operations.

The definition deals with product, process and two methods, marketing and organisation.

Product and process innovation are required to be 'new or significantly improved' while the two methods are required to be 'new'. In an innovation survey, the state of the product, process or methods is determined by a survey respondent. In addition to being 'new or significantly improved' a product has to be 'introduced on the market' and a process or method has to be 'brought into actual use in the firm's operation'. The innovation takes place the moment the two conditions have been met.

The Oslo Manual is partially implemented by the Community Innovation Survey (CIS) of the European Union (EU)¹ and the survey is conducted every two years with core questions and a module of current policy interest which changes with each survey (Arundel and Smith, 2013). In this, and similar innovation surveys around the world, a definition of innovation for measurement purposes is essential. It makes possible comparison of innovation overtime and across jurisdictions.

2.2. Economic sectors

The paper is about measuring innovation in all economic sectors and the implications of doing that. The sector definitions are taken from the System of National Accounts (SNA) 2008 Manual (EC et al., 2009).²

According to SNA 2008 (EC et al., 2009, para. 4.24) "All residential institutional units are allocated to one and only one of the following five institutional sectors:

- The non-financial corporations sector;
- The financial corporations sector;
- The general government sector;
- The non-profit institutions serving households sector;
- The households sector"

In this and earlier papers (Gault, 2015, 2016) the non-financial and the financial corporations sector are combined to form the business sector³ and when the public sector is discussed it is the general government sector combined with the aggregate of public corporations (EC et al., 2009, para 22.41). The "institutional unit" referred to in the definition is "an economic entity that is capable, in its own right, of owning assets, incurring liabilities and engaging in economic activities and in transactions with other entities" (EC et al., 2009, para. 4.2). There are two classes of institutional units, persons or groups of persons in the form of households, and legal or social entities. In the business sector, the institutional unit is the firm.

The SNA 2008 makes a key distinction between the business sector, as just defined, and the general government sector as follows: "Fundamental to the distinction between corporations and government is the basis on which production is undertaken. Corporations produce for the market and aim to sell their products at economically significant prices. Prices are said to be economically significant if they have a significant effect on the amount that producers are willing to supply, and the amounts purchasers wish to buy" (EC et al., 2009, para. 4.18). Economically significant prices will recur in the discussion of innovation in the business sector. 'Products' in the SNA "are goods and services

(including knowledge-capturing products) that result from the process of production". This definition (EC et al., 2009, para. 6.14) is used in the Oslo Manual and in this paper.

The relative magnitude of economic activity in the sectors varies with the stage of development of the country. Developing countries tend to have a smaller business sector than developed ones and larger public sectors. In developed countries the contribution of the NPISH sector to GDP is less than 2%. For the households sector, actual individual consumption can be used to gauge its weight and 70% of GDP is not uncommon. In terms of the measurement of innovation, the business sector has been studied for over twenty-five years and studies of innovation in the public sector are emerging. The NPISH sector is less well studied but it includes organisations such as grant making and giving services and family services (Statistics Canada, 2009) which can influence innovation activities in other sectors. This makes the NPISH sector a key element in a systems approach to innovation measurement and it can be surveyed in the same way as the business or the public sector. In the households sector, von Hippel (2017, p.21) has reported on the percentage of consumers in the population aged 18 or over for the UK, US, Japan, Finland and Canada and finds that between 4 and 6 percent develop products for their own use.⁴ Of these populations about 1% make the resulting knowledge available to potential users. This is a significant number with economic and social implications for an innovation system.

2.3. A systems approach

A system consists of actors, or economic agents, engaged in activities, having linkages with other actors. The activities and linkages lead to short term outcomes and longer-term impacts. The system is bounded, which means that there are boundary or framework conditions which influence the activities of the actors and what flows through the linkages.

When a systems approach is applied to innovation,⁵ the actors are firms, public institutions, non-profit institutions serving households, and households (including individuals). The innovation activities include, but are not limited to, in-house and external research and development (R&D), capital expenditure, human resource development, design and market development. The linkages are any interaction between actors such as grants, contracts, use of intellectual property instruments, hiring human resources and many others. Examples of framework conditions are the rules governing incorporation of a firm, bankruptcy, health and safety in the workplace, basic wages, approval of credentials, tax legislation, intellectual property law, trade rules and culture.

