Office of the Information Commissioner
Queensland

the Australia and New Zealand
School of Government

Transparency and Productivity

The effects of open and transparent Public Sector Information management practices on costs and productivity

Occasional Paper No. 2

John Houghton and Nicholas Gruen

The Queensland Office of the Information Commissioner and the Australia and New Zealand School of Government are collaborating on a partnership to identify the ways in which transparency can augment quality public administration. The Occasional Paper series is part of the partnership program.

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About the Australia and New Zealand School of Government

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(2) To produce a high-quality teaching case study collection available for training and executive development (currently around 150 cases are available for use); and
(3) To undertake an active research program investigating topics of immediate relevance to public sector managers.

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About the Queensland Office of the Information Commissioner

The Information Commissioner is appointed by Governor in Council and reports to the Legal Affairs and Community Safety Committee of the Queensland Legislative Assembly. The aim of the Office of the Information Commissioner is to be Queensland's independent, influential and practical authority on information rights and responsibilities. Its statutory functions are designed to foster an open culture in the public sector.

The key services of the Office are:

- Foster improvements in the quality of practice in right to information and information privacy in Queensland public sector agencies;
- Promote the principles and practices of right to information and information privacy in the community and within government;
- Independent, timely and fair review of decisions made under right to information and information privacy legislation;
- Independent and timely privacy complaint resolution service.

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About the series

The Queensland Office of the Information Commissioner and the Australia and New Zealand School of Government are collaborating on a partnership that draws together a broad network of policy-makers, practitioners and leading academics.

The partnership is designed to build awareness of the impact of transparency and its utility as a public sector management tool. Drawing the connections between the new approach to information management brought about by the right to information reforms, research and practice we hope that the series will foster a more open public sector culture.

The Occasional Papers explore the available evidence base, point to areas that would benefit from more research and study, draw new insights and begin to define what transparency looks like as a tool. They also provide practical tips about when, where and how transparency can best be applied to current public administration challenges.

Written by academics, public servants or other experts, the papers bring together research and practice. All the papers have been critically appraised by a group formed for that purpose. The authors of the papers were included. Particular acknowledgement for their contributions go to Professor John Wanna, Professor Michael Di Francesco, and Office of the Information Commissioner staff Ms Rachael Rangihaeata, Mr Justin Toohey, and Mr Steve Haigh, who kept this project on track with great care and skill.

We trust that you find the Occasional Papers stimulating and thought provoking. All papers in the series are published on the ANZSOG and OIC websites.

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Information Commissioner's foreword

This paper is part of a series examining the impact of transparency and how it can be used as a strategic management tool. The utility of transparency has not been clearly articulated as part of the public sector manager's tool-kit. This is hardly surprising when confidentiality and anonymity have been ingrained in the public service culture. This series is aimed at objectively evaluating the available evidence as to whether openness can be a far more powerful tool than secrecy in serving the public interest. Where transparency can be used as a tool, the series also identifies the practical application and the lessons learnt so far. For the purpose of this paper transparency consists of openness, volunteering information, publication of performance data and benchmarks; use of websites to inform and allow public fora/dialogues/blogs.

One of the objectives of Freedom of Information legislation was to 'democratise' information held by government. FOI was an end in itself. The effective exercise of the entitlement to vote is dependent upon there being a free flow of information to the electorate about government decisions and activity. The Independent FOI Review Panel, chaired by Dr David Solomon found that a major barrier to effective FOI implementation was the public sector's culture of secrecy. Recent national and international FOI reforms are designed to shift the public sector information management culture from 'closed' to 'open'. Public sector information is now commonly legislated as open to the public unless contrary to the public interest.

Public sector information is increasingly recognised in legislation to be a community asset or national resource. Public sector information can also be a strategic asset. Public sector managers are charged with achieving important economic, social and environmental goals effectively, efficiently, economically and ethically. This series of papers is designed to show how transparency can be used as a means to the end: effective policy implementation while minimising costs to the taxpayer. In the series there are papers that show the impact of transparency in improving public sector performance, productivity, implementation, integrity, and innovation.

This paper evaluates the impact of transparency on productivity. The operational savings for public sector data holders in reduced processing costs is clear. Improved methodologies also now allow combined measurement of both the direct and indirect benefits of open access to publicly owned or funded data. Models based on proprietary ownership, restrictive licensing and cost recovery cost more to administer and inhibit the value of public sector data assets. Instead, models based on open access save money, maximise reuse, improve productivity and reduce red tape. The Australian Bureau of Statistics saved $1 million in data processing, delivered a further $5 million of savings to data users while contributing $25 million to the economy. The growing body of evidence is clear – transparency can be a key tool for driving productivity improvements.

In 2012 it is sometimes asked, "What is the next big thing in public administration?" I hope the answer will be "Transparency".

Julie Kinross
Information Commissioner (Qld)

Executive summary

This paper presents a critical review of recent and current studies focusing on the value and productivity impacts of open and transparent access to public sector information (PSI) in Australia and overseas. The aim is to establish the current state of evidence concerning the effects of open and transparent PSI management practices on productivity, highlighting those practices that are shown to improve productivity.

Public sector information (PSI)

It is generally accepted that the most economically significant forms of PSI include geospatial, meteorological, hydrological and environmental information, economic and social statistics, as they provide the greatest opportunities for commercial use and re-use and provide fundamental information in support of private and public sector decision making. Nevertheless, there is potential for a wide variety of PSI to affect economic and social outcomes and to improve the transparency and efficiency of government.

Of course, there are limitations. While policy guidelines at the federal and state levels encourage open access to information as the default position, they also note areas that might be exempt (e.g. for reasons of privacy, confidentiality, official secrecy, etc.) and provide guidance under such circumstances.[1] Agencies should consult the relevant guidelines for their jurisdiction.

What is productivity?

Productivity is a measure of efficiency, and is often expressed as the ratio of output to what is input to produce it. Hence productivity improvement can be realised through producing more output with the same input, by producing the same output with less input, or both.

Productivity can be internal to an organization or agency (e.g. where a public sector agency provides services more efficiently), or it can be external (e.g. where an agency provides services so that they are easier to access and use, and/or have greater impact in use).

Transparency, access and productivity

Transparency and open access to PSI can affect efficiency and productivity in many ways. These include:

- Direct efficiency and productivity impacts for government agencies, through activity cost savings, activity streamlining, enhancing service delivery, improving the services delivered, etc.;

[1] See, for example, http://www.oaic.gov.au/publications/guidelines/part13_ips.html

- Efficiency and productivity impacts for users of government information and services, through accession and activity cost savings, simplified and/or improved services, integration of services, etc.;
- Wider impacts for users, through enabling the development of innovative products and services drawing on openly accessible PSI, thereby generating new revenue streams and business opportunities; and
- Wider impacts for the consumers of these new products and services, through cost savings, enhanced product and services availability, etc.

This review focuses on studies that have attempted to quantify these impacts, exploring the costs and productivity impacts of more open and transparent access to a wide range of PSI.

Evidence of the links between transparency, access and productivity

There are many case study examples and more formal measurement frameworks that demonstrate a link between transparent and open PSI management practices and productivity. We look at studies that examine agency costs, cost savings and benefits, and impacts on information users and the wider economy.

Many of the case studies examined in this paper delivered considerable productivity benefits. For example:

- In the first six months of operation the *Victorian Water Resources Data Warehouse* achieved a decrease in implied costs per download from $750.00 to $1.45 within six months of automating data request processing.
- The Australian Bureau of Statistics estimated savings of $1 million per annum in handling, enquiry and transaction costs circa 2005-06 as a result of making publications and data free online and adopting creative commons licensing. Data users were estimated to have saved around $300,000 per annum in transaction costs in addition to the $4.7 million saved from not paying access and licensing costs.
- The Catalan Spatial Data Infrastructure project identified internal efficiency benefits of over 500 hours per month. Using an hourly rate of €30 for technical staff in local government, these savings exceeded €2.6 million per year.
- Bristol City Council's open data catalogue identified benefits in reduced transaction costs through online service delivery. The cost of a typical transaction reduced by up to 15 times – from GBP 15 if answered in person, or GBP 12 if answered by telephone to GBP 1 per internet query.
- Geoscience Australia's provision of geospatial products resulted in an estimated increase in GDP of $1.8 billion in 2010.

We find that there are one-off costs for agencies during the transition (e.g. in establishing new open data systems and dismantling old systems for dissemination) and there may also be a recurring loss of revenue from sales (e.g. in no longer seeking cost recovery). Nevertheless, agencies and their information users also stand to save recurring costs (e.g. the transaction costs involved in cost recovery and licensing activities), and can free up staff and other resources from

these activities. There are also wider economic benefits (e.g. through greater use of quality information and the development of innovative PSI-based products and services). By making PSI freely and openly available for use, governments encourage engagement and participation and realise increased return on investment in PSI.

Mechanisms for realising productivity gains

In addition to these direct agency and user costs and cost savings, there are a number of possible efficiency and productivity impacts arising from free access and standardised licensing and data formats.

For agencies, potential efficiency and productivity impacts include:

- An increase in the level of use and uses per funding dollar;
- Enhanced performance against key performance indicators;
- Enhanced agency profile from greater use and exposure, which can result in greater appreciation and central funding, and/or bring greater demand for enhanced products and services, thereby increasing revenue; and
- Greater focus on core business activities (*e.g.* reduced shopfront and e-commerce operations).

For users, potential efficiency and productivity impacts include:

- The purchase price savings and savings in handling and transaction costs noted above, enabling cost reduction and efficiency gains;
- Greater licensing certainty/reduced uncertainty and freedom to use leading to more predicable investment decisions, as well as savings in licensing enquiry efforts; and
- Use of better/fuller/more detailed data, rather than settling for a lesser/cheaper substitute.

The key mechanisms for realising productivity gains are clear:

- PSI should be made available free or at the marginal cost of distribution (i.e. effectively free online), if at all possible;
- It should be covered by clear and simple licensing that is standardised and readily understood by existing and potential users, and be machine readable (e.g. creative commons licensing);
- There should be minimal restrictions on use, non-discrimination regarding users and uses (e.g. there is no reason to restrict use to non-commercial uses);
- The information should be easily discoverable, and attention should be paid to quality metadata, ensuring the information is easy to find in search engines;
- It is important to engage with potential users through promotional activities and awareness raising (e.g. competitions, hack and mash-up days, etc.); and
- It is important to deal with concerns and confront barriers to openness and transparency.

The report of the Government 2.0 Taskforce outlines the principles and there are a number of guides to publishing PSI that outline the steps to take and issues to consider (e.g. http://webguide.gov.au/web-2-0/publishing-public-sector-information/).

Contents

EXECUTIVE SUMMARY ..... **VII**

CONTENTS ..... **X**

1. INTRODUCTION **1**

2. PUBLIC SECTOR INFORMATION AND CONTENT **2**

3. PRODUCTIVITY AND HOW IT CAN BE MEASURED **5**

4. MECHANISMS BY WHICH PSI ACCESS AND TRANSPARENCY CAN IMPROVE PRODUCTIVITY **6**

5. A REVIEW OF STUDIES LINKING ACCESS AND TRANSPARENCY TO PRODUCTIVITY **9**

5.1 PUBLIC SECTOR INFORMATION 9
5.1.1 Reviews and summaries *9*
5.1.2 National and regional studies of wider economic impacts *10*
5.1.3 Studies of the direct and wider economic impacts of specific forms of PSI *12*
5.1.4 Direct impacts on agencies and users *15*
5.2 THE FINDINGS OF PUBLICLY FUNDED RESEARCH 19
5.2.1 Research publications *20*
5.2.2 Research data *24*

6. CASE STUDY EXAMPLES OF PRODUCTIVITY IMPACTS **27**

7. PRACTICES, MECHANISMS, LESSONS AND TOOLS **32**

8. MEASURING PRODUCTIVITY IMPACTS **35**

8.1 BENCHMARKING AND MEASUREMENT METHODS 36
8.2 RECENT DEVELOPMENTS 37
8.3 AN AUSTRALIAN EXAMPLE 38

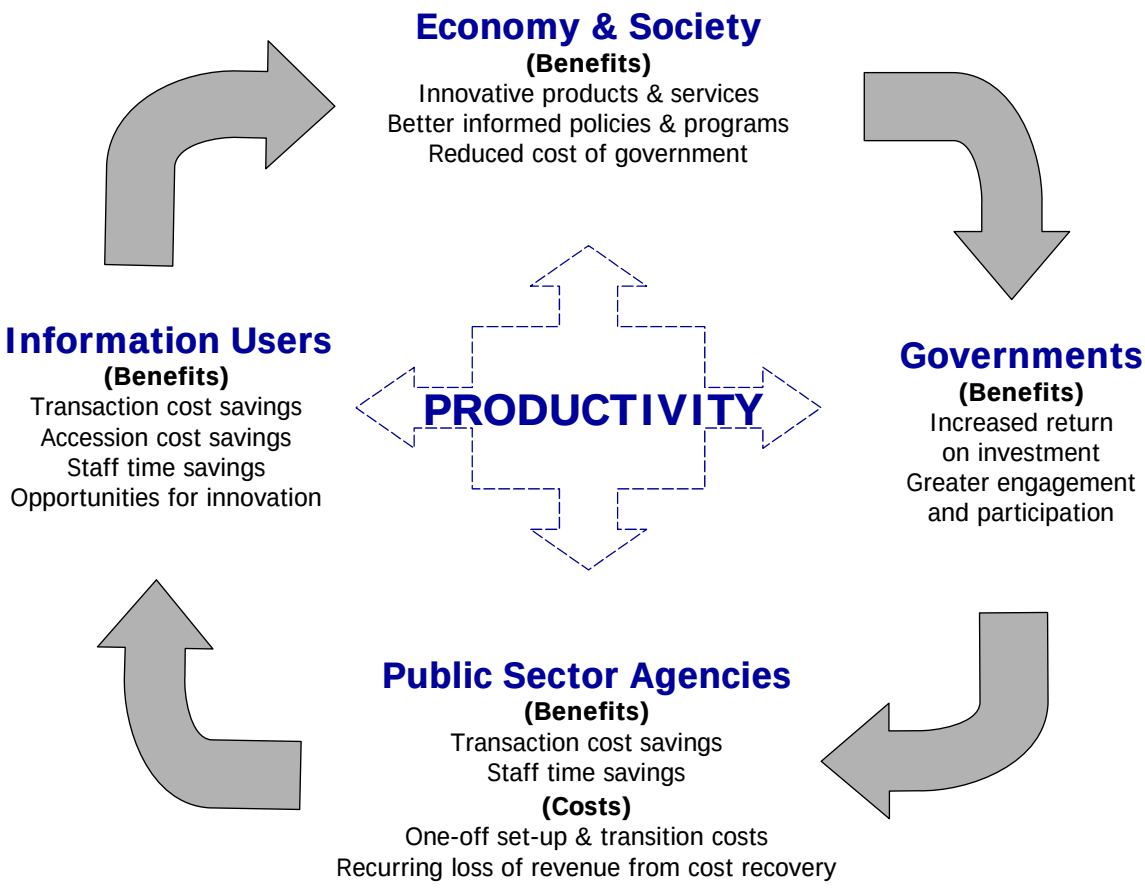
9. CONCLUSIONS **39**

1. Introduction

This paper presents a critical review of recent and current studies focusing on the value and productivity impacts of open and transparent access to public sector information (PSI) in Australia and overseas. The aim is to establish the current state of evidence concerning the effects of open and transparent PSI management practices on productivity, highlighting those practices that are shown to improve productivity.

