REVIEW OF RECENT STUDIES ON PSI RE-USE AND RELATED MARKET DEVELOPMENTS

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EXECUTIVE SUMMARY / KEY FINDINGS

- Public bodies hold a very wide array of information and content ranging from demographic, economic and meteorological data to art works, historical documents and books. Given the pervasive availability of such information and content in digital form and the widespread use of information and communication technologies (ICTs) by secondary users, public sector information and content are an increasingly valuable resource for the production of innovative value-added goods and services and a major source of educational and cultural knowledge for the wider population.

- Knowledge is a source of competitive advantage in the "information economy", and for this reason alone it is economically important that public information is widely diffused. There are many benefits from improving access and facilitating reuse of PSI, taking into account legal requirements and restrictions. These benefits include development of new products built directly on PSI; development of complementary products such as new software and services; reduction of transaction costs in accessing and using information; efficiency gains in the public sector itself; and increasingly the crossing of different public and private information to provide new goods and services. There are further benefits from using PSI in a myriad of direct and indirect applications across the economy and society.

- Governments also have basic commitments that citizens can access public information and national cultural heritage such as paintings, monuments and books, and to ensure social inclusion. New communication tools, including social networks, interactive Web sites and games are facilitating wider diffusion of public sector information by reaching groups of people previously unlikely to directly access PSI or PSI-related services.

- This literature review looks at **PSI market size and impacts** following the widely cited estimates in the **MEPSIR study (2006)**. MEPSIR concluded that the direct PSI re-use market in 2006 for the EU25 plus Norway was worth **EUR 27 billion**.

- On the basis of more recent studies the narrowly defined **EU27 direct PSI re-use market** was of the order of **EUR 28 billion in 2008.** All studies show relatively rapid growth in PSI-related markets, and assuming annual growth of 7%, the direct PSI-related market would have been **around EUR 32 billion in 2010**. Considering re-use activities in domains not included in the studies analysed in this report (for example, where re-use is not a principal activity, or in government and research activities) **the market value of direct PSI re-use (the economic "footprint") is undoubtedly larger.**

- PSI-related information can be used in a very wide range of direct and indirect applications across the economy. The **aggregate direct and indirect economic impacts from PSI applications and use across the whole EU27 economy are estimated to be of the order of EUR 140 billion annually**.

- The above estimates of direct and indirect PSI re-use are based on **business as usual**, but other analysis suggests that if **PSI policies were open, with easy access for free or marginal cost of distribution, direct PSI use and re-use activities could increase by up to EUR 40 billion for the EU27**.

- **With easier access, improved infrastructure and lower barriers, aggregate direct and indirect economic benefits for the whole EU27 economy could have been of the order of EUR 200 billion (1.7% of GDP) in 2008.**

- Thus it is clear that new applications and uses in a wide variety of goods and services and future innovations associated with easier access to PSI are more important than the direct PSI market, and emerging second-order uses can be expected to add further economic and social benefits to the EU27 economy.

- Studies on individual PSI reuse sectors suggest that removing current barriers to access and improving the underlying infrastructure could achieve considerable gains. In **the geospatial sector, economic benefits could be increased by some 10-40% by improving access, data standards, and building skills and knowledge**. Productivity gains from geospatial applications in local government could double over the next 5 years if better policies were adopted. Large new markets could also develop in financial, energy and construction sectors if access to information were improved.

- **In terms of efficiency gains** in existing operations, **improving accessibility of information necessary for obligatory environmental impact assessments could potentially reduce EU27 costs by 20% or around EUR 2 billion per year**, **open access to R&D results could result in recurring gains of around EUR 6 billion per year**, and **if European citizens each saved as little as 2 hours per year** by more rapid and comprehensive access to public information, **this would be worth at least EUR 1.4 billion per year**.

- In comparison, **direct revenues to governments from PSI are relatively low** and are much lower than the estimated benefits from access to PSI. **EU27 government revenues at the upper end of estimates are of the order of EUR 1.4-3.4 billion** based on revenues in the Netherlands and the United Kingdom respectively. However, these two countries have been relatively effective in collecting revenues, and total revenues for the EU27 are likely to be considerably lower, with sales revenues usually less than 1% of agency budgets and a maximum of one-fifth of budgets in a few cases.

- There **is emerging evidence that improving access and lowering prices dramatically have positive impacts on the number of users and development of new uses. At the same time, changing access and pricing policies provide opportunities for reviewing the role of the public task in generating and distributing PSI and implementing other changes to make PSI more accessible**.