The systems approach for the description and analysis of innovation is a basic instrument⁶ which can be applied to national, regional, or sectoral systems of innovation. It is used in this paper for classification purposes and as a basis for a conceptual framework discussed in Section 3.2.

3. A general definition and why it is needed

3.1. A general definition

In earlier work (Gault, 2012), a proposal was made to change 'introduced on the market' for product innovation in the Oslo Manual definition to 'made available to potential users'. The objective at the time was to make the definition applicable to the households sector as well as to the business sector. While 'potential users' was broader than

¹ See <http://ec.europa.eu/eurostat/web/microdata/community-innovation-survey>.

² Building the System of National Accounts – basic concepts (Eurostat, 2017) provides a good overview of the SNA.

³ In this paper and the Oslo Manual, SNA sectors are used. The Frascati Manual, that deals with R&D, uses a Higher Education sector, not found in the SNA (OECD, 2015a).

⁴ There was also a survey done in South Korea with a result of 1.5%. This is discussed in von Hippel (2017).

⁵ See Edquist (2005) and Edquist (1997, p.43) for descriptions of innovation systems.

⁶ See Forrester (1971, 1982), Simon (1996) and von Bertalanffy (1968) for applications of system thinking.

‘on the market’ both conveyed a potential transfer from the boundary of the institutional unit (firm or household) to a user. The change also opened up the possibility of firms innovating by making free products available to potential users, in addition to introducing products to the market at market prices (Gault, 2010).

In later work (Gault, 2015, 2016) the process or method was combined into a process with three components, production and delivery, organisational change, and market/communication development. The process was required to be “brought into actual use in the operation of the institutional unit, including the making of product available to potential users”.

The proposed general definition is the following.

An *innovation* is the implementation of a new or significantly changed product or process. A product is a good or a service. Process includes production or delivery, organisation and marketing processes.

A new or significantly changed product is *implemented* when it is made available to potential users. New or significantly changed processes are implemented when they are brought into actual use in the operation of the institutional unit, including the making of product available to potential users.

The general definitions of the four types of innovation are discussed in Gault (2015, 2016) and are presented here for completeness.

A *product innovation* is a product, made available to potential users, that is new or significantly changed with respect to its characteristics or intended uses.

A *production or delivery innovation* is the implementation of a new or significantly changed production or delivery process. This includes significant changes in inputs, infrastructure within the institutional unit, and techniques.

An *organisational innovation* is the implementation of a new or significantly changed organisational method in the business practice, workplace organisation or external relations of the institutional unit.

A *marketing/communication innovation* is the implementation of a new or significantly changed method of promoting products of the institutional unit.

3.2. Why the general definitions are needed

3.2.1. International standards and discourse

The definitions presented above apply to all of the economic sectors in the SNA and are intended to lead to a discussion among statisticians and policy developers with interest in innovation in each sector and the whole economy. The objective of such discussion would be the incorporation of general definitions in international standards in the form of manuals for the collection and interpretation of innovation data in each sector providing support for the production of official statistics on innovation in each sector, just as the Oslo Manual provides guidance for the business sector. With common definitions there would be a standard approach, and a common language based on that used in the SNA.

3.2.2. Classification and theory

An innovation system which includes all economic sectors provides a means of classifying information about the actors (institutional units, firms in the case of the business sector), the innovation activities in which they engage (see the Oslo Manual for examples), linkages of the actors within sectors and across sector boundaries, leading to short term outcomes (e.g. jobs and growth) and longer-term impacts.

Measuring innovation in the business sector and the engagement of the firm in innovation activities, of which R&D is one, shows that more firms innovate than do R&D. That raises a policy question about promoting innovation in firms that do not perform R&D.⁷ The CIS measures sources of ideas for innovation and sources of collaborators with ‘clients or customers’ ranked near or at the top and universities and

governments lower down the ranking.

While an innovation system view of the economy provides a conceptual framework for statistical measurement and analysis in all economic sectors it does not constitute a theory of innovation. The quest for a theory has been ongoing for some time as illustrated by a conclusion from a US National Research Council (1997) workshop: “no theory adequately describes and explains private sector innovation processes, how and why they are changing, and the implications of the changes for the performance of industry and the national economy”. The question of theory⁸ or conceptual framework has been addressed by Lundvall in a postscript to the reprinting of his 1992 book (Lundvall, 2010, p.329) where he makes the point that “innovation system is a concept rather than a ‘general theory’” However, he does argue that an innovation system “does what theory is supposed to do: it helps to organise and focus the analysis, it helps to foresee what is going to happen, it helps to explain what has happened and it helps to give a basis for rational action”. In this sense, an innovation system where the collection and analysis of data related to innovation is guided by the same definition of innovation in all economic sectors is an important step towards a theoretical framework.