Our review highlights findings, issues, themes, lessons and challenges, and it identifies case studies where increased access and transparency has increased productivity, and highlights the mechanisms through which this has occurred. However, being limited to studies using more or less robust methods to estimate the economic impacts of open and transparent PSI management practices, our review is by no means comprehensive. For example, it does not cover the vast anecdotal evidence, nor does it cover the literature on policy transparency and transparent government.

Figure 1: Transparency, access and productivity



Source: Authors' analysis.

We find that there are one-off costs for agencies during the transition (e.g. in establishing new open data systems and dismantling old systems for dissemination) and there may also be a recurring loss of revenue from sales (e.g. in no longer seeking cost recovery). Nevertheless, agencies and their information users also stand to save recurring costs (e.g. the transaction costs involved in cost recovery and licensing activities), and can free up staff and other resources from these activities. There are also wider economic benefits (e.g. through greater use of quality information and the development of innovative PSI-based products and services). By making PSI freely and openly available for use, governments encourage engagement and participation and realise increased return on investment in PSI.

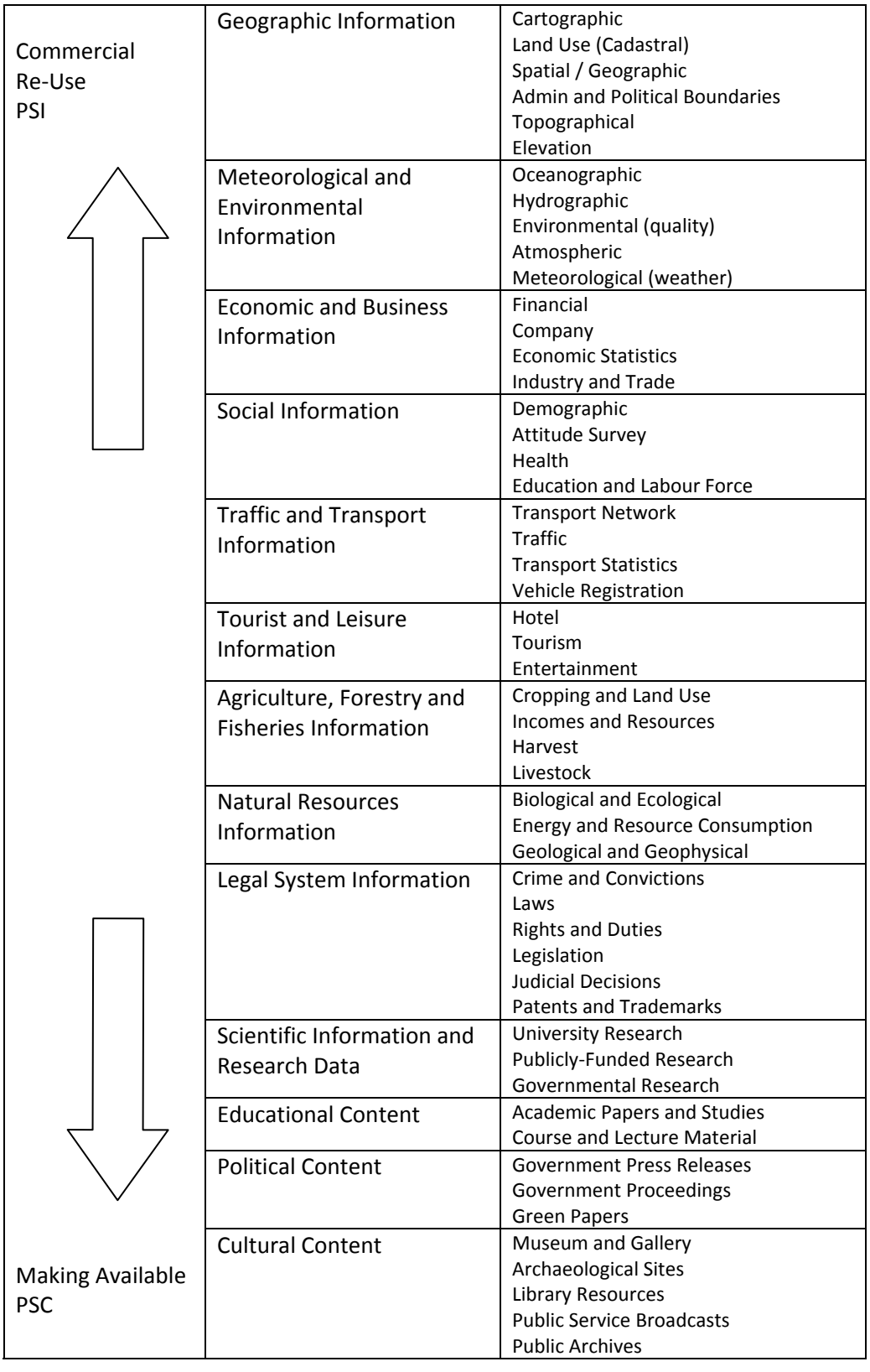
2. Public sector information and content

The OECD (2006) defines Public Sector Information (PSI) as any kind of information that is produced and/or collected by a public body and is part of the institution's mandated role. It is common to differentiate between public sector information (PSI) and public sector content (PSC). The first category comprises the public sector's knowledge, which may be the basis for information-intensive industries that use the raw data to produce sophisticated products. The second refers to cultural, educational and scientific public knowledge, for which wide public diffusion and long-term preservation (e.g. via museums, libraries, schools) are major governmental objectives (Figure 2).[2]

Vollmer (2011) notes that PSI is characterized in different ways and as representing a variety of perspectives. For instance, some view the dissemination and re-use of PSI as a means to increase the transparency and accountability of government. Others view PSI as primarily a means for improving internal government communication and efficiency. Some view PSI as a vehicle for promoting economic activity and innovation. Others are exploring ways for PSI to be used as a means for international diplomacy and global information sharing. Some see PSI as civic capital, working to increase citizen participation in government activities.[3] Hence, there are multiple dimensions linking open and transparent PSI management practices and productivity.

[2] OECD (2006) *Digital Broadband Content: Public Sector Information and Content*, OECD, Paris. Available http://www.oecd.org/document/62/0,3746,en_2649_34223_32160190_1_1_1_1,00.html (April 2011).
[3] Vollmer, T. (2011) *State of Play: Public Sector Information in the United States*, ePSIplatform Topic Report No 25. Available http://epsiplatform.eu/sites/default/files/Topic_Report_no25_State_of_Play_US.pdf

Figure 2: Public Sector Information and Content domains with examples



Geographic Information	Cartographic Land Use (Cadastral) Spatial / Geographic Admin and Political Boundaries Topographical Elevation
Meteorological and Environmental Information	Oceanographic Hydrographic Environmental (quality) Atmospheric Meteorological (weather)
Economic and Business Information	Financial Company Economic Statistics Industry and Trade
Social Information	Demographic Attitude Survey Health Education and Labour Force
Traffic and Transport Information	Transport Network Traffic Transport Statistics Vehicle Registration
Tourist and Leisure Information	Hotel Tourism Entertainment
Agriculture, Forestry and Fisheries Information	Cropping and Land Use Incomes and Resources Harvest Livestock
Natural Resources Information	Biological and Ecological Energy and Resource Consumption Geological and Geophysical
Legal System Information	Crime and Convictions Laws Rights and Duties Legislation Judicial Decisions Patents and Trademarks
Scientific Information and Research Data	University Research Publicly-Funded Research Governmental Research
Educational Content	Academic Papers and Studies Course and Lecture Material
Political Content	Government Press Releases Government Proceedings Green Papers
Cultural Content	Museum and Gallery Archaeological Sites Library Resources Public Service Broadcasts Public Archives

Note: The steady gradation implied by the arrows is schematic and simplified, as on this axis there would be much overlap between categories. For example, it is easy to imagine some geographic information having less potential for commercial re-use than some social information. Source: OECD (2006) *Digital Broadband Content: Public Sector Information and Content*, OECD: Paris.

The Open Data Handbook notes:

In terms of transparency, projects such as the Finnish 'tax tree' and British 'where does my money go' show how your tax money is being spent by the government. And there's the example of how open data saved Canada $3.2 billion in charity tax fraud. Also various websites such as the Danish folketsting.dk track activity in parliament and the law making processes, so you can see what exactly is happening, and which parliamentarians are involved.

Open government data can also help you to make better decisions in your own life, or enable you to be more active in society. A woman in Denmark built findtoilet.dk, which showed all the Danish public toilets, so that people she knew with bladder problems can now trust themselves to go out more again. In the Netherlands a service, vervuilingsalarm.nl, is available which warns you with a message if the air-quality in your vicinity is going to reach a self-defined threshold tomorrow. In New York you can easily find out where you can walk your dog, as well as find other people who use the same parks. Services like 'mapumental' in the UK and 'mapnificent' in Germany allow you to find places to live, taking into account the duration of your commute to work, housing prices, and how beautiful an area is. All these examples use open government data.

Economically, open data is of great importance as well. Several studies have estimated the economic value of open data at several tens of billions of Euros annually in the EU alone. New products and companies are re-using open data. The Danish husetsweb.dk helps you to find ways of improving the energy efficiency of your home, including financial planning and finding builders who can do the work. It is based on re-using cadastral information and information about government subsidies, as well as the local trade register. Google Translate uses the enormous volume of EU documents that appear in all European languages to train the translation algorithms, thus improving its quality of service.

Open data is also of value for government itself. For example, it can increase government efficiency. The Dutch Ministry of Education has published all of their education-related data online for re-use. Since then, the number of questions they receive has dropped, reducing work-load and costs, and the remaining questions are now also easier for civil servants to answer, because it is clear where the relevant data can be found. Open data is also making government more effective, which ultimately also reduces costs. The Dutch department for cultural heritage is actively releasing their data and collaborating with amateur historical societies and groups such as the

Wikimedia Foundation in order to execute their own tasks more effectively. This not only results in improvements to the quality of their data, but will also ultimately make the department smaller.[4]
A similar range of examples of the impacts of opening government data is given in Pollard (2011) under the sub-headings of: democratic engagement (e.g. http://www.theyworkforyou.com/), better services (e.g. http://www.fixmystreet.com/), and the knowledge economy.[5]

It is generally accepted that the most economically significant forms of PSI are geospatial, meteorological, hydrological and environmental information, economic and social statistics, as they provide the greatest opportunities for commercial use and re-use and provide fundamental information in support of private and public sector decision making. Nevertheless, as the quotation from *The Open Data Handbook* (above) demonstrates, there is potential for a wide variety of information and transparent information management practices to affect economic and social outcomes and to improve the transparency and efficiency of government.

However, there are limitations. While policy guidelines at the federal and state levels encourage open access to information as the default position, they also note areas that might be exempt (e.g. for reasons of privacy, confidentiality, official secrecy, etc.) and provide guidance under such circumstances.[6] Agencies should consult the relevant guidelines for their jurisdiction.

3. Productivity and how it can be measured

Productivity is a measure of efficiency, and is often expressed as the ratio of output to what is input to produce it. Hence productivity improvement can be realised through producing more output with the same input, by producing the same output with less input, or both.

Productivity can be internal to an organization or agency (e.g. where a public sector agency provides services more efficiently), or it can be external (e.g. where an agency provides services so that they are easier to access and use and/or have greater impact in use).
Measuring productivity is notoriously difficult for public sector activities. Nevertheless, there are readily measurable indicators of efficiency that can be applied to public sector agencies and the users of their products and services. These include:

- Simple indicative measures of the ratio of output to input (e.g. the number of service enquiries per dollar cost of enquiry support at a constant level of user satisfaction);
- Agency and user activity and transaction costs (e.g. the time and money spent by agencies providing a given service and by users accessing and using it); and
- Wider economic impacts (e.g. the emergence of new value-adding uses of PSI, new businesses and new re-users).

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[4] Available http://opendatahandbook.org/en/
[5] Pollard, P. (2011) *Opening up government data: making the case*, ePSIplatform Topic Report No 26. Available http://epsiplatform.eu/sites/default/files/Topic_Report_No26_Opening_Gov_Data.pdf
[6] See, for example, http://www.oaic.gov.au/publications/guidelines/part13_ips.html

This review focuses on studies that have attempted to quantify these impacts.

4. Mechanisms by which PSI access and transparency can improve productivity

There has been an increasing awareness across governments of the key role that information plays in society both from an economic and social perspective. Promoting the use of PSI is an important element. As Paterson and Nokes (2011) note: by giving the public, developers and business increased access to information, governments can:

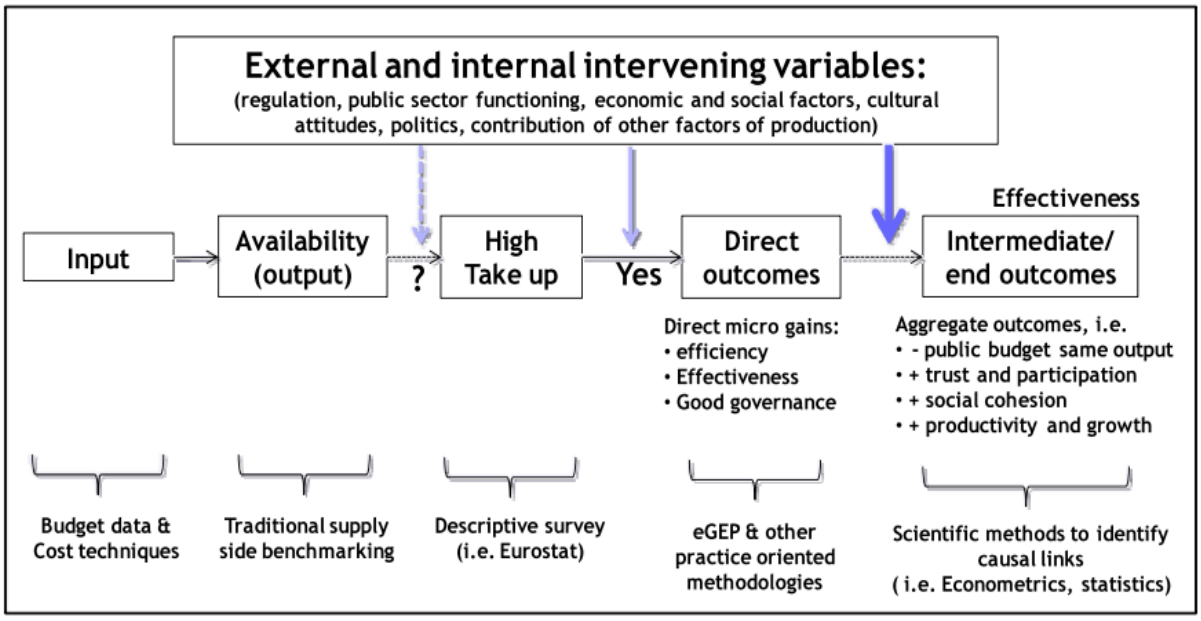
- *Make government more accountable and approachable* - replacing bureaucratic accountability with democratic accountability by making the information about the workings of government available to the public and enabling the public to hold government accountable.
- *Create better value for money* - providing better insight into how government spends taxpayer's money, encouraging agencies to attend to service quality and efficiency.
- *Stimulate growth* - by enabling businesses to develop innovative new information-based products and applications using public data.
- *Reform public services*, through:
- *Providing choice* - giving citizens the information they need to make informed decisions about the public services they use and "incentivising" providers to improve the quality of their services.
- *Opening up public sector contracts* - giving companies, social enterprises, charities, employee-owned co-operatives and individuals the opportunity to compete to offer people high quality services by giving them access to public sector contract and procurement data.[7]

Transparency exposes government behaviour to citizens' scrutiny. In doing so, and in combination with existing free tools for publishing and collaboration, it enables citizens to reduce information asymmetries, monitor government performance and expose inefficiencies, thereby stimulating innovation.[8]

[7] Paterson, G. and Nokes, J. (2011) *Simplifying PSI re-use in the United Kingdom: the UK Government Licensing Framework and the Open Government Licence*, ePSIplatform Topic Report No 22. Available http://epsiplatform.eu/content/topic-report-no-22-simplifying-psi-re-use-united-kingdom-uk-government-licensing-framework-0

[8] Osimo, D (2008) Benchmarking eGovernment in the Web 2.0 era: what to measure, and how, *European Journal of ePractice*, Vol 4. Available http://www.epractice.eu/en/journal/volume/4

Figure 3: Measurement framework for eGovernment



Source: Codagnone, C. and Undheim, T.A. (2008) Benchmarking eGovernment: tools, theory, and practice, *European Journal of ePractice* Vol 4.