- On the other hand, research suggests that where pricing is lowered to the marginal cost of distribution, **government agency revenues foregone from direct sales of PSI could be provided via replacement funding from central government**, mixed with "updater" funding models, where, for example, businesses pay a higher levy to update their data in business registers. The **extra funding involved is estimated to be very small compared with the budgets of public sector bodies providing public sector information** and is even smaller when compared with additional benefits from greater PSI-related economic activity. Research also suggests that the number of users may increase dramatically, increasing marginal cost pricing revenues.

- There are gradations in approaches to improving access and facilitating reuse depending on where countries are positioned in their PSI re-use policies. Policy strategies include: opening up PSI that has been difficult to access and reuse; reviewing restrictions on access and use and amending unnecessary restrictions; reviewing the public task; facilitating access to third party rights holders' material where rights holders agree. It is also worthwhile improving the IT infrastructure and rationalising terms of access/use policy for intra-government PSI reuse (e.g. between national and local governments) with direct benefits to governments and related spillovers to the private sector. Furthermore the **international dimensions of PSI access need strengthening, both in accessing international data, and international access and use of national data**. Finally, general

equilibrium and consumer surplus analysis could be undertaken to give more comprehensive pictures of benefits from better access to and use of PSI.

TASK DESCRIPTION

The re-use of Public Sector Information is a new emerging area of the "ICT sector", which has proven to be a very difficult area to measure given its very specific nature.

In the context of the forthcoming review of the PSI Directive, there is a need to update the figure of the potential market value of PSI re-use in Europe, since the currently available figures are that of the MEPSIR Study undertaken in 2006, which concluded that the PSI re-use market was worth potentially EUR 27 billion.

Since 2006 many development have taken place in the context of the PSI arena, namely the full transposition of the PSI Directive in Member States, the implementation of deployment measures in some Member States to reap the full benefits of PSI re-use, as well as the development of new products and services based on PSI and similar digitisable information. In this context a revised and updated figure of the potential value of the PSI re-use market in Europe is required to take account of different developments that have taken place since 2006.

In order to achieve the revised figure it is required that the services of an independent PSI Economist are purchased in order to perform the following tasks:

- To summarise the findings of the currently available studies on PSI re-use, either sectoral or national, and assess any changes/development since 2006.

- Based on the above, to provide estimates of the value of PSI re-use in Europe.

1. INTRODUCTION

The public sector is a large producer, collector and repository of a wide variety of data/information and content. Two main technological developments have radically changed and re-shaped the role of public sector information and content. These are: i) technologies that enable the digitisation of public resources as they are produced, and retrospectively for public resources already existing; and ii) deployment of broadband technologies that enable better access and find-ability of PSI and much more rapid dissemination of it.[1]

Digitisation is a crucial factor for the commercial exploitation of PSI and the diffusion of content held for example in public cultural establishments. Once digitised, information and content becomes more storable, transportable and exchangeable bringing new opportunities and challenges for the public sector in areas including information management, maintenance, access, preservation and interoperability. The innovations of information and content digitisation and dissemination enabled by high speed Internet have transformed the business of information and content distribution and reinvented the way governments, public organisations and businesses interact with each other and with the public.

New technological possibilities and efficient use of ICTs have also introduced new tools for the diffusion of cultural and educational content to achieve socio-economic goals such as social inclusion and the provision of learning facilities. The Internet also provides a virtual space where vast amounts of digital material are deposited daily, much of which relying on short-lived technologies, raising questions for preservation and interoperability.

1.1. Definitions

Public sector information (PSI) directly generated by public institutions and information and content held by cultural establishments, archives, and the like is any kind of information that is produced and/or collected and held by a public body as part of its public task. In Europe, better access to public sector information has received broad attention following Directive 2003/98/EC on the Re-use of Public Sector Information. This Directive is being reviewed as a key part of the ambitious Digital Agenda for Europe (European Commission, 2010), notably in its scope, principles on charging for access and use, competition and intellectual property issues.

[1] The Introductions is drawn in particular from previous work undertaken by the OECD (OECD, 2006). Note that OECD work distinguished between: public sector information, which is information generated by governments that tends to be readily re-usable, and includes e.g. geographical and meteorological information; and public content, which is held by governments for a clear public good task to make it widely available, and includes e.g. public cultural holdings, public archives, etc. As these two types of information are on a continuum rather than being two distinctly different groups with a clear dividing line, in this report they are divided into two categories of public sector information, while still retaining their attributes of being on a continuum.