3.3. New indicators and coherent analysis

If public sector institutions and households (including individuals) are surveyed, using the same definitions for innovation, there will be consistent⁹ information, and indicators, about the propensity to innovate, sources of information and collaboration for innovation and expenditure on innovation activities.¹⁰ The linkages that cross sectoral boundaries will provide information on knowledge flows and human resource movement that could be the subject of policy intervention with the indicators used to monitor implemented policy. The key to all of this is a consistent approach in all sectors.

3.4. Next steps

The general definitions in Section 3.1 are a proof of concept showing that the same definitions can be applied in all economic sectors. However, it is a long way from proof of concept to internationally agreed manuals like the Oslo Manual. Part of the objective of this paper is to move the discussion about the need for such manuals out of statistical offices and policy departments and into a wider community of academics, civil society and other users of statistical information about innovation.

In the current situation, the Oslo Manual is managed by delegations to the OECD Working Party of National Experts on Science and Technology Indicators (NESTI), one of which is the European Commission. The delegations include statisticians and policy analysts from the relevant government departments. The hope is that the indicators resulting from the statistical surveys are relevant to policy development, monitoring and evaluation, and to research into the innovation policy process. The statisticians are responsible for ensuring that the measurements are feasible and conform to international standards. The discussion occurs among public servants and some invited experts. Given the importance of innovation and its impact on people there is case for widening the community of discourse.

4. Empirical work in the public and the households sectors

The discussion of general definitions in Gault (2015, 2016) drew upon the definitions of public sector innovation in the MEPIN project

⁸ See also Borrás and Edquist (2016).

⁹ See UN (2013), para. 3.40 on common concepts, definitions and classifications.

¹⁰ OECD (2010b) provides an earlier view of coherent measurement of innovation in different sectors.

⁷ See Table 3 in Boroush and Jankowski, 2016.

and the definitions in the third edition of the Oslo Manual for the business sector (Bloch, 2010a,b; Bugge et al., 2011; Bloch, 2013; Bloch and Bugge, 2013; OECD/Eurostat, 2005). In this section, there is a review of other work in the public and the households sectors and how this work can be accommodated by general definitions of innovation and the various types of innovation.

For the last decade, the taxonomy proposed by Windrum (2008), drawing on Kock and Haukness (2005), has been used to classify public sector innovations, an example of which is found in the Australian Public Service Commission report (APSC, 2011 p.210). The taxonomy follows.

1. Services innovation
2. Service delivery innovation
3. Administrative or organisational innovation
4. Conceptual innovation
5. Policy innovation
6. Systemic innovation

Following Windrum's own comments, classifications 1–3 align directly with those in the Oslo Manual, where they would appear as product innovation, process (production or delivery), and organisational innovation.

The remaining three classifications are examples of 'restricted innovation' discussed in Section 5.2. They are presented here to illustrate how a general definition would deal with them. Windrum describes conceptual innovation as "the development of new world views that challenge assumptions that underpin existing service products, processes and organisational forms", and provides the 'minimalist state' (or minimalist government) as an example of a radical conceptual innovation. The restricted general definition would require that a product or process innovation has, as an outcome, the characteristics of the minimalist state. As more than one sector could be involved, if public services were contracted out, data would have to be collected on linkages between the sectors resulting from the innovation. Subsequent surveys would confirm that the outcome included the characteristics of the 'minimalist state' or not.

'Policy innovation' at the ministerial level comes in two forms (Windrum, 2008): "incremental innovation based on policy learning by government and radical innovation sparked by conceptual innovation." Again, it is a question of measuring the presence of innovation, using the general definitions and a survey instrument and adding, either at the same or a later time, measures of policy innovation – such as learning.

'Systemic innovation' "involves new or improved ways of interacting with other organisations and knowledge bases" (Windrum, 2008). It is here that the linkages that are part of the systems approach, and the capacity to measure flows, become essential. For example, a new procurement process that supported innovation in the business sector could be an innovation made available to potential users. To confirm that it was a systemic innovation, measurement would have to be made in both the public sector and the business sector.