Transparency and open access to PSI can affect efficiency and productivity in many ways. These include:

- Direct efficiency and productivity impacts for government agencies, through activity cost savings, activity streamlining, enhancing service delivery, improving the services delivered, etc.;
- Efficiency and productivity impacts for users of government information and services, through accession and activity cost savings, simplified and/or improved services, integration of services, etc.;
- Wider impacts for users, through enabling the development of innovative products and services drawing on openly accessible PSI, thereby generating new revenue streams and business opportunities; and
- Wider impacts for the consumers of these new products and services, through cost savings, enhanced product and services availability, etc.

  Codagnone and Undheim (2008) give some hint of these mechanisms in their outline of measurement frameworks for eGovernment (Figure 3).

Box 1: Permissions, information innovation and serendipity

Free access to information and serendipity are closely related. A central fact about the human condition, ignored in many economic models, is that even at our most sophisticated we are only boundedly rational. A person or group cannot consider all possible propositions and information states they could encounter. Thus, the possible outcomes of any research project, large or small, can never be fully anticipated. Serendipity is central to our relationship to information.

Many serendipitous discoveries arise when a prepared mind makes a previously unnoticed connection between seemingly disparate pieces of information. The number of such discoveries that are possible in a given information network depend on the number of people with access to the network and on the number of connections they can potentially make. This is of the order the square of the number of pieces of information accessible to each member of the network.

Even seemingly moderate restrictions on the freedom of information may drastically reduce the potential for serendipitous discovery. This is true whether we are talking about freedom as in availability without payment or in another sense of the freedom to copy and tinker with others' work and ideas.

Suppose that requirements for paid access, or practices that put off participation reduce the number of network participants by 80 per cent (this seems likely given the general pattern in which most value accrues to the top 20 per cent of participants in any activity) and, that each participant only accesses 20 per cent of the information that would be available in the absence of those restrictions. Then the number of observed connections potentially available is only 0.8 per cent (0.2*0.2*0.2) of those that would be available without restrictions. While this is a purely illustrative example, there is no reason to suppose that it overstates the loss of potential discovery associated with restricting the size of networks.

In policy terms, the ubiquity of serendipity and the inherent impossibility of predicting serendipitous discovery or connection implies that there must always be a presumption in favour of free inquiry, free discussion and therefore of free access to information. This presumption may be rebuttable in particular cases, but the burden of proof should always be firmly on those arguing to restrict freedom.

Source: Professor John Quiggin, Federation Fellow, University of Queensland, cited by Government 2.0 Taskforce (2009) I. Department of Finance and Deregulation, Canberra. Available http://www.finance.gov.au/publications/gov20taskforcereport/

As the following sections of this review suggest, the mechanisms and tools to facilitate PSI openness and transparency are many and varied. However, it is clear that:

- PSI should be made available free or at the marginal cost of distribution (i.e. effectively free online), if at all possible;
- It should be covered by clear and simple licensing that is standardised and readily understood by existing and potential users, and be machine readable (e.g. creative commons licensing);
- There should be minimal restrictions on use, non-discrimination regarding users and uses (e.g. there is no reason to restrict use to non-commercial uses);

- The information should be easily discoverable, and attention should be paid to quality metadata, ensuring the information is easy to find in search engines;
- It is important to engage with potential users through promotional activities and awareness raising (e.g. competitions, hack and mash-up days, etc.); and
- It is important to deal with concerns and confront barriers to openness and transparency.

The report of the Government 2.0 Taskforce outlines the principles and issues,[9] and there are a number of guides to publishing PSI that outline the steps to take and issues to consider (e.g. http://webguide.gov.au/web-2-0/publishing-public-sector-information/).

5. A review of studies linking access and transparency to productivity

Public Sector Information (PSI) takes many forms (Figure 2). It can include any information generated or collected through government expenditure. Given this breadth, a wide range of studies with different foci touch on the value of information and the benefits of increased access to and/or more transparent management of information. Each suggests possible linkages, mechanisms and methods, although some are more directly relevant than others. Our purpose here is to review this literature and assess whether and under what circumstances there is a link between open and transparent information management practices and productivity.

Given the enormous range and volume of studies, this review cannot be comprehensive. Rather, it focuses on the major studies that have been influential and widely cited and on studies that go beyond anecdotes and attempt to measure the impacts of open and transparent PSI management practices.

5.1 Public Sector Information

There are a number of studies exploring the link between PSI access and transparency and productivity that focus on wider economic impacts, the value and benefits to be derived from making PSI more freely available. There are also studies exploring the more direct costs and benefits for governments, government agencies and users. Approaches have included top-down econometric modelling, extrapolations based on surveys of PSI producers and/or users, estimates based on agency costs and consumers' willingness to pay (*i.e.* contingent valuation), and estimates of elasticities and multipliers.

5.1.1 Reviews and summaries

There are also summary studies that review the literature - at that time. For example, the National Committee for CODATA at the US National Academies, and the Working Party on the Information Economy at the Organisation for Economic Co-operation and Development held a joint workshop to explore the socio-economic effects of PSI on digital networks, which brought

[9] Government 2.0 Taskforce (2009) *Engage: Getting on with Government 2.0*. Department of Finance and Deregulation, Canberra. Available http://www.finance.gov.au/publications/gov20taskforcereport/index.html

together a range of analysts working on valuing and measuring the impacts of various forms of PSI.

The proceedings provide a useful review of work in the area up to 2008 (Uhlir Ed. 2009).[10] Bringing together a range of studies and reports, part one of the workshop report provides some background on the goals, values and policy perspectives from Europe and the United States, part two presents a number of examples of assessment methods used by those who study the effects of placing PSI online, and part three presents a review of the literature measuring the social and economic costs and benefits of PSI, summarises the discussion and suggests development directions. Participants at the workshop included representatives of PSI producers, oversight and regulatory agencies, private sector (re)users and agency-based and independent researchers with experience of researching the field. Consequently, the report provides useful information on the issues facing agencies and external users of PSI (e.g. agency concerns about privacy and possible loss of revenue, user search and transaction costs, etc.) as well as discussion of research methods. Each will be picked up in the detailed review below.

Vickery (2011) undertook are review of recent evidence on the importance and growth of PSI markets for the European Commission, focusing on quantitative studies, and on the basis of that evidence provided a top-down estimate of the value of the PSI market in Europe and the economic value of PSI in Europe in general.[11] The report provides an up-to-date summary of PSI market value studies, albeit at a highly aggregated level. Again, the details will be picked up in the following review.

Corbin (2009) provided a review of indicators used in PSI studies up to that time.[12] There is also a series of "State of Play" reports and a wide range of other reports and guides relating to PSI access and transparency available at the European ePSI Platform portal (http://epsiplatform.eu/).

5.1.2 National and regional studies of wider economic impacts

Among the studies looking at the value of PSI and its current and/or potential wider economic impacts, there are a few canonical studies as well as a number of more detailed studies.

PIRA (2000) combined measures of the investment cost (i.e. the amount spent on the collection/generation of the PSI) and expenditure on PSI by users and re-users, then for final users, estimated the value as expenditure on PSI or, where the PSI was freely available, as the

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[10] Paul Uhlir ed. (2009) *The socioeconomic effects of public sector information on digital networks: Towards a better understanding of different access and reuse policies*, National Academies Press, Washington DC. Available http://www.nap.edu/openbook.php?record_id=12687&page=40.

[11] Vickery, G. (2011) *Review of recent studies on PSI re-use and related market developments*, Report to the European Commission by Information Economics, Paris. Available http://ec.europa.eu/information_society/policy/psi/docs/pdfs/report/psi_final_version_formatted.docx.

[12] Corbin, C. (2009) *A review of indicators used in PSI studies*, EC PSI Group. Available http://www.docstoc.com/docs/38748503/A-review-of-indicators-used-in-Public-Sector-Information.

investment cost of its collection/generation.[13] They estimated the investment value of PSI (i.e. what governments invest in the acquisition of PSI) and the economic value of PSI (i.e. the national income attributable to activities built on the exploitation of PSI). In the European Union, they put the former at around EUR 9.5 billion per annum in 1999 and the latter at around EUR 68 billion (equivalent to approximately 1.4% of EU GDP).

The PIRA report was popularised by Weiss (2001) in the influential report *Borders in Cyberspace*.[14] Drawing on the PIRA report, Weiss highlighted the comparison between the US and Europe, noting that the US invested twice as much as Europe in PSI, but earned 40 times more from it - USD 750 billion versus EUR 68 billion. Weiss suggested that this was because the US had an open access model for PSI, whereas the EU countries had a cost recovery approach to PSI. However, a number of subsequent analysts have questioned both the numbers and the conclusions. Aside from the many difficulties in estimation and attribution, a potential problem with the PIRA approach is that it may overestimate the value of PSI because it does not account for the possible use of alternative information.

In the MEPSIR study of Dekkers *et al*. (2006), demand and economic performance were measured in an extensive survey by directly asking both PSI holders and re-users for key economic data, such as total turnover against turnover related to PSI, total number of staff against the number of staff dedicated to handling PSI, and estimates of the domestic market size for a particular type of PSI. The market value was then estimated from the average revenues multiplied by the average number of re-users per PSI domain, minus the cost of PSI collection/generation.[15] This produced a much lower number than suggested by the PIRA study, despite it being market size rather than value added and coming five years latter. They put the overall market for PSI in the EU plus Norway at around EUR 27 billion (approximately 0.25% of aggregated GDP).[16]

Making some adjustments to the MEPSIR estimates with the benefit of hindsight, Te Velde (2009) suggested that the value might drop further from EUR 27 to EUR 5 billion or even EUR 3 billion.[17] While these numbers are 15 to 20 times less than those reported in the original PIRA study, Te

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[13] PIRA. (2000) *Commercial exploitation of Europe's public sector information*, Brussels: European Commission. Available http://www.epsiplus.net/psi_library/reports/commercial_exploitation_of_europe_s_public_sector_information_pira_study.

[14] Weiss, P. (2002) *Borders in Cyberspace: Conflicting Public Sector Information Policies and their Economic Impacts,* National Oceanic and Atmospheric Administration. Available http://epsiplatform.eu/reports/borders-in-cyberspace

[15] Dekkers, M., Polman, F., te Velde, R., & de Vries, M. (2006) *MEPSIR: Measuring European Public Sector Information Resources*, Brussels: European Commission. Available http://www.epsiplus.net/psi_library/reports/mepsir_measuring_european_public_sector_resources_report.

[16] Dekkers, M., Polman, F., te Velde, R. and de Vries, M. (2006) *MEPSIR: Measuring European Public Sector Information Resources*, European Commission, Brussels. Available http://www.epsiplus.net/psi_library/reports/mepsir_measuring_european_public_sector_resources_report.

[17] Te Velde, R. (2009) 'Public Sector Information: Why Bother?,' in Paul Uhlir (ed.) *The socioeconomic effects of public sector information on digital networks: Towards a better understanding of different access and reuse policies,* National Academies Press, Washington DC. Available http://www.nap.edu/openbook.php?record_id=12687&page=40.

Velde noted some other studies suggesting similar numbers. For example, using the UK Office of Fair Trading study findings (discussed below) and extrapolating to the EU suggested a total PSI value of EUR3 billion to EUR 5 billion, and extrapolating from a Dutch study focused on geo-spatial information suggested a value of EUR 5 billion to EUR 7 billion.

In their report to the UK Office of Fair Trading, DotEcon (2006)[18] and collaborator Pollock (2009)[19] adopted a bottom-up approach to estimating the economic value of PSI products and services in the UK in an effort to overcome some of the limitations of the PIRA approach. DotEcon adopted a contingent valuation approach and estimated the net economic value of PSI from willingness to pay for PSI minus the cost of supplying it. Using a survey and published sources, the value of PSI was estimated from the net consumer surplus from PSI (*i.e.* the amount that customers might be prepared to pay over and above what they do pay to have access), and the total producer surplus that arises from the provision of PSI (*i.e.* the extent to which revenues exceed the costs of supplying the product or service). Adding these two estimates gave the net economic value of PSI in the UK - around GBP 590 million per annum in 2005.

The DotEcon report also provided estimates of the value lost from not making PSI freely available, by looking at the consumer detriment resulting from:

- Unduly high pricing;
- Restriction of downstream competition, such as refusing to supply or discrimination; and
- Failure to exploit PSI.

They estimated the cost of these detriments at GBP 20 million from high pricing, GBP 140 million from restriction of downstream competition, and GBP 360 million from failure to exploit PSI. This goes to the heart of the important counterfactual issues, starting to look at the value of things that do not happen unless PSI is made freely available. They suggest that the net value of PSI in the UK could have been increased to GBP 1.1 billion by resolving the problems identified (i.e. approximately doubled).[20] While much less subject to over-estimating the value of PSI, a potential weakness of this approach lay in estimating price elasticities of demand, especially where the PSI was supplied free of charge.

5.1.3 Studies of the direct and wider economic impacts of specific forms of PSI

While there are many studies of the direct and wider economic impacts of specific forms of PSI, meteorological and geospatial data have been common foci for attention as it is generally believed that they have the biggest potential for generating value in (re)use, thereby increasing

[18] DotEcon. (2006) *The commercial use of public information (CUPI)*, Report oft861, London: Office of Fair Trading. Available http://www.oft.gov.uk/OFTwork/publications/publication-categories/reports/consumer-protection/oft861.
[19] Pollack, R. (2009) *The Economics of Public Sector Information*, CWPE 0920, Cambridge: University of Cambridge. Available http://www.econ.cam.ac.uk/dae/repec/cam/pdf/cwpe0920.pdf.
[20] Graves, A. (2009) 'The price of everything but the value of nothing,' in Paul Uhlir (ed.) *The socioeconomic effects of public sector information on digital networks: Towards a better understanding of different access and reuse policies,* National Academies Press, Washington DC. Available http://www.nap.edu/openbook.php?record_id=12687&page=40.

the return on investment in their collection (i.e. realise more value for a given level of cost, improving productivity).