There is no standard international terminology for the whole public information/content area and its subsets. Outside of the EU27, for example in Korea reference is made to "public knowledge information resources", and in the United States the terms "public information" and "government information" are widely used. Furthermore, PSI may also be used as an umbrella term for all information and content produced and held by public bodies, but there may also be exclusions.[2]

For analytical and operational reasons it is useful to differentiate between:

- Public sector information which often has characteristics of being: dynamic and continually generated, directly generated by the public sector, associated with the functioning of the public sector (e.g., meteorological data, geo-spatial data, business statistics), and often readily useable in commercial applications with relatively little transformation of raw data, as well as being the basis of extensive elaboration; and

- Public sector information held by cultural establishments and the like which often has characteristics of being: static (i.e. it is an established record), held by the public sector rather than being directly generated by it (e.g., cultural archives, artistic works where third-party rights may be important), not directly associated with the functioning of government, and not necessarily associated with commercial uses but having public good characteristics (e.g., culture, education).

The first category may be the basis for information-intensive industries; these employ the raw PSI data to produce increasingly sophisticated and pervasive products such as location-related applications accessed from smart-phones. This area has received most attention and has been until now the focus of e.g. the EC Directive on the re-use of PSI. The second includes cultural, educational and scientific public knowledge; wide public diffusion and long-term preservation (e.g. in museums, libraries, schools) are major government objectives. The public task is potentially clearer, but because of rapid growth of interest in all kinds of cultural goods and services, the potential for market and non-market development of this kind of public sector information is very large. Over time the distinctions have become less clear-cut and there is a continuum of uses and applications between the ends of the spectrum (e.g. geo-spatial information with very high commercial use, and cultural archives with limited popular interest but very high value to some users). The main objectives of re-use at the two ends of the spectrum are different although for example cultural and educational information is increasingly used to produce commercial products.

1.2. Objectives, approach and scope

The objectives of this study are to:

- Review recent evidence on the importance and growth of PSI, principally in Europe, to the extent that quantitative studies are available;

- On the basis of this recent evidence estimate to the extent possible top-down estimates of the value of the PSI market in Europe and the economic value of PSI in Europe in general;

[2] The EC Directive on the re-use of public sector information (2003/98/EC, 17 November 2003) excluded information and content generated and held by cultural and educational institutions, and public sector broadcasters, whereas the OECD Recommendation of the Council for enhanced access and more effective use of Public Sector Information [C(2008)36] includes all information and content generated and/or held by public bodies, defined as: "information, including information products and services, generated, created, collected, processed, preserved, maintained, disseminated, or funded by or for the Government or public institution".

- Summarise some aspects of recent studies at sector level or in particular detailed areas.

It must be emphasised that at pan-European level there is a continuing absence of robust quantitative data on: i) the size, growth and impacts of PSI-related activities; and ii) the economics of cost, pricing and distribution models of PSI and the socio-economic benefits and any related costs of improved access to public sector information held by cultural, educational and other non-market establishments and institutions.

Scientific information and research data is in general not included in this survey, and it is generally outside of the scope of the EC Directive. However universities (which can also be in a completely private sector environment) are major users of public data, for example health data, and government-funded research establishments and universities are involved in setting up and maintaining databases that have significant economic impacts on the research environment (more efficient research data collection and use) and the private sector (commercial applications). See for example analysis of the role of open access in improving the flow of science and research information (OECD, 2005). Nevertheless estimates of the magnitude of benefits from improved access to scientific research results are included in this study, although these benefits are not directly comparable with market size estimations. For the estimation methodology see Houghton (2009).

Public sector information held by cultural establishments is covered in this study to the extent that it is included in the publications and reports reviewed. Nevertheless as public sector cultural content was not part of the original Directive 2003/98/EC on the Re-use of Public Sector Information, it is generally not included in the publications and reports reviewed here to the extent that this can be determined from examination of these publications and reports.

Public broadcasting is also not covered in this survey along with most other cultural information. This was also specifically excluded from the original Directive 2003/98/EC. In many countries there are fully or partly state owned broadcasters that are government financed or subsidised. These broadcasters produce content that may be used by private companies or other public actors such as educational institutions, depending on access and usage rights. Public broadcasters also face the challenge of digitising and making their content more widely available, e.g., their back archives.