The European Commission (EC, 2011), in the 2010 Innobarometer, has reported measurement of innovation in the public administration. The survey looks at new or significantly improved services delivered in a three year period and notes that the propensity to innovate is dependent on the size of the institutions, a result found also by Earl (2002, 2004). The definition used to support the measurement is very close to that of the Oslo Manual (OECD/Eurostat, 2005) and could be readily accommodated by the general definitions. Similarly, the Nesta pilot survey (Hughes et al., 2011) provides measures of innovation in public sector organisations based on the MEPIN project and the EU Community Innovation Survey (CIS).

Arundel and Huber (2013) discuss the measurement of innovation in the public sector and comment on the absence of an agreed definition of innovation before proposing to use "public sector innovation

involves novelty and the intention of making something better, for instance through new or improved services and processes". This is accommodated by the general definitions, but, in addition, a definition of 'better' would be required.

Then, there is Arundel et al. (2016) where the assertion is made that "there is sufficient evidence, drawn from surveys of innovation in the public sector and cognitive testing interviews with public sector managers, to provide basic recommendations for how to measure innovation in the public sector".

The key point is that the examples of measuring innovation in the public sector can be accommodated by the general definitions proposed in Section 3, ideally supported by statistical registers of public sector institutional units. Survey results and related information appear in the European Public Sector Innovation Scoreboard (EPSIS) (EC, 2013), discussed by Bloch and Bugge (2013). Earlier work appears in the EC Innobarometer 2010 (EC, 2011). At the OECD, there is the Observatory of Public Sector Innovation (OPSI) which collects examples of innovation but does not follow any definition. As well as providing examples of innovation in the public sector through an on-line platform, OPSI is a network of practitioners and a source of guidance based on case studies.¹¹ Both EPSIS and OPSI demonstrate that data on innovation in the public sector and resulting indicators are important and are used for multiple purposes.

Households sector innovation, in some form, has been measured for decades by von Hippel and colleagues and this work is reviewed in von Hippel (2017, 2016, 2007, 2005); von Hippel (1988) and in Harhoff and Lakhani (2016). von Hippel (2017, p.101) shows that innovation in the households sector can include the four types of innovation used in paragraph 146 of the Oslo Manual (OECD/Eurostat, 2005) and also discusses the implementation of an innovation in paragraph 150 from the perspective of free innovation, citing Gault (2012).

For free innovation, the expectation is that households, individuals, and groups will modify goods or services for their own benefit or develop them for their own benefit if the goods or services are not available. To avoid the requirement that product be introduced on the market, Gault (2012) has suggested that 'introduced on the market' be replaced by 'made available to potential users'. This removes the need to sell the good or service at economically significant prices and enables free innovation. For process innovation, the same restrictions apply as in the other SNA sectors.

OECD is initiating a project to examine the measuring of innovation by individuals, stimulated in part by von Hippel (2007, 2016). This is a step towards developing international standards for innovation in the households sector.

As a result of years of substantial work on innovation in the business sector, the public sector and the households sector, there is empirical evidence supporting the use of general definitions to support measurement in all SNA sectors.

5. Policy development, monitoring, evaluation, research and learning

Innovation, to paraphrase the general definitions in Section 3, is about making a new or significantly changed product available to potential users or finding a different way of making it available through the three component processes in Section 3. The question in this section is why the measuring of these activities and the production of indicators for all sectors of the economy is relevant to policy and, if it is, whether there should be international standards (manuals) to guide the measurement.

¹¹ See <https://www.oecd.org/governance/observatory-public-sector-innovation.htm>.

5.1. Policy learning

A key issue in any policy process is learning. The OECD Innovation Strategy 2015 makes the point that:

Policy learning rests on an efficient and well-developed institutional framework, strong capabilities for evaluation and monitoring, applying available good practices, and an efficient and capable government bureaucracy. Incorporating policy monitoring and evaluation at the design stage of policymaking will support evidence-based decision making and accountability and enables policy learning over time, as can experimentation with policy measures at a small scale. Better measurement of innovation outcomes and impacts is essential in this context (OECD, 2015b).

There is also an OECD innovation strategy for the public sector (OECD, 2015c) but there is no equivalent for the households sector.

Policy starts with an objective of government which either becomes legislation or makes use of existing legislation to provide rules pursuant to the legislation to guide the implementation of the policy. As the OECD quotation suggests, building monitoring and evaluation into the design of the policy makes it easier to provide the evidence that the policy has achieved its objectives, or not, leading to policy learning and change in the policy implementation. This requires statistical measurement to show that the innovation has taken place. Later measurement can identify outcomes and impacts.