Meteorological information

The US National Oceanic and Atmospheric Administration (NOAA) has produced a number of reports that seek to demonstrate the value of its activities and of making meteorological and related information freely available. Reporting on NOAA's work, Weiher (2009) noted that: while economic theory provides a rationale for publicly supplied information, it does not say how much publicly supplied information should be produced. So, NOAA has to make cost-benefit calculations to decide how much to produce. NOAA managers compare the net benefits of a particular system or data collection activity with other data systems and, ultimately, with other public investments such as health or highways.[21]

Weiher (2009) cited a number of examples of NOAA's analysis:

- Estimating that value of installing the NEXRAD system, the next generation weather radars the US in the late 1980s and early 1990s, NOAA looked at weather related fatalities and injuries before and after NEXRAD was introduced and found a reduction in fatalities and injuries of around 40%.
- Another study estimated the benefits of a coastal and ocean observation systems, and found benefits of more than USD 700 million annually, which came from the value of information through a series of coastal and ocean-related industries, such as oil and gas, fishing, recreation, tourism, etc.
- Another study looked at the benefits of real-time oceanographic data (e.g. tides and currents for different ports) and found that in the Houston-Galveston Bay port - a large port in the Gulf of Mexico, used mainly for oil and gas imports - the benefits of such data were around $15 million a year. If such benefits were added up across all ports in the US, it is clear that the benefits would be substantial.
- And another NOAA study estimated of the value of daily weather forecasts in the US. The benefits are mainly nonmarket use benefits, for which there is not a market *per se* because forecasts are freely available on TV and radio, in newspapers and on the Internet. Such benefits cannot be measured multiplying prices by quantities sold since they are not exchanged in the market. However, using contingent valuation via stated preferences, it was estimated that there is a willingness-to-pay of about USD 103 per household in the approximately 110 million US households, totalling $11.4 billion in annual value (including $3 billion in a typical hurricane season alone).[22]

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[21] Weiher, R. (2009) 'Assessing the Economic and Social Benefits of NOAA Data Online,' in Paul Uhlir (ed.) *The socioeconomic effects of public sector information on digital networks: Towards a better understanding of different access and reuse policies,* National Academies Press, Washington DC. Available http://www.nap.edu/openbook.php?record_id=12687&page=40.

[22] Weiher, R. (2009) 'Assessing the Economic and Social Benefits of NOAA Data Online,' in Paul Uhlir (ed.) *The socioeconomic effects of public sector information on digital networks: Towards a better understanding of different access and reuse policies,* National Academies Press, Washington DC. Available http://www.nap.edu/openbook.php?record_id=12687&page=40.

Vollmer (2011) also notes that: NOAA has been held up as a success story with regard to innovation and a demonstration that economic activity can be generated by making data freely available.[23] NOAA maintains a website dedicated to showcasing the economic and social benefits of their PSI and products.[24]

Geospatial information

There have been a number of studies of the value and impacts of geospatial information at an aggregate level, and some that look at direct agency and user costs and benefits. We review the former here and the latter in the next section.

In Australia, ACIL Tasman (2008) used a value-added approach based on General Equilibrium (GE) modelling, with input data derived from case studies, which were used as a guide to estimating the direct impacts of spatial information on selected sectors in the Australian economy, and a GE approach to modelling economy-wide impacts.[25] They estimated that industry revenue in 2006-07 could have been of the order of $1.37 billion and industry gross value added around $682 million. Using a General Equilibrium (GE) modelling approach, they concluded that the economic footprint of the spatial information industry was larger.[26] A potential issue with this approach is how to scale from case studies to sector-wide impacts (*i.e.* understanding the relationship between the cases and the sector).

A similar approach was used by Allen Consulting (2008) to estimate the benefits of high resolution positioning services. They concluded that:

- The gross benefit flowing from existing uptake in the agricultural, mining and construction sectors is estimated to range between $829 million and $1 486 million per annum, depending on the size of productivity gains assumed. This represents a contribution to national GDP of between 0.08 per cent and 0.14 per cent.
- Application of precision GNSS to asset mapping by utilities and local government Australia-wide is estimated to result in operating cost savings of $435 million to $870 million per annum and capital cost savings of up to $2.3 billion per annum. applications of precision GNSS in open cut mining are estimated to b delivering between $371 million and $744 million annually.
- Current uptake of precision GNSS technology in the broad acre cropping sector is estimated to be delivering an annual benefit of between $152 million and $206 million. The current

[23] Vollmer, T. (2011) *State of Play: Public Sector Information in the United States*, ePSIplatform Topic Report No 25. Available http://epsiplatform.eu/sites/default/files/Topic_Report_no25_State_of_Play_US.pdf

[24] http://www.ppi.noaa.gov/economics/societal-impacts/

[25] ACIL Tasman (2008) *The Value of Spatial Information*, Spatial Information Systems Limited. Available www.crcsi.com.au/uploads/publications/PUBLICATION_324.pdf.

[26] ACIL Tasman (2008) *The Value of Spatial Information*, Spatial Information Systems Limited. Available www.crcsi.com.au/uploads/publications/PUBLICATION_324.pdf.

benefits being experienced by the construction sector are more than twice this amount, at between $306 million to $535 million.[27]

To support a review of Geoscience Australia (GA), the Department of Finance and Deregulation commissioned ACIL Tasman to report on the economic value of the core areas of GA's work, including that relating to pre-competitive geological information on petroleum and minerals, and its work in gathering, processing and disseminating geospatial, earth monitoring and groundwater information.[28] In both areas, ACIL Tasman investigated the public good aspects of the products and services produced by GA, and the private and public benefits flowing from them.

ACIL Tasman divided impacts into productivity and non-productivity benefits. Productivity benefits are realised in areas such as logistics, precision agriculture, asset mapping, and infrastructure maintenance. Non-productivity benefits arise through improving public decision making, natural resource management including water management, natural disaster and emergency management and national security.

Looking at productivity benefits, ACIL Tasman adopted a representative figure of $12 billion in productivity benefits for 2010. They considered that it would be conservative to attribute 15% of the overall productivity benefits to GA's efforts. This results in an estimated increase in GDP due to the accumulated impact of GA's provision of geospatial products and services of $1.8 billion for 2010.

ACIL Tasman considered that a plausible estimate of the non-productivity benefits of geospatial, earth monitoring, groundwater and hazards information would be $1.7 billion per annum. They did not attempt to assign a particular percentage of this benefit to GA, given the difficulty in attributing value between various fundamental data acquisition and value adding activities. However, they claimed that a large portion was likely to be attributable to GA.

5.1.4 Direct impacts on agencies and users

While there is no clear delineation, there have been fewer studies focusing on the more direct efficiency and productivity impacts on agencies and users. Nevertheless, a large number of studies mention such impacts as a part of the analysis. We review some of the more prominent ones here.

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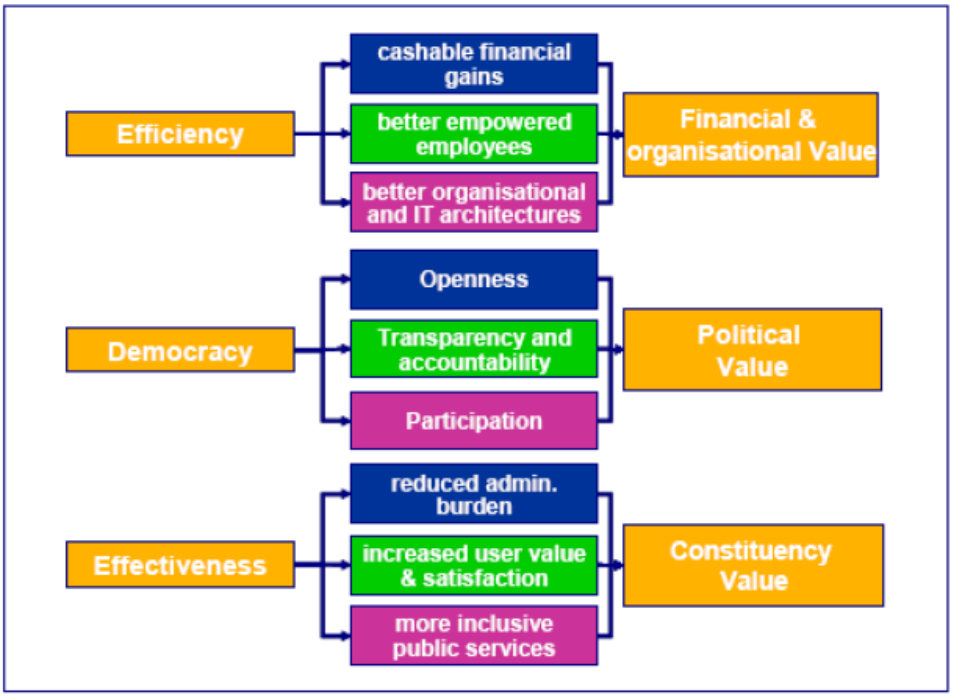
[27] Allen Consulting (2008) *Economic benefits of high resolution positioning services*, Prepared for Victorian Department of Sustainability and Environment and the Cooperative Research Centre for Spatial Information. Available http://www.dse.vic.gov.au/__data/assets/pdf_file/0007/104668/PUBLICATION_348.pdf

[28] This summary draws on Department of Finance and Deregulation (2011) *Strategic Review of Geoscience Australia*, Canberra.

There have been a number of studies in Europe looking at spatial data infrastructure, including a seminal study in Catalonia (Almirall *et al*. 2008).[29] It is worth looking at this study in detail, primarily for the methodology and indicators used, but also for the findings.

The study utilised the methodological framework developed by the e-Government Economics Project (eGEP), funded by the European Commission DG INFSO. The use of this framework was recommended as one of the possible ways forward after comparing the methodologies and findings of SDI-related studies in the workshop organised by the JRC in 2006. What makes the eGEP framework interesting is that it is underpinned by a theoretical model of the expected benefits of e-government services, it attempts to capture both economic and social/political values, and puts forward a set of measurable indicators together with a methodology to undertake the measurements. The overall framework of impacts proposed by eGEP is shown in Figure 4.

Figure 4: eGEP Measurement Framework Benefits



Source: Almirall, P.G., Bergada, M.M. and Ros, P.Q. (2008) *The Socio-Economic Impact of the Spatial Data Infrastructure of Catalonia*, JRC Scientific and Technical Reports, p26

eGEP proposed some 90 indicators to measure the impacts of e-government based on a range of available data sources, including official statistics, administrative records, user surveys, and web

[29] Almirall, P.G., Bergada, M.M. and Ros, P.Q. (2008) *The Socio-Economic Impact of the Spatial Data Infrastructure of Catalonia*, JRC Scientific and Technical Reports. Available http://inspire.jrc.ec.europa.eu/reports/Study_reports/catalonia_impact_study_report.pdf

crawlers. From this starting point, the Catalonian study selected a range of indicators that would be relevant in the context, and then convened a meeting with a panel of local authorities and representatives of the user community to discuss the proposed methodology and indicators. The meeting led to modifications to the indicators proposed and indicated to the study team that it was necessary to collect the information needed through face to face interviews rather than surveys. For government agencies there were indicators covering:

- Efficiency (e.g. monetary gains, better prepared personnel, and improvements in the organisation);
- Effectiveness (e.g. benefits for residents, user satisfaction, and extension of services); and
- Democracy (e.g. openness and transparency and participation).
  For users indicators included monetary, technological and strategic impacts (See Annex 1 for details).[30]

The Catalonian study was based on a sample of 20 local authorities participating in the Catalan Spatial Data Infrastructure (SDI) (IDEC) together with 3 control local authorities not participating in the SDI, and 15 end-user organizations, of which 12 were private companies operating in the geographic information sector, and 3 large institutional users of geographic information. In relation to costs they found that:

The total direct cost of establishing and operating the IDEC over a five year period (2002-06) was of €1.5 million, of which €325 000 for each of the first two years (2002-03) necessary to launch the SDI, and €283 000 per annum to operate and develop the infrastructure in the three subsequent years (2004-06). Human resources represented 76% of the costs during the launch period (the rest being capital investment), and 91% during operation. These costs do not include the creation and updating of topographic data, which is under the responsibility of the Cartographic Institute of Catalonia (ICC), and would happen regardless of the development of the SDI, nor the indirect costs associated with the physical and technological infrastructure (e.g. office space) provided by the ICC. They do include the following: metadata creation and maintenance, development of geo-services (including geoportal, catalogue, Web Map Service client), preparation of data for publication, applications, hardware and software, and management.[31]

In relation to benefits, they found that:

The evidence collected for 2006 clearly shows that ***the main benefits of the IDEC accrue at the level of local public administration through internal efficiency benefits (time saved in internal queries by technical staff, time saved in attending queries by the public, time saved in internal processes) and effectiveness benefits (time saved by the public and by companies in dealing with***

[30] Almirall, P.G., Bergada, M.M. and Ros, P.Q. (2008) *The Socio-Economic Impact of the Spatial Data Infrastructure of Catalonia*, JRC Scientific and Technical Reports, pp26-27. Available http://inspire.jrc.ec.europa.eu/reports/Study_reports/catalonia_impact_study_report.pdf

[31] Almirall, P.G., Bergada, M.M. and Ros, P.Q. (2008) *The Socio-Economic Impact of the Spatial Data Infrastructure of Catalonia*, JRC Scientific and Technical Reports, p5. Available http://inspire.jrc.ec.europa.eu/reports/Study_reports/catalonia_impact_study_report.pdf

public administration). [emphasis added] *Extrapolating the detailed findings from 20 local authorities to the 100 that participate in the IDEC, the study estimated that the internal efficiency benefits account for over 500 hours per month. Using an hourly rate of €30 for technical staff in local government, these savings exceed €2.6 million per year. Effectiveness savings are just as large at another 500 hours per month. Even considering only the efficiency benefits for 2006 (i.e. ignoring those that may have accrued in 2004-05, as well as the effectiveness benefits), the study indicates that the total investment to set up the IDEC and develop it over a four year period (2002-05) is recovered in just over 6 months. Wider socio-economic benefits have also been identified but not quantified. In particular, the study indicates that web-based spatial services allow smaller local authorities to narrow the digital divide with larger ones in the provision of services to citizens and companies*.[32]

This methodology makes an important contribution to exploring the more direct and, to a lesser extent, wider impacts of making PSI openly and transparently available. It is also crucial in the identification of the importance of transaction costs and internal efficiency benefits.

In a study for the Australian National Data Service, Houghton (2011) explored the costs and benefits of free access to PSI and standardised licensing and data formats, using the cases of national statistics, fundamental spatial data and hydrological data. While there are many ways in which the provision of more open access to PSI can affect the costs of government agency producers and the many existing and potential users of the information, the study focused on three main elements:

- The costs and cost savings experienced by the PSI producing agencies involved in provision of free and open access to information;
- The costs and cost savings experienced by the users of PSI that relate to accessing, using and re-using the information; and
- The potential wider economic and social impacts of freely accessible PSI, arising from increased use and measured in terms of returns to investment in its production.[33]

This is one of the few examples of a study that brings together the direct agency and user impacts of open and transparent access to PSI, and the wider economic impacts. It is also one of the few studies to compare the situation before and after the introduction of free and open access and standard licensing.

The report outlines the type of information required for the analysis, which is based on an activity-cost approach, a welfare economics approach to estimating the increase in consumer surplus arising from increased use, and estimating the potential increase in returns to investment in the information creation arising from increased use. It explored agency and user activity costs,

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[32] Almirall, P.G., Bergada, M.M. and Ros, P.Q. (2008) *The Socio-Economic Impact of the Spatial Data Infrastructure of Catalonia*, JRC Scientific and Technical Reports, p5. Available http://inspire.jrc.ec.europa.eu/reports/Study_reports/catalonia_impact_study_report.pdf

[33] Houghton, J.W. (2011) *Costs and benefits of data provision,* Report to The Australian National Data Service, Canberra. Available http://ands.org.au/resource/cost-benefit.html.

consumer welfare and return on investment. Analysis was based primarily on agency sourced information (e.g. internal costs, customer records, website usage statistics, etc.).

It is clear from the case studies presented that even the subset of benefits that can be measured outweigh the costs of making PSI more freely and openly available, with the cost impacts often negligible or, in fact, negative (i.e. cost savings). It is also clear that it is not simply about access prices, but also about the transaction costs involved. Standardised and unrestrictive licensing, such as Creative Commons, and data standards are crucial in enabling access that is truly open (*i.e.* free, immediate and unrestricted).

For example, Houghton (2011) found that the net cost to the Australian Bureau of Statistics (ABS) of making publications and statistics freely available online and adopting Creative Commons licensing was likely to have been around $3.5 million per annum at 2005-06 prices and levels of activity, but the immediate cost savings for users were likely to have been around $5 million per annum. Moreover, there were significant agency savings of around $1 million per annum (e.g. handling subscriptions and sales, financial transaction fees, user enquiries and support, etc.). The agency also noted the benefits of freeing up staff resources from such activities and being able to redeploy them to the core business.

Estimates of the impacts of making ABS publications and data free online on consumer welfare ranged from $4 million to $5 million per annum at 2005-06 prices and levels of activity. The wider impacts in terms of additional use and uses bring substantial additional returns, with estimates suggesting overall costs associated with free access to ABS publications and data online and unrestrictive standard licensing of around $4.6 million per annum and measurable annualised return on investment benefits of perhaps $25 million (*i.e.* more than five times the costs).

The case of the ABS shows that, while there are costs involved in moving to open access to PSI and potential loss of revenue, there are also agency savings and benefits, as well as wider benefits to users leading to overall productivity gains.

5.2 The findings of publicly funded research

There is a very active debate about scientific and scholarly publishing, the high cost of subscription journals, consequent access limitations and the potential advantages of open access publishing models. Indeed open access is growing. At the time of writing the Directory of Open Access Journals (www.doaj.org) listed 7 535 open access journal titles with more than 760 000 articles freely and openly accessible, and the Directory of Open Access Repositories (www.opendoar.org) listed 2 170 open access repositories containing research and related materials. Bjork *et al*. (2010) estimated that just over 20% of all research articles published in 2008 were open access (i.e. freely available in full text) in 2009.[34]

[34] Björk B-C, Welling P, Laakso M, Majlender P, Hedlund T, et al. (2010) 'Open Access to the Scientific Journal Literature: Situation 2009,' *PLoS ONE 5(6)*: e11273. Available doi:10.1371/journal.pone.0011273

As a part of the Open Access debate, there is a growing literature on the costs and, to a lesser extent, the benefits of more open access to research publications. To date, less attention has been given to the value of open curation and sharing of research data, although a few studies exist. While publicly funded research publications and data are a special form of PSI, they share key features with other forms of PSI. Most notably, the incentive to produce the content does not depend on copyright. Unlike the author of a novel, neither researchers nor government officials depend upon the exploitation of copyright to fund their production of content.

5.2.1 Research publications

Research publications have been the focus of much economic analysis, although most focuses on the costs of creation, access and preservation and few studies look at the value and benefits of access.

Houghton *et al*. (2006) and Houghton *et al*. (2009) were among the first studies to explore the costs *and* benefits of open access to research publications.[35] Houghton *et al*. (2009) outlined a detailed activity cost model based on the IDEF0 modelling standard often used in business process reengineering, and used it as the basis for their analysis of the potential costs and cost savings throughout the scholarly communication lifecycle arising through alternative publishing models. The focus of this part of their work was the activity cost differences between the alternative models and efficiency gains in terms of research information search, discovery and access, research library negotiation, acquisition and handling, publisher handling, and wider use efficiencies. Their estimates suggested that UK higher education could have saved around £80 million per annum circa 2007 by shifting from subscription to open access journal publishing, and more than £110 million per annum by shifting to open access self-archiving with overlay peer review and production services.[36] The main contributor to these system saving was research efficiency gains .

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[35] Houghton, J.W., Steele, C. and Sheehan, P. (2006) *Research Communication Costs in Australia: Emerging Opportunities and Benefits*, Report to the Department of Education and Training, Canberra. Available http://hdl.handle.net/1885/44485. Houghton, J.W., Rasmussen, B., Sheehan, P.J., Oppenheim, C., Morris, A., Creaser, C., et al. (2009) *Economic Implications of Alternative Scholarly Publishing Models: Exploring the Costs and Benefits*, Report to The Joint Information Systems Committee (JISC) by Victoria University & Loughborough University. Available http://ie-repository.jisc.ac.uk/278/.

[36] *Subscription publishing* refers primarily to academic journal publishing and includes individual subscriptions and the, so called, Big Deal (*i.e.* where institutional subscribers pay for access to online aggregations of journal titles through consortial or site licensing arrangements). In a wider sense, however, subscription publishing includes any publishing business model that imposes reader access tolls and restrictions on use designed to maintain publisher control over access in order to enable the collection of those tolls. *Open access publishing* refers primarily to journal publishing where access is free of charge to readers, while authors, their employing or funding organisations pay for publication, or the publication is supported by other sponsors making it free for both readers and authors. Use restrictions can be minimal as no access toll is imposed. *Open access self-archiving* refers to the situation where authors or their publishers deposit their work in on-line open access institutional or subject-based repositories, making it freely available to anyone with Internet access. Again, use restrictions can be minimal.

Exploring the wider impacts of more open access to research findings Houghton and Sheehan (2009) and Houghton *et al*. (2009) developed a modified Solow-Swan model to estimate the impacts of changes in the accessibility of the information and efficiency in its access and use on returns to R&D expenditure.[37] The standard Solow-Swan approach makes some key simplifying assumptions, including that:

- All R&D generates knowledge that is useful in economic or social terms (*efficiency of R&D*); and
- All knowledge is equally accessible to all entities that could make productive use of it (*accessibility of knowledge*).

Obviously, these assumptions are not realistic. In the real world there are limits to efficiency and barriers to access. Addressing these, they introduced *accessibility* and *efficiency* into the standard Solow-Swan model as negative or friction variables, then explored the impact on returns to R&D of reducing the friction by increasing accessibility and efficiency.

Houghton *et al*. (2009) produced range estimates, looking at typical rates of return from 20% to 60% (Arundel and Geuna 2003; 2004)[38] and plausible increases in accessibility and efficiency of 1% to 10%, but for the purposes of discussion, based on an extensive review of the literature, they took the lower bound average 20% social return on public sector R&D and suggested that a 5% increase in accessibility and efficiency might be plausible. They suggested that, given a 20% rate of return to public sector R&D, a 5% increase in accessibility and efficiency would have been worth around £124 million per annum circa 2006 in increased returns to higher education R&D expenditure in the UK. Houghton *et al*. (2009) then put the costs, cost savings and returns to R&D together in a cost-benefit analysis. Because there is a lag between research expenditure and the realisation of economic and social returns to that research, the impact on returns to R&D was lagged and the value of those returns discounted accordingly.[39] The cost-benefit comparisons were made over a 20 year transitional period, and suggested that the cost savings and additional returns to R&D resulting from enhanced accessibility and efficiency would exceed the costs of open access models. For example, during a transitional period they estimated that, in an open access world:

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[37] Houghton, J.W., & Sheehan, P. (2009) Estimating the potential impacts of open access to research findings, *Economic Analysis and Policy* 39(1). Available http://www.eap-journal.com/vol_39_iss_1.php. Houghton, J.W., Rasmussen, B., Sheehan, P.J., Oppenheim, C., Morris, A., Creaser, C., et al. (2009) *Economic Implications of Alternative Scholarly Publishing Models: Exploring the Costs and Benefits*, Report to The Joint Information Systems Committee (JISC) by Victoria University & Loughborough University. Available http://ie-repository.jisc.ac.uk/278/.

[38] Arundel, A. and Geuna, A. (2003) *Proximity and the Use of Public Science by Innovate European Firms*, Royal Economic Society Annual Conference 2003 86, Royal Economic Society. Arundel, A. and Geuna, A. (2004) Proximity and the use of public science by innovative European firms, *Economics of Innovation and New Technology* 13(6), 2004, pp. 559-580.

[39] To reflect the fact that a shift to open access publishing or self-archiving would be prospective and not retrospective, and that the economic value of impacts of enhanced accessibility and efficiency would not be reflected in returns to R&D until those returns were realised.

- The benefits from cost savings and increased returns to R&D resulting from open access publishing all journal articles produced in UK higher education would be around three times the costs;
- The benefits of 'Green OA' self-archiving in parallel with subscription publishing would be around seven times the costs; and
- The benefits from open access self-archiving with overlay editorial and peer review services would be around four times the costs.[40]

To date, this is one of the few methods to have explored both the direct efficiency impacts of more open access to information in the form activity costs and cost savings, and the wider economic and efficiency impacts in the form of increased returns to R&D arising from increasing the accessibility of the information. It has been applied in a number of subsequent studies by the original authors and colleagues[41] and by others.[42]

There is an increasing number of research funding agencies mandating that the findings from the research they fund be made openly and freely available. In the United States, the National Institutes of Health (NIH) spends USD 28 billion on research annually, resulting in around 65 000 peer-reviewed articles. The NIH Public Access Policy "requires scientists to submit final peer-reviewed journal manuscripts that arise from NIH funds to the digital archive PubMed Central upon acceptance for publication."[43] Through the PubMed repository, these manuscripts and materials are made openly and freely available to the public. The original policy went into effect in May 2005 and was voluntary. Later, the policy became mandatory, and was made permanent in March 2009.[44] The NIH has been successful in getting a high level of compliance with the policy,

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[40] Houghton, J.W., Rasmussen, B., Sheehan, P.J., Oppenheim, C., Morris, A., Creaser, C., et al. (2009) *Economic Implications of Alternative Scholarly Publishing Models: Exploring the Costs and Benefits*, Report to The Joint Information Systems Committee (JISC) by Victoria University & Loughborough University. Addendum available http://www.cfses.com/EI-ASPM/JISC%20EI-ASPM%20Report%20%28Addendum%20April%2009%29.pdf

[41] Houghton, J.W., de Jonge, J. and van Oploo, M. (2009) *Costs and Benefits of Research Communication: The Dutch Situation, S*URFfoudation, Utrecht (June 2009). Available http://www.surffoundation.nl/wiki/display/economicstudyOA/Home. Houghton, J.W. (2009) *Costs and Benefits of Alternative Publishing Models*: *Denmark*, DEFF, Copenhagen (September 2009). Available http://www.knowledge-exchange.info/Admin/Public/DWSDownload.aspx?File=%2fFiles%2fFiler%2fdownloads%2fDK_Costs_and_benefits_of_alternative_publishing_models.pdf. Houghton, J.W. (2010) 'Costs and benefits of alternative scholarly publishing models: Lessons and developments,' in *Publishing in the networked world: Transforming the Nature of Communication*, Eds. Turid Hedlund and Yasar Tonta. ISBN 978-952-232-086-5, pp.385-403. Available http://hdl.handle.net/10227/599.

[42] CEPA/RIN (2008) *Activities, costs and funding flows in the scholarly communications system*, RIN, London. Available http://www.rin.ac.uk/our-work/communicating-and-disseminating-research/activities-costs-and-funding-flows-scholarly-commu. CEPA and Ware, M. (2010) *Transition dynamics of improving access to research*, RIN, London. Available http://www.cepa.co.uk/publications.php. CEPA/RIN (2011) *Heading for the open road: costs and benefits of transitions in scholarly communications*, RIN London. Available http://www.rin.ac.uk/our-work/communicating-and-disseminating-research/heading-open-road-costs-and-benefits-transitions-s.

[43] http://publicaccess.nih.gov/

[44] Vollmer, T. (2011) *State of Play: Public Sector Information in the United States*, ePSIplatform Topic Report No 25. Available http://epsiplatform.eu/sites/default/files/Topic_Report_no25_State_of_Play_US.pdf

and at the time of writing there were some 2.3 million articles freely and openly available on PubMed Central.

The access that this gives medical and health researchers and practitioners around the world to the latest research is of enormous value, perhaps especially for researchers and practitioners in developing countries who might otherwise have very limited access. For example, Chan *et al*. (2005) noted that: according to a recent survey conducted by the World Health Organization, in the 75 countries with an annual GNP per capita of less than USD 1 000, some 56% of medical institutions had no subscriptions to journals over the last five years; and in countries with a GNP of USD 1 000 to 3 000, 34% had no subscriptions and a further 34% had an average of two subscriptions per year.[45]

The Federal Research Public Access Act (FRPAA) currently under consideration in the United States seeks to extend the NIH policy by requiring that US government agencies with annual extramural research expenditures over $100 million make manuscripts of journal articles stemming from research funded by that agency publicly available via the Internet.[46] Houghton *et al*. (2010) outlined one possible approach to measuring the impacts of the proposed US *Federal Research Public Access Act* (FRPAA) on returns to public investment in R&D.[47] The project involved further development and refinement of the modified Solow-Swan model (discussed above), particularly in relation to the most appropriate lag and distribution over time of returns to R&D, the most appropriate depreciation rate for the underlying stock of R&D knowledge arising from federally funded R&D, and metrics to measure potential changes in accessibility and efficiency.

Key data required for the modelling included: the implied archiving costs, the volume of federally funded research outputs (journal articles), and the levels of federal research funding and expenditure trends. The preliminary analysis used publicly available sources and published estimates. Data relating to federal research funding, activities and outputs were taken from the National Science Board *Science and Engineering Indicators 2010*,[48] and the analysis explored three sources for archiving costs: the LIFE^2 Project lifecycle costs, and submission equivalent costings from arXiv and NIH.[49] In order to enable anyone to use alternative values for the various parameters, test sensitivities and explore the issues for themselves, a simplified model is available

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[45] Chan, L., Kirsop, B. and Arunachalam, S. (2005) 'Open Access Archiving: the fast track to building research capacity in developing countries,' *SciDevNet*, November 2005. Available http://www.scidev.net/ms/openaccess/.

[46] http://www.taxpayeraccess.org/issues/frpaa/index.shtml

[47] Houghton, J.W., Rasmussen, B. and Sheehan, P. (2010) *Economic and Social Returns on Investment in Open Archiving Publicly Funded Research Outputs*, The Scholarly Publishing and Academic Resources Coalition (SPARC), Washington DC. Available http://www.arl.org/sparc/publications/papers/vuFRPAA/index.shtml

[48] National Science Board (NSB) *Science and Engineering Indicators 2010*, National Science Foundation (NSB 10-01), 2010. Available http://www.nsf.gov/statistics/

[49] Ayris, P. *et al*. *The LIFE^2 Final Report*, London & Bristol: The Joint Information System Committee (JISC), 2008. Available http://www.life.ac.uk/2/documentation.shtml. arXiv.org. *arXiv Business Model White Paper*, Cornell University, 2010. Available http://arxiv.org/help/support/whitepaper. National Institutes of Health (NIH) *Analysis of Comments and Implementation of the NIH public access policy*, Washington DC.: NIH, 2008. Available http://publicaccess.nih.gov/analysis_of_comments_nih_public_access_policy.pdf.

in MS Excel format.[50] Preliminary modelling by Houghton *et al*. (2010) suggested that over a transitional period of 30 years, the potential *incremental* benefits (i.e. over and above the existing NIH mandate) of the proposed FRPAA archiving mandate for all federally funded R&D might be worth around:

- Four times the estimated cost using the higher end LIFE^2 lifecycle costing;
- Eight times the cost using the NIH costing, which it was suggested would probably be the best estimate; and
- Twenty-four times the cost using the historical arXiv costing.
  Perhaps two-thirds of these benefits would accrue within the US, with the remainder spilling over to other countries. Hence, the US national benefits might be of the order of 3 to 16 times the costs, with the benefits from increased accessibility worth more than USD 1 billion over 30 years (Net Present Value).[51]

These studies demonstrate that more transparent and open access to publicly funded research publications can bring cost savings and efficiency improvements for both the producers and users of the information, as well as increasing the return on investment in the research by making it more accessible and increasing use (i.e. improving the productivity of publicly funded research, with both cost savings and more impact per funding dollar input).

5.2.2 Research data

Efforts to understand the costs and benefits involved in research data curation and sharing typically mix quantitative and qualitative methods, and rely primarily on case studies and extrapolation from there. Some have provided templates for assessing costs and benefits, but few have tried to look at the value or benefits of open access to, and sharing of, data.

In a series of projects under the title Keeping Research Data Safe (KRDS) Beagrie *et al.* (2008; 2010) explored the costs and benefits of research data curation and sharing in the UK and elsewhere in Europe.[52] The initial KRDS study investigated the medium to long-term costs to Higher Education Institutions (HEIs) of the preservation of research data, and provided a brief overview of the potential benefits to HEIs from preservation of research data. [53] It developed a framework and guidance for determining costs consisting of:

- A list of key cost variables and potential units of record;

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[50] http://www.cfses.com/SPARC-FRPAA/.

[51] Houghton, J.W., Rasmussen, B. and Sheehan, P. (2010) *Economic and Social Returns on Investment in Open Archiving Publicly Funded Research Outputs*, The Scholarly Publishing and Academic Resources Coalition (SPARC), Washington DC. Available http://www.arl.org/sparc/publications/papers/vuFRPAA/index.shtml

[52] Beagrie, N., Chruszcz, J., & Lavoie, B. (2008) *Keeping Research Data Safe: a cost model and guidance for UK Universities*, Joint Information Systems Committee. Available http://www.jisc.ac.uk/publications/publications/keepingresearchdatasafe.aspx. Beagrie, N., Lavoie, B., & Woollard, M. (2010) *Keeping Research Data Safe 2 Final Report* London: JISC. Available http://www.jisc.ac.uk/publications/reports/2010/keepingresearchdatasafe2.aspx#downloads.

[53] Beagrie, N., Chruszcz, J. and Lavoie, B. (2008) *Keeping Research Data Safe*, JISC, London and Bristol. Available http://www.beagrie.com/krds.php.

- An activity model divided into pre-archive, archive, and support services and divided into the major phases from an activity model and by duration of activity; and
  A resources template including major cost categories.

A series of case studies from Cambridge University, King's College London, Southampton University, and the Archaeology Data Service at York University, illustrated different aspects of costs for research data within HEIs. Selective illustrations of cost-benefits and costs over time were also provided.[54] Importantly, the study noted that the costs of a central data repository are an order of magnitude greater than that suggested for a typical institutional repository focused on e-publications alone - although likely less than the user and producer costs that would result from simply opening data, without appropriate curation (e.g. related metadata, sourcing information and guides).

Fry *et al*. (2008) sought to identify benefits arising from the curation and open sharing of research data.[55] They suggested that potential benefits include:

- Maximised return on investment in data collection;
- Broader access where costs would be prohibitive for individual researchers/institutions;
- Potential for new discoveries from existing data, especially where data are aggregated and integrated;
- Reduced duplication of data collection costs and increased transparency of the scientific record;
- Increased research impact and reduced time-lag in realising those impacts;
- New collaborations and new knowledge-based industries.
  Broader, indirect benefits might include:
- Transparency in research and funding;
- Use of data sets in education to enhance the data awareness of students;
- Enhanced researchers' skills through access to a broader range of data, tools and standards having the potential to increase data quality; and
- Increased visibility and promotion of those institutions and researchers that had performed best.[56]

The Fry *et al*. study used a mixed-method approach, including a literature review and qualitative case studies to inform the development of a model on which to build a business case for data sharing in UK Higher Education. This was based on extensions to the research data preservation

[54] Beagrie, N. (2009) *Draft Guide to Cost/Benefit Analysis for Research Data Services,* Charles Beagrie, Salisbury. Available http://www.beagrie.com/DMIcost&benefit_programmeguidev1.pdf.

[55] Fry, J., Lockyer, S., Oppenheim, C., Houghton, J.W. and Rasmussen, B. (2008) *Identifying benefits arising from the curation and open sharing of research data produced by UK Higher Education and research institutes*, JISC, London and Bristol. Available http://www.jisc.ac.uk/media/documents/programmes/digitalrepositories/jiscdataproposal-public.pdf.

[56] Summary derived from Beagrie, N. (2009) *Draft Guide to Cost/Benefit Analysis for Research Data Services,* Charles Beagrie, Salisbury. Available http://www.beagrie.com/DMIcost&benefit_programmeguidev1.pdf.

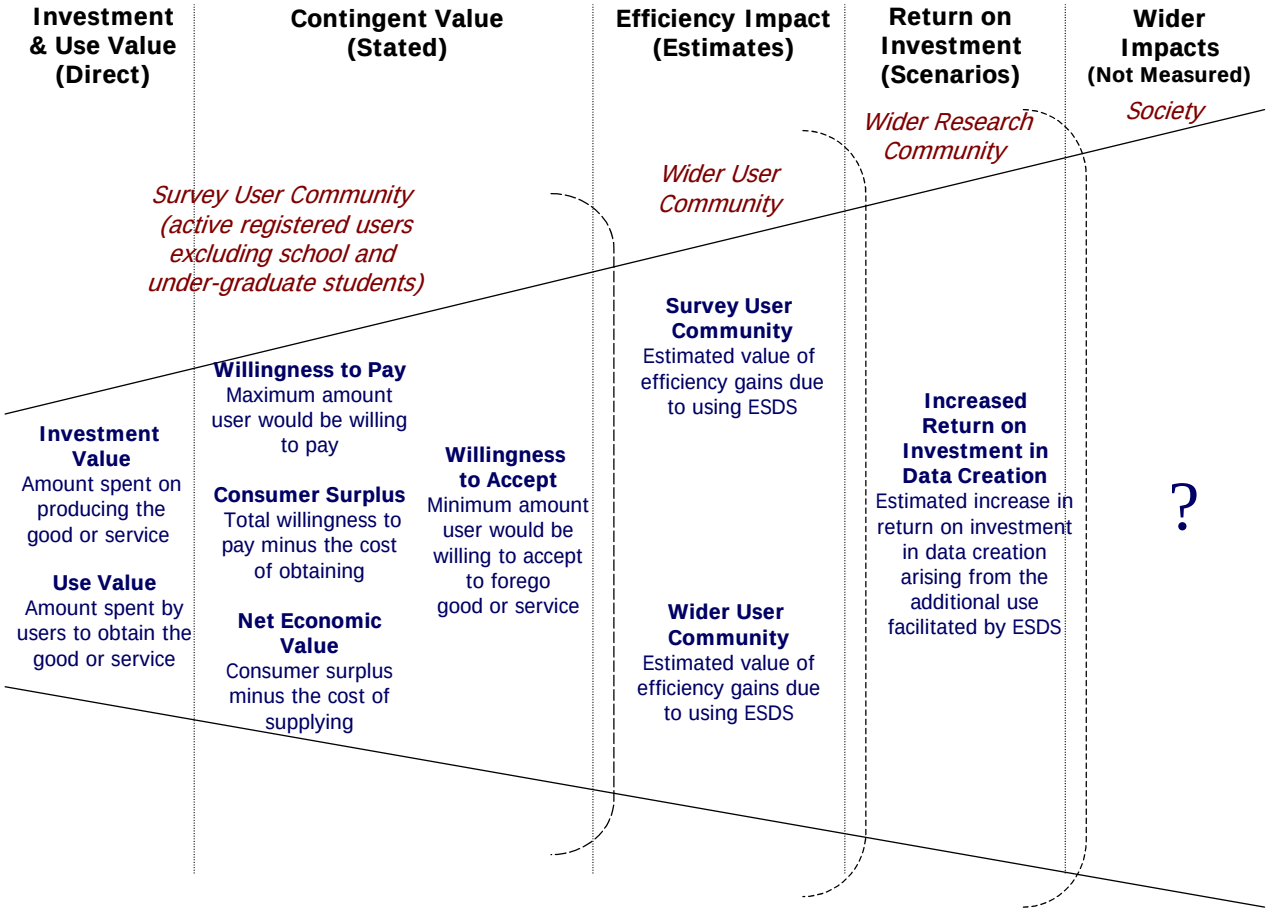
cost model proposed by Beagrie, to allow estimation of cost-benefits to users depositing or accessing data. The case studies investigated were the European Bioinformatics Institute (EBI) and Qualidata, which is part of the Economic and Social Data Service. Based on the work of co-authors Houghton and Rasmussen, the report presented a simple example of cost-benefit analysis applicable to an individual dataset or repository, based on costs and potential cost savings. It described the data requirements and walked the reader through the process step-by-step. The approach was then extended to explore the more diffuse benefits of data curation and sharing at the institutional and disciplinary levels. Importantly, the report included an outline questionnaire and template to facilitate cost-benefit analysis.[57]

Recognising that no single approach has dominated across the studies of research publications, research data and PSI that attempt to measure the value and economic impacts, Beagrie *et al*. (2012) drew on a number of approaches to explore the economic value and benefits of the UK Economic and Social Data Service (ESDS), beginning with approaches that can be seen as estimating minimum values and moving progressively toward approaches that can be seen as measuring some of the wider value (Figure 6). These included: investment and use value; contingent valuation using stated preference techniques; economic welfare in the form of consumer surplus and net economic value; and estimates of efficiency impacts and increases in returns on investment in data creation arising from the open sharing of data.[58]

Wider benefits and impacts are explored by looking at the *efficiency gains* enjoyed by users and assigning an economic value to them (e.g. activity cost savings), and by estimating the impacts of increased data use on *returns to investment* in the data collection/creation and the related data infrastructure services necessary for hosting and sharing the data. As these latter impacts are recurring during the useful life of the data Beagrie *et al.* (2012) used a simple Perpetual Inventory Method to estimate the overall value of the impacts over time. The analysis was based on an extensive user survey, supported by agency and user interviews and case studies.

[57] http://www.jisc.ac.uk/media/documents/programmes/digitalrepositories/jiscdataproposal-public.pdf.
[58] Beagrie, N., Palaiologk, A. Williams, P. and Houghton, J.W. (2012) *Economic Evaluation of Research Data Service Infrastructure: A Study for The ESRC*, Economic And Social Research Council. Available http://www.esrc.ac.uk.

Figure 6: Methods exploring the value and impacts of ESDS research data infrastructure.



Source: Beagrie, N., Palaiologk, A. Williams, P. and Houghton, J.W. (2012) *Economic Evaluation of Research Data Service Infrastructure: A Study for The ESRC*, Economic And Social Research Council, London.

Again, these studies explore the direct costs and benefits and wider economic impacts, and demonstrate the productivity improvements arising from open access, sharing and curation of research information (i.e. how greater value can be realised from the same level of research spending when the research results are made freely and widely available).

6. Case study examples of productivity impacts

In addition to the studies described in detail above, there are many examples of the efficiency and productivity impacts that arise through making PSI more openly and transparently available.
Governments spend a lot of time answering queries. Providing data for the citizen online in a searchable format can lead to a drop in the cost of servicing customers for the PSI holder while increasing transparency. Pollard (2011) reported that in the UK, when Bristol City Council introduced its open data catalogue it identified benefits in reduced transaction costs. It claimed

that the cost of a typical transaction was up to 15 times more expensive if answered in person (cost GBP 15) or telephone (cost GBP 12) than if answered over the internet (cost GBP 1). Furthermore, costs from servicing Freedom of Information Act requests could be reduced. It was estimated in 2007 that the annual cost of FOI requests in the UK was GBP 26 million for central government and that local government costs are similar.[59] Hence, potentially significant savings can be made.

As noted, Houghton (2011) found that in more than one of the case studies, agency and user transaction costs and cost savings were significant and that transparency of licensing was important in realising the savings. The Australian Bureau of Statistics (ABS) was estimated to have saved around $1 million per annum internally in handling, enquiry and transaction costs circa 2005-06 as a result of making publications and data free online and adopting creative commons licensing, and users engaged in the same transactions were estimated to have saved around $300,000 per annum in transaction costs in addition the $4.7 million saved from not paying access and licensing costs.[60]

Exploring the case of hydrological data, Houghton (2011) noted that water data has been fragmented and it is too early to measure the impacts of making National Water Account data available centrally. However, the *Victorian Water Resources Data Warehouse,* which gives access to both raw and summary data on water quality and quantity throughout Victoria, provides an example of the cost and use impacts of making water data freely available online. Secondary sources and informal consultations conducted for the study suggested that annual water data collection costs in Victoria were running at around $6.7 million in the late 1990s, of which 60% or $4 million related to water quantity data, 25% or $1.7 million to ground water data and 15% to water quality data. At that time, there were around 600 requests for water quantity data and 100 for water quality data per annum, suggesting an average cost per user request of some $7 180. It was reported that only around 5% of requests were from the private sector.[61]

Immediately prior to the establishment of the *Victorian Water Resources Data Warehouse* in 2004, there were three contractors serving user data requests at a cost of around $300 000 per annum. They handled around 400 requests per annum, suggesting an implied cost of around $750 per user request. Establishing the *Victorian Water Resources Data Warehouse* was a 5-year project costing around $870 000. In the early years of its operation it was reported to have handled 60 000 data requests in the first six months, at an implied cost of $1.45 each.[62] In mid 2011, the site reported a total of 1 257 958 visitors (an average of approximately 180 000 per annum). While not all visits amount to a data request, it seems that use increased and costs per

[59] Pollard, P. (2011) *Opening up government data: making the case*, ePSIplatform Topic Report No 26. Available http://epsiplatform.eu/sites/default/files/Topic_Report_No26_Opening_Gov_Data.pdf
[60] Houghton, J.W. (2011) *Costs and benefits of data provision,* Report to The Australian National Data Service, Canberra. Available http://ands.org.au/resource/cost-benefit.html.
[61] Watson, A. (1997) *Pricing Principles for CMSA Hydrologic Data and Information*, Melbourne.
[62] Consultation with Stuart Minchin, CSIRO.

use have fallen dramatically. Both the supply of and access to water data is more cost-effective and efficient.

GEO (2010) noted that the Earth's atmosphere, oceans and landscapes are changing rapidly. Monitoring and modelling these changes are critical to enabling governments, civil society and the private sector to make informed decisions about climate, energy, food security, natural hazard, health and other challenges. Many studies of the dissemination of PSI have demonstrated the value of open access to such information online. The lack of restrictions on their re-use provides much greater economic and social returns than proprietary dissemination systems with access costs and re-use restrictions. Real life examples mirror the findings of these studies:

- CBERS (China Brazil Earth Resources Satellite) removal of imagery charges resulted in increased access from 1 000 images per year to 10 000 images per month with more than 10 000 new users registered in the first year. Ninety-eight per cent of users surveyed agreed with the policy of open data access and reported the creation of many new jobs, the creation of new businesses, and improved research and teaching.
- The US Geological Survey achieved similar results following removal of Landsat's charges for Internet users, which resulted in more Landsat data (more than 1 million images) being processed and distributed in 2009 than in the whole previous 38 year mission history combined.
- Conversely, the ASTER Global Digital Elevation Model (GDEM) saw a reversal in fortunes following the introduction of charges in January 2006, with a substantial reduction in data distribution. A reversal in policy to no charge in June 2009 again provided a clear indication of dramatically increased usage of ASTER data worldwide (with over 6.5 million tiles distributed in FY 2009).

Improving data access and sharing systems significantly increases data value by reducing the cost and re-use restrictions for users.[63]

Miller (2010) notes that: data sourced from public bodies plays a role in a growing number of apps, assisting citizens in everything from checking the weather and locating their nearest recycling point or bus stop, to reporting graffiti and faulty street lights. In a number of cases, government agencies and departments commission their own apps, focussed solely upon delivering their data to end users. Elsewhere, the data is being accessed by third party developers, and integrated into apps that might also fulfil non-government functions.

PSI, formally released and made available to developers via a resource like data.gov.uk, offers rich potential to builders of apps. Some of those apps, will be intended almost exclusively to make a specific PSI resource accessible and useful. Far more, potentially, will be built for some other purpose entirely, and will simply draw upon one or more PSI resources to add value and context. A

[63] GEO (2010) *GEOSS Data Sharing Action Plan*. GEO-VII Plenary.

commercial restaurant booking app, for example, might be full of restaurant descriptions from the establishments themselves, and reviews from customers, but access PSI environmental health records for the restaurants and perhaps PSI information on railway stations and bus stops near each location. The point is not PSI, but PSI delivers clear value in making the app better, richer, and more useful.[64]

This example demonstrates the importance of making PSI freely available not just for others to use, but for them to combine and integrate with other information, adding value beyond that on the PSI itself.

Box 2: Anecdotal evidence of the potential impacts of open data

It was late in the afternoon, on a typically harsh Canadian winter day, as Rob McEwen, the CEO of Goldcorp Inc., stood at the head of the boardroom table confronting a room full of senior geologists. The news he was about to deliver was not good. In fact it was disastrous, and McEwen was having a hard time shielding his frustration.

The small Toronto-based gold-mining firm was struggling, besieged by strikes, lingering debts, and an exceedingly high cost of production, which had caused them to cease mining operations. Conditions in the marketplace were hardly favorable. The gold market was contracting, and most analysts assumed that the company's fifty-year-old mine in Red Lake, Ontario, was dying. Without evidence of substantial new gold deposits, the mine seemed destined for closure, and Goldcorp was likely to go down with it. Tensions were running at fever pitch. McEwen had no real experience in the extractive industries, let alone in gold mining. Nevertheless, as an adventurous young mutual fund manager he had gotten involved in a takeover battle and emerged as Goldcorp, Inc.'s majority owner. Few people in the room had much confidence that McEwen was the right person to rescue the company. But McEwen just shrugged off his critics.

He turned to his geologists and said, "We're going to find more gold on this property, and we won't leave this room tonight until we have a plan to find it." At the conclusion of the meeting he handed his geologists $10 million for further exploration and sent them packing for Northern Ontario. Most of his staff thought he was crazy but they carried out his instructions, drilling in the deepest and most remote parts of the mine. Amazingly, 2 few weeks later they arrived back at Goldcorp headquarters beaming with pride and bearing a remarkable discovery: Test drilling suggested rich deposits of new gold, as much as thirty times the amount Goldcorp was currently mining!

The discovery was surprising, and could hardly have been better timed. But after years of further exploration, and to McEwen's deep frustration, the company's geologists struggled to provide an accurate estimate of the gold's value and exact location. He desperately needed to inject the urgency of the market into the glacial processes of an old-economy industry.

In 1999, with the future still uncertain, McEwen took some time out for personal development. He wound up at an MIT conference for young presidents when coincidentally the subject of Linux

[64] Miller, P. (2010) *The rise of the App: a PSI opportunity?* ePSIplatform Topic Report No 18. Available http://epsiplatform.eu/topicreports

came up. Perched in the lecture hall, McEwen listened intently to the remarkable story of how Linus Torvalds and a loose volunteer brigade of software developers had assembled the world-class computer operating system over the Internet. The lecturer explained how Torvalds revealed his code to the world, allowing thousands of anonymous programmers to vet it and make contributions of their own.

McEwen had an epiphany and sat back in his chair to contemplate. If Goldcorp employees couldn't find the Red Lake gold, maybe someone else could. And maybe the key to finding those people was to open up the exploration process in the same way Torvalds "open sourced" Linux.

McEwen raced back to Toronto to present the idea to his head geologist. "I'd like to take all of our geology, all the data we have that goes back to 1948, and put it into a file and share it with the world," he said. "Then we'll ask the world to tell us where we're going to find the next six million ounces of gold." McEwen saw this as an opportunity to harness some of the best minds in the industry. Perhaps understandably, the in-house geologists were just a little skeptical.

Mining is an intensely secretive industry, and apart from the minerals themselves, geological data is the most precious and carefully guarded resource. It's like the Cadbury secret-it's just not something companies go around sharing. Goldcorp employees wondered whether the global community of geologists would respond to Goldcorp's call in the same way that software developers rallied around Linus Torvalds. Moreover, they worried about how the contest would reflect on them and their inability to find the illusive gold deposits.

McEwen acknowledges in retrospect that the strategy was controversial and risky. "We were attacking a fundamental assumption; you simply don't give away proprietary data," he said. "It's so fundamental," he adds, "that no one had ever questioned it." Once again, McEwen was determined to soldier on.

In March 2000, the "Goldcorp Challenge" was launched with a total of $575,000 in prize money available to participants with the best methods and estimates. Every scrap of information (some four hundred megabytes worth) about the 55,000-acre property was revealed on Goldcorp's Web site. News of the contest spread quickly around the Internet, as more than one thousand virtual prospectors from fifty countries got busy crunching the data.

Within weeks, submissions from around the world came flooding in to Goldcorp headquarters. As expected, geologists got involved. But entries came from surprising sources, including graduate students, consultants, mathematicians, and military officers, all seeking a piece of the action. "We had applied math, advanced physics, intelligent systems, computer graphics, and organic solutions to inorganic problems. There were capabilities I had never seen before in the industry," says McEwen. "When I saw the computer graphics I almost fell out of my chair." The contestants had identified 110 targets on the Red Lake property, 50 percent of which had not been previously identified by the company. Over 80 percent of the new targets yielded substantial quantities of gold. In fact, since the challenge was initiated an astounding eight million ounces of gold have been found. McEwen estimates the collaborative process shaved two to three years off their exploration time.

Today Goldcorp is reaping the fruits of its open source approach to exploration. Not only did the contest yield copious quantities of gold, it catapulted his under-performing $ 100 million company into a $9 billion juggernaut while transforming a backward mining site in Northern Ontario into one of the most innovative and profitable properties in the industry. Needless to say McEwen is

one happy camper. As are his shareholders. One hundred dollars invested in the company in 1993 is worth over $3 000 today.
Perhaps the most lasting legacy of the Goldcorp Challenge is the validation of an ingenious approach to exploration in what remains a conservative and highly secretive industry. Rob McEwen bucked an industry trend by sharing the company's proprietary data and simultaneously transformed 2 lumbering exploration process into a modem distributed gold discovery engine that harnessed some of the most talented minds in the field.
McEwen saw things differently. He realized that the uniquely qualified minds to make new discoveries were probably outside the boundaries of his organization, and by sharing some intellectual property he could harness the power of collective genius and capability. In doing so he stumbled successfully into the future of innovation, business, and how wealth and just about everything else will be created. Welcome to the new world of wikinomics where collaboration on a mass scale is set to change every institution in society.

Source: Tapscott, D. and Williams, A.D. (2008) *Wikinomics: How mass collaboration changes everything*. Penguin Books, London.

There are many examples and much anecdotal evidence presented in studies and reports, Box 2 is just one example. While real world examples can be compelling, many do not represent the robust methods sought in this review. For example, the outcome described in the example in Box 2 could have been got through a competition that required contestants to sign a non-disclosure agreement: it is about bringing a wider range of people and skills to bear on the issue, not about open access to the data, per se. However, of course, in general, more people are more likely to see and use data that is openly and transparently accessible. Moreover, the results of their work is more likely to the transparently and openly usable when based on open data than might otherwise be the case.

7. Practices, mechanisms, lessons and tools

There is widespread discussion of the practices and mechanisms likely to bring most success. Among the most often mentioned is clarity about what open means. The Open Data Handbook says: open data is data that can be freely used, reused and redistributed by anyone - subject only, at most, to the requirement to attribute and share alike.[65]

The potential benefits noted in the various examples presented above can be realised by turning PSI into open data. This will only happen if it is really open (i.e. if there are no restrictions (legal, financial or technological) to its re-use by others). The implications are clear.

[65] Available http://opendatahandbook.org/en/

- The PSI should be made available free or at the marginal cost of distribution (i.e. effectively free online), if at all possible. Obviously there will be privacy issues in some areas, but the vast majority of PSI has no such limitations.
- It should be covered by clear and simple licensing that is standardised and readily understood by existing and potential users, and be machine readable (e.g. creative commons licensing).
- There should be minimal restrictions on use, non-discrimination regarding users and uses (e.g. there is no reason to restrict use to non-commercial uses).
- To make the information easily discoverable attention to quality metadata is essential and a one-stop portal for government data can be useful.
- Engaging with potential users and promotional activities and awareness raising have been successful around the world (e.g. competitions, hack and mash-up days, etc.).

It is also important to deal with concerns and confront barriers to openness and transparency. As Pollard (2011) notes:

Whilst there are benefits in opening up public sector information for re-use custodians of public data also perceive risks that can hamper the opening up of PSI. In particular, there are issues relating to resources, data quality and institutional change. However, where there is a commitment to opening public data there is evidence that these risks can be managed.

'We don't have the resources' - *Many countries are currently experiencing budgetary constraints leading to reluctance to take on more tasks particularly were the public sector body itself may not benefit. However, data publishing need not be complicated or costly if a step-by-step approach is taken and effort can be made to identify agency benefit from investment in data publishing, for example, transaction costs in responding to queries or Freedom of Information requests can be reduced. The possibility of an increased workload due to enquiries from the public or media about published data can be managed by providing information about the data and the level of support that can be expected. In addition, contact with the public can lead to an increased awareness of the importance of data accuracy which can benefit the custodian.*

'We are worried about data accuracy and data privacy' - *Publishing public data can reveal inaccuracies that embarrass the PSI custodian or cause harm, but such anxieties can be minimised by a gradual approach where stakeholders are consulted and the reliability of the data explained. When the UK government published crime data, journalists criticised inaccuracies (in part caused by the recording of some crimes at the police station itself) and reported fears that the information could impact negatively on house prices. However, even in this high profile case with the site receiving 18 million hits per hour, it was possible to manage expectations. Journalists argued that the data will improve through exposure, that not all stakeholders had been consulted and that crime should not be swept 'under the carpet' simply because of fears about house prices.*

Public bodies also worry that they may release personal data (or confidential business data) and believe that determining whether or not data can safely be published requires expert legal advice. However, it is usually the case that datasets which contain personal data have already been identified and marked with privacy flags to meet data protection legislation.

'It is our data, we decide how it is used' - *Cultural barriers are difficult to address because they are often unacknowledged. There is a perception that to publish data is to relinquish the power associated with the data to a wider audience, described as a fear of loss of 'interpretational sovereignty'... Where public data is subject to cost recovery policies resistant to releasing data can become more entrenched because of the potential loss of a secure income stream. In many cases, the decision cannot be made by the PSI holder acting alone.*[66]

There is no doubt that there are some technical, legal and cultural barriers to open and transparent access to PSI, but none are insurmountable if they are acknowledged and dealt with. Tensions with existing cost recovery policies will need to be specifically addressed. Information producers have been encouraged to commercialise intellectual property and cost recovery has been built into the funding models of some institutions. Business systems and behaviours that have evolved in this climate can conflict with more recent policy settings encouraging open access. Explicit guidance will be required to reconcile these approaches.

As the Open Data Handbook suggests, it is important to keep it simple (e.g. start with datasets that are easy to deal with an unlikely to have privacy or other legal concerns), engage early and often (e.g. talk with actual and potential users to understand what they want), and address common concerns and fears (e.g. identify the concerns and deal with them as early as possible). They suggest that the four main steps to success are:

- Choose your dataset(s) - choose the dataset(s) you plan to make open. Keep in mind that you can (and may need to) return to this step if you encounter problems at a later stage.
- Apply an open license - determine what intellectual property rights exist in the data, apply a suitable 'open' license that licenses all of these rights and supports the definition of openness (NB. if you cannot do this go back to step 1 and try a different dataset).
- Make the data available - in bulk and in a useful format. You may also wish to consider alternative ways of making it available, such as via an API.
- Make it discoverable - post on the web and perhaps organize a central catalogue to list your open datasets.[67]

While such guidelines are useful, it is also important to learn from others: search for comparable examples from around the world (e.g. the European PSI platform http://epsiplatform.eu/), and talk to other government agencies in Australia that have already moved to open and transparent access and learn from the leaders (e.g. Australian Bureau of Statistics, GeoScience Australia, etc.). Less commonly discussed, but, perhaps, no less important, is for government agencies to avoid competing with/spoiling competition with potential (re)users. For example, it has become common for government agencies to subsidise the development of, and make freely available,

[66] Pollard, P. (2011) *Opening up government data: making the case*, ePSIplatform Topic Report No 26. Available http://epsiplatform.eu/sites/default/files/Topic_Report_No26_Opening_Gov_Data.pdf
[67] Available http://opendatahandbook.org/en

apps and other value added products that can undermine the basis for innovation and commercialisation (e.g. weather, transport timetabling, etc.). The underlying data should be made freely and transparently available to potential (re)users. Any in-house value adding activities should be carefully considered and only undertaken if there is little or no likelihood of the emergence of commercial alternatives.

As an example, Miller (2010) noted that commercial developers are currently making money writing apps for a wide range of public sector clients. In those cases, the app is typically given away for free, which raises longer term questions about the wisdom of such an approach. The [UK] Met Office app, for example, is rich, fully-featured, authoritative, and free. As such, it is difficult for a third party to create a weather app for the UK (whether based upon Met Office data or some other source), charge for it, and expect to sell in significant quantities. If, on the other hand, the Met Office had simply made its data easily accessible, a range of similar apps might have emerged and competed for attention on the basis of cost, features, etc. For those unwilling to pay for one of these apps, the Met Office public service weather forecast would still have been freely accessible via their web site, and via partners such as the BBC. In areas where the responsible public sector body has not commissioned production of a dedicated app, we have already seen third party developers willing to step in and make freely available PSI more useful to end users; end users who are prepared to pay for this added value.[68] This example demonstrates the potentially innovation and competition limiting effects of agencies' making their information available in value added for.

8. Measuring productivity impacts

There are a number of frameworks that have been developed to measure the benefits of open and transparent access to PSI, eGovernment, etc. that could be applied. There are also useful discussions and reviews. For example, the fourth issue of the *European Journal of ePractice* focused on the topic of the 'efficiency and effectiveness' of public eServices. It included analytical articles and examples of how innovative deployment of ICT combined with institutional and organisational change have contributed to increasing the efficiency and effectiveness of public administrations.[69] Beyond this special issue, the journal is a very useful source.

Millard (2008) noted that the eGovernment policy focus has moved over the last five years from being mainly concerned with efficiency to being concerned both with efficiency and effectiveness. His paper examined the current and future development of eGovernment policy making, and the critical role that measurement and impact analysis has in it. From an almost exclusive focus on the efficiency impacts of eGovernment over government itself, there is a clear movement towards an increased attention on effectiveness impacts, as well as to wider governance impacts. This is going hand-in-hand with a change away from measuring only the inputs and outputs of eGovernment

[68] Miller, P. (2010) *The rise of the App: a PSI opportunity?* ePSIplatform Topic Report No 18. Available http://epsiplatform.eu/topicreports

[69] http://www.epractice.eu/files/ePractice-Journal-Volume-4_0.pdf

initiatives towards a much greater emphasis on analysing and measuring the outcomes for constituents and the impacts on society as a whole, for example through increased public value.[70]

8.1 Benchmarking and measurement methods

While all methods have limitations, the following are among some of the more widely used and established methods for benchmarking and measuring productivity impacts:

The eGEP Measurement Framework Model is built around the three value drivers of *efficiency*, *democracy,* and *effectiveness* and elaborated in such a way as to produce a multidimensional assessment of the public value potentially generated by eGovernment, not limited to just the strictly quantitative financial impact, but also including more qualitative impacts (Figure 5, above).[71] It has been used in a number of studies, including the study on impacts of spatial data in Catalonia described in detail above.[72] Reflections on its development have also been published.[73]

Open Government and Public Value Tool - identifies a range of Public Value Impacts, which are described as categories that capture the range of possible results of opening government. The tool then considers the meaning of 'value' according to four criteria: Value in what sense? For whom? By what mechanisms? And under what conditions? It proposes an answer in terms of six changes that may be achieved by openness:

- Efficiency – changes in outputs or goal attainment with the same resources, or obtaining the same outputs or goals with lower resource consumption.
- Effectiveness – changes in the quality and/or quantity of the desired outcome.
- Intrinsic enhancements – changing the environment or circumstances of a stakeholder in ways that are valued for their own sake.
- Transparency – change in access to information about the actions of government officials or operation of government programs that enhances accountability or citizen influence on government
- Participation – changes in frequency and intensity of direct citizen involvement in decision making about or operation of government programs or in selection of or actions of officials

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[70] Millard, J. (2008) eGovernment measurement for policy makers, the *European Journal of ePractice*, Vol 4, pp19-32. Available http://www.epractice.eu/files/ePractice-Journal-Volume-4_0.pdf

[71] EC (2006) *eGEP Measurement Framework,* EC, Brussels. Available http://www.umic.pt/images/stories/publicacoes200709/D.2.4_Measurement_Framework_final_version.pdf

[72] Almirall, P.G., Bergada, M.M. and Ros, P.Q. (2008) *The Socio-Economic Impact of the Spatial Data Infrastructure of Catalonia*, JRC Scientific and Technical Reports. Available http://inspire.jrc.ec.europa.eu/reports/Study_reports/catalonia_impact_study_report.pdf

[73] Codagnone, C. (2008a) *Visionary eGovernment perspectives*, Delivered within the Benchlearning Framework Contract for the European Commission, DG Information Society, Unit H2. Codagnone, C. (2008b) *eGEP 2.0*, Delivered within the Benchlearning Framework Contract for the European Commission, DG Information Society, Unit H2. Codagnone, C. (2007) Measuring eGovernment: Reflections from eGEP Measurement Framework Experience, *European Review of Political Technologies*, 4, 89-106.

- Collaboration – changes in frequency or duration of activities in which more than one set of stakeholders share responsibility or authority for decisions about operation, policies, or actions of government.[74]

The tool itself is available under a free licence for use by government and is accompanied by a report that explains the rationale behind it.[75]

The Open Government Dashboard - is a tool to assess the progress of open government initiatives in the United States. A scorecard was developed that indicates the progress of agencies in a variety of open government initiatives.[76] The tool is designed to assess progress towards the goals outlined in the Open Government Directive and judges agencies' performance in areas such as transparency, participation and public consultation. The scorecard incorporates criteria for the publication of high value data and data integrity; public consultation, participation, transparency and collaboration; and an agency's overall plan for fulfilling the directive. The dashboard gives a visual representation of agencies' progress.[77]

8.2 Recent developments

Osimo (2008) argues that the approaches for measuring eGovernment, which centre on the availability of online services, have served their purpose well, but are now rapidly reaching the end of their usefulness.[78] In view of recent developments linked to web 2.0, he proposes that *transparency* of public data should be considered as a flagship eGovernment initiative, just as "making services available online" was in a previous era. In order to support this proposal, he analyses:

- The case for government transparency as a flagship goal;
- The degree of policy priority which is increasingly given to it;
- The originality of the idea with respect to the traditional debate on transparency and "open government"; and
- The possible benefits and drawbacks of transparency as a flagship initiative for eGovernment policy.

He then puts forward a new simple and cost-effective method, based on the existing methods for measuring transparency. It focuses on 20 basic forms of PSI, rather than 20 basic public services. Instead of measuring the four stages of online interactivity (from no information to transaction), it

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[74] OAIC (2011) *Issues Paper 2: Understanding the Value of Public Sector Information in Australia*, OAIC, Canberra. Available http://www.oaic.gov.au/publications/papers/issues_paper2_understanding_value_public_sector_information_in_australia.html

[75] http://www.ctg.albany.edu/publications/online/pvat/

[76] http://www.whitehouse.gov/open/around

[77] AIC (2011) *Issues Paper 2: Understanding the Value of Public Sector Information in Australia*, OAIC, Canberra. Available http://www.oaic.gov.au/publications/papers/issues_paper2_understanding_value_public_sector_information_in_australia.html

[78] Osimo, D (2008) Benchmarking eGovernment in the Web 2.0 era: what to measure, and how, *European Journal of ePractice*, Vol 4. Available http://www.epractice.eu/en/journal/volume/4

assesses the four states of transparency and reusability of public data (from no information to reusable and machine-readable data).[79]

Aside from the methodological contribution, Osimo highlights one of the most important points. Namely, that not about making eGovernment services available, but rather about making data available, making it reusable and machine readable.

8.3 An Australian example

Measuring the Costs and Benefits of Data Provision - suggests one possible framework focused on agency and user cost impacts, efficiency and productivity impacts and wider economic impacts, and provides a guide to data requirements.[80] Separating any one-off costs associated with making PSI openly and freely available from any on-going annual costs, this study outlined likely agency and user cost impacts through the information life-cycle, including: data collection/creation, data assurance (i.e. quality, privacy, copyright, etc.), curation, dissemination, permission, access and (re)use.

In addition to these direct agency and user costs and cost savings, there are a number of possible efficiency and productivity impacts arising from free access and standardised licensing and data formats.

For agencies, potential efficiency and productivity impacts include:

- An increase in the level of use and uses per funding dollar;
- Enhanced performance against key performance indicators;
- Enhanced agency profile from greater use and exposure, which can result in greater appreciation and central funding, and/or bring greater demand for enhanced products and services, thereby increasing revenue; and
- Greater focus on core business activities (*e.g.* reduced shopfront and e-commerce operations).

For users, potential efficiency and productivity impacts include:

- The purchase price savings and savings in handling and transaction costs noted above, enabling cost reduction and efficiency gains;
- Greater licensing certainty / reduced uncertainty and freedom to use leading to more predicable investment decisions, as well as savings in licensing enquiry efforts; and
- Use of better / fuller / more detailed data, rather than settling for a lesser / cheaper substitute.

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[79] Osimo, D (2008) Benchmarking eGovernment in the Web 2.0 era: what to measure, and how, *European Journal of ePractice*, Vol 4. Available http://www.epractice.eu/en/journal/volume/4

[80] Houghton, J.W. (2011) *Costs and benefits of data provision,* Report to The Australian National Data Service, Canberra. Available http://ands.org.au/resource/cost-benefit.html.

Wider economic and social impacts relate to what Beagrie *et al*. (2010) referred to as investors and society or the public at large.[81] Clearly the funders of the data collection (investors) have a strong interest in protecting and maximising the return on their investment in the data collection/creation activity through ready availability and increased use. (Re)users of the PSI have an interest not only in the time and cost involved in access, but also in the opportunities for innovation and the development and introduction of new products and services. Society or the public at large will benefit from access to and use of these innovative products and services, as well as the potential efficiency and productivity of the government agencies they support through taxation, better informed and potentially better government and business decisions.

While difficult to measure, Houghton (2011) outlines a possible approach to measuring the direct agency cost and efficiency (productivity) impacts and estimating impacts on consumer welfare and potential wider productivity impacts in terms of increased returns to investment in PSI arising through increased use, that is based very largely on internal agency data.[82] Hence, it is relatively easy to collect the necessary data for the analysis outlined.

9. Conclusions

There are many issues arising and limitations to the various approaches that have been employed to measure the value and productivity impacts of open and transparent access to PSI (e.g. establishing the direction of causation and abstracting from the many intervening variables coming between accessibility and wider impacts). Nevertheless, there are measurement frameworks that demonstrate the probability of a link between transparent and open PSI management practices and productivity.

There are many case study examples and more formal measurement frameworks that demonstrate a link between transparent and open PSI management practices and productivity. We look at studies that examine agency costs, cost savings and benefits, and impacts on information users and the wider economy.

We find that there are one-off costs for agencies during the transition (e.g. in establishing new open data systems and dismantling old systems for dissemination) and there may also be a recurring loss of revenue from sales (e.g. in no longer seeking cost recovery). Nevertheless, agencies and their information users also stand to save recurring costs (e.g. the transaction costs involved in cost recovery and licensing activities), and can free up staff and other resources from these activities. There are also wider economic benefits (e.g. through greater use of quality information and the development of innovative PSI-based products and services). By making PSI freely and openly available for use, governments encourage engagement and participation and realise increased return on investment in PSI.

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[81] Beagrie, N., Lavoie, B. and Woollard, M. (2010) *Keeping Research Data Safe 2*, JISC, London and Bristol. Available http://beagrie.com/krds-i2s2.php.

[82] Houghton, J.W. (2011) *Costs and benefits of data provision,* Report to The Australian National Data Service, Canberra. Available http://ands.org.au/resource/cost-benefit.html.

The key mechanisms and lessons are clear:

- The PSI should be made available free or at the marginal cost of distribution (i.e. effectively free online), if at all possible.
- It should be covered by clear and simple licensing that is standardised and readily understood by existing and potential users, and be machine readable (e.g. creative commons licensing).
- There should be minimal restrictions on use, non-discrimination regarding users and uses (e.g. there is no reason to restrict use to non-commercial uses).
- The information should be easily discoverable including by search, so attention to quality metadata is essential. A one-stop portal for government data can also be useful (e.g. data.gov.au) as can data collections and catalogues (e.g. www.ands.org.au).
- It is important to engage with potential users - promotional activities, awareness raising and engagement with users have been successful around the world (e.g. competitions, hack and mash-up days, etc.).
- It is also important to deal with concerns and confront barriers to openness and transparency. Such barriers exist at most levels of organizations requiring leadership from the top and a multi-tiered approach to addressing the barriers.

The report of the government 2.0 taskforce outlines the principles and issues,[83] and there are a number of guides to publishing PSI that outline the steps to take and issues to consider (e.g. http://webguide.gov.au/web-2-0/publishing-public-sector-information/).

[83] Government 2.0 Taskforce (2009) *Engage: Getting on with Government 2.0*. Department of Finance and Deregulation, Canberra. Available http://www.finance.gov.au/publications/gov20taskforcereport/index.html

Annex I

Indicators for local authorities

EFFICIENCY

Impact	Indicator
Monetary gains	Savings in time (hours/month)
	Expected or predicted savings in consumables (qualitative)*
Better prepared personnel	More motivated employees with new training (qualitative)*
Improvements in the organisation	Time saved in the redesigned processes (hours/month)
	New processes (*e.g.* cadastre maintenance, license teams) (list-qualitative)
	Interoperable services (*e.g.* public service, permits) (list-qualitative)
	Interdepartmental data sharing (list-qualitative)
	Better planning of actions and decisions (list-qualitative)
	GIS services accessible from municipal websites (list-qualitative)

EFFECTIVENESS

Impact	Indicator
Benefits for residents	Time saved by residents (hours/month)
	Time saved by companies (hours/month)
User satisfaction	Repeat users of services (qualitative)*
	Volume of data queries and downloads (number)
	User satisfaction (qualitative)
Extension of services	Use of new services by businesses (qualitative)*
	Use of new services by residents (qualitative)*
	Uses enabled exclusively by SDI (qualitative)

DEMOCRACY

Impact	Indicator
Openness and transparency	Interactive services and web access (number)
	Available metadata records (number)
Participation	Complaints, queries, suggestions, errors, etc. transmitted electronically (number/month)*

NOTE: The indicators marked with * were originally meant to be quantitative but during the survey it became clear that it was not possible to quantify them at the current state of development, and therefore were assessed in qualitative terms.

Indicators for users

Private companies

Impact	Indicator
Monetary	Increase in sales (€/month)
	Reduction of programming time (hours/month)
	Increase in added value (qualitative)
	Savings in licenses (€/month)
	Reduction of maintenance time (qualitative)
	Increase in profitability of projects (qualitative)
Technological	More technologically advanced projects (qualitative)
	More-structured projects (qualitative)
	Better-prepared personnel (qualitative)
	Amount of training (hours/worker/year)
Marketing	Increased requests by clients for IDEC geoservices (qualitative)
	Increased awareness and interest in GIS (qualitative)
	Easier sales (qualitative)
	Increased business (qualitative)

Institutional Users

Impact	Indicator
Monetary	Reduction of the costs of projects and applications (hours or €/month)
	Reduction in data maintenance costs (€)
	Reduction of implementation costs (e.g. reduced licence fees) (€)
	Better quality of outputs (qualitative)
Technological	Reduction in data updating time (hours/month)
	Simplification of project management (hours saved/month)
	Problems in use of IDEC Geoservices (qualitative)
Strategic	Increased ability to undertake previously infeasible projects (qualitative)
	Increased ability to handle large data volumes (qualitative)
	Improved project management (qualitative)
	Increased awareness of and/or interest in GIS (qualitative)

Source: Almirall, P.G., Bergada, M.M. and Ros, P.Q. (2008) *The Socio-Economic Impact of the Spatial Data Infrastructure of Catalonia*, JRC Scientific and Technical Reports.