2. DEFINITIONS AND VALUE-CHAINS

2.1. Different information and content types

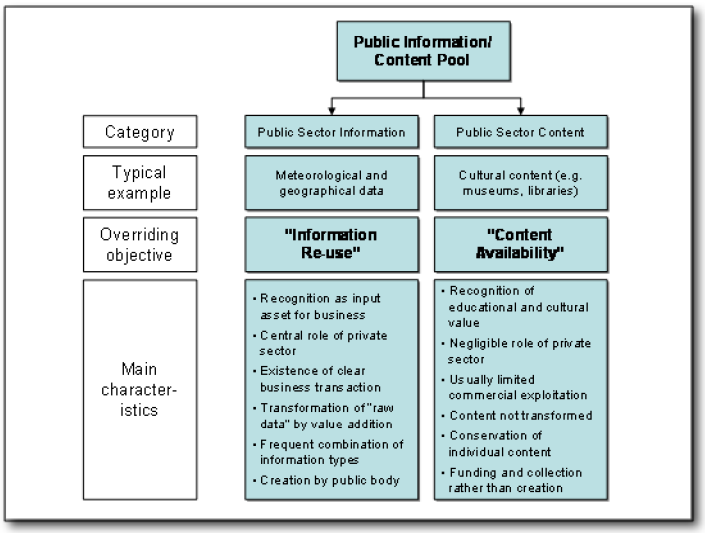
The pool of public information/content and the public bodies involved in its creation and/or collection are highly diverse. For example, data is collected to support formulating regulation, to provide information for research, to preserve cultural heritage, to allow taxation or simply for registration and administrative purposes. The public institutions involved are national and local governments, non-departmental public bodies, research organisations as well as executive agencies and international organisations.

2.1.1. Information domains

Public sector information domains and examples are shown in Table 1. This list is neither exhaustive nor are individual domains exclusive. For example, the category "Natural resource information" includes information that can be part of "Scientific information" and "Research data" or "Geographic information"; moreover, it is difficult to draw clear divisions between cultural, educational and scientific content. Content types that are commonly used in commercial applications are geographic, meteorological, business and financial, social and transport as well as (some) legal system information. Cultural, educational and scientific information and political information are often directly made widely available by governments. But, as Table 1 indicates the different domains are a continuum of examples rather than a mutually exclusive and collectively exhaustive classification system.

The public sector constitutes a major resource pool as it produces and collects a multitude of information. For public authorities this information – once collected and used for its original purpose – has two distinct dimensions as primary objectives and characteristics of each diverge (Figure 1). One comprises the aim to facilitate the commercial "re-use" of information. The other is concerned with public sector information held by cultural establishments and the like ("public sector content" in Figures 1 and 2 and in Table 1) where the aim is usually the wide diffusion and preservation of these public goods for various socio-economic purposes.

Figure 1. Categorisation and characterisation of the public information pool



Source: Adapted from OECD, 2006.

Table 1. Public sector information domains with examples

Commercial re-use of PSI	Geographic Information	cartographic information
		land use info (cadastral data)
		spatial data/geographical coordinates
		administrative and political boundaries
		topographical information
		elevation data
	Meterological and Environmental Information	oceanographic data
		hydrographic data
		environmental (quality) data
		atmospheric data
		meteorological (weather) data
	Economic and Business Information	financial information
		company information
		economic and statistics
		industry and trade information
	Social Information	demographic information
		attitude surveys
		data on health/illness
		education and labour statistics
	Traffic and Transport Information	transport network information
		traffic information
		transport statistics
		car registration data
	Tourist and Leisure Information	hotel information
		tourism statistics
		entertainment (local and national)
	Agricultural, Farming, Forestry and Fisheries information	cropping/land use data
		farm incomes/use of resources
		fish farming/harvest information
		live stock data
	Natural Resource Information	biologic and ecologic information
		energy resource/consumption information
		geological and geophysical information
	Legal System Information	crime/conviction data
		laws
		information on rights and duties
		information on legislation
		information on judicial decisions
		patent and trademark information
	Scientific Information and Research data	university research
		publicly-funded research institutes
		governmental research
	Educational Content	academic papers and studies
		lecture material
	Political Content	governmental press releases
		local and national proceedings of governments
		green papers
Making available PSC	Cultural Content	museum material
		gallery material
		archeological sites
		library resources
		public service broadcast archives
		other public archives

Source: OECD, 2006, adapted from PIRA, PSINet and other studies.

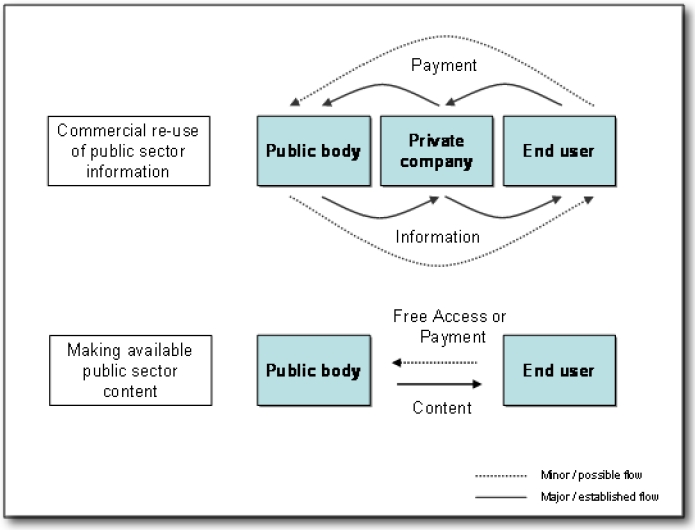
2.2. Users and applications

2.2.1. Commercial re-use of public sector information

"Re-use" centres on exploiting the economic value of public information. PSI serves as "raw material" which can be used to develop new products and services. Whereas public bodies are the creators and suppliers of the original material, the private sector plays a major role as intermediary and information processor between source of information (public body) and end users (Figure 2). Payment occurs in exchange for information; private businesses pay for PSI and consumers for value-added information products and/or services. Public bodies also integrate the value chain vertically and provide products directly to final users. There have been wide differences across countries in access and pricing approaches, but these are

increasingly converging on making access easier, with data priced at marginal costs of storage and distribution.[3]

Figure 2. Typical information, content and payment flows



Source: Adapted from OECD, 2006.

2.2.2. Making available public sector information held by cultural establishments

Public institutions also invest in the dissemination and preservation of public sector information held by cultural establishments to realise various social and educational goals, as well as being involved in potential "re-use" of this collected and preserved information. As the main objective is wide diffusion, this has usually been freely available to private individuals and for educational purposes, with low prices occasionally charged to recoup some costs. Traditionally, the private sector was only marginally involved in efforts to make cultural content and public sector information held by cultural establishments widely available (Figure 2 above). With increased pressure on government budgets following the global financial crisis and its aftermath, private industry and individuals have come to play an increasing role, and in some countries the private sector and individuals have had a continuing role in distributing cultural content, for example, in exchange for marketing possibilities (e.g. private sponsoring of exhibitions and cultural events). Furthermore cultural information is increasingly important in a wide range of market and non-market applications with the growth of popular interest and access to all aspects of culture.

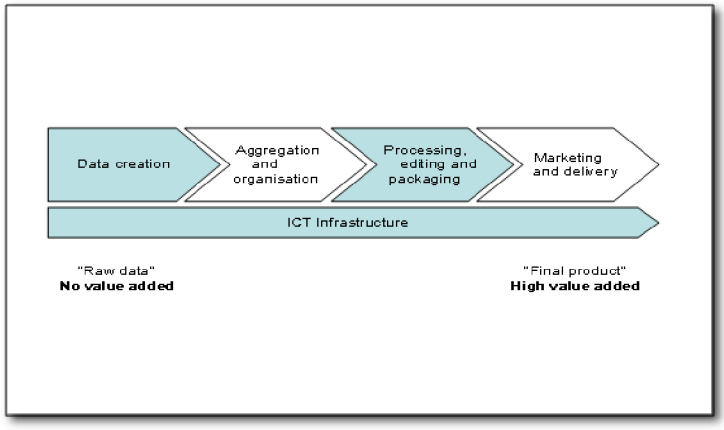
[3] For example, the United States has adopted an open access approach and much PSI is freely available at Federal level, although there remain wide differences at state and local level in access and pricing regimes. See Uhlir in National Academy of Sciences (2009).

2.3. Value chains

2.3.1. Value chain of commercial re-use of public sector information

The value chain of commercial re-use of PSI is composed of: i) data creation, ii) aggregation and organisation, iii) processing, editing and packaging