The resulting statistics can be used to compare the propensity to innovate in sectors, over time, across geography, by industry, by size of the institutional unit, and by other variables of analytical interest. The general definitions, to the extent possible, are not normative. They support the identification of the activity of innovation, but not that it is 'good' or 'bad'.

Not all definitions of innovation are designed for measurement purposes, but they can be used to support discussion of innovation policy. An example, noted in Bloch and Bugge (2013), is Mulgan's definition of innovation in the public sector (Mulgan, 2007), "public sector innovation is about new ideas that work at creating value" followed by a qualification of "ideas". Once the policy objectives are agreed, statistical measurement can follow, but it may require the imposition of restrictions on the definitions.

5.2. Restricted innovation and policy objectives

There is no requirement in the Oslo Manual definition of innovation to address social challenges, to support sustainable development or to promote inclusion. For these restrictions to be added, the population of innovative firms must be reduced to those that demonstrate that they satisfy the restriction. In some cases, statistical measurement must be made some time after the occurrence of the innovation to see whether the innovation has met the requirement (consider inclusive innovation as an example). This introduces the concept of restricted innovation which is an integral part of working with a general definition. A specific example, discussed in Gault (2014), is the Mashelkar (2012) definition of inclusive and sustainable innovation.

Innovation policies and firm strategies may have an intention to promote inclusive green sustainable innovation and institutional units may be influenced by incentives offered to adopt new or significantly changed processes, or to produce new or significantly changed products to achieve this objective. It is not uncommon for innovation surveys to ask respondents about their intentions for the innovations that they are reporting.

However, outcomes and impacts of the activity of innovation require time to happen. This means that there must be measurement following the first measurement of innovation to identify the outcomes, and later, the impacts. This may require follow-up surveys of institutional units that were innovative to see if carbon emissions had indeed been reduced, that minority groups were included in the activity as employees, users or collaborators and that the innovation allowed the

institutional unit to survive, demonstrating that it was sustainable. Social surveys may also be required to demonstrate that the excluded community has, from its perspective, been included as a result of the activity of innovation. Identifying outcomes and longer term impacts, as part of policy monitoring and evaluation is not a simple undertaking that is why the monitoring, evaluation and the supporting measurement should be part of the policy from the beginning. It also demonstrates that the initiator of the policy is conscious of the resulting accountability and of the opportunity for policy learning.

6. Conclusion

The result of implementing the general definitions in all economic sectors would be coherent statistics on innovation activities of institutional units. The statistics could be variables of analytical interest, such as sources of information for innovation, types of collaborator for innovation, geography, industry, size (employment or turnover), or engagement in innovation activities such as capital investment in machinery and equipment, software or R&D or in training and other means of knowledge transfer. Using the same definitions in all sectors would support coherence of data and consistency of analysis.

There have been official statistics on innovation in the business sector for twenty-five years but not for innovation in other economic sectors. This paper addresses that gap by developing a conceptual framework that includes a systems approach to innovation and a general definition that is applicable in all economic sectors. The conceptual framework provides a basis for consistent analysis of innovation in all sectors which includes the influence of innovation in one sector on actors and activities in other sectors.

The analysis of the system, rather than activities in a single sector, can provide a basis for the development of more comprehensive policy and the resulting indicators can be used to monitor and evaluate innovation policy when it has been implemented. The objective of innovation policy is not just increasing the number of institutional units that innovate, but supporting social and economic outcomes, such as jobs and economic growth. To measure such outcomes, the definition of innovation has to be restricted so that the subset of institutional units that satisfy the restriction can be identified. In cases where the outcomes take time to appear, additional surveys are required which introduce a time difference from the innovation to the desired outcome such as inclusiveness, sustainability and change in the state of the poor. The statistical measurements then support policy development, monitoring and evaluation of implemented policy, and policy learning resulting from the monitoring and evaluation.

The general definitions, and the words used to construct them, are provided as a basis for discussion. Historically, definitions of innovation in the business sector have resulted from deliberation of the delegates to the OECD Working Party of National Experts on Science and Technology Indicators (NESTI), based on empirical evidence leading to a consensus on which of the findings are sufficiently robust to be included in manual. This paper is a contribution to that process. It is also intended to encourage engagement in the subject by statisticians and the broader academic community.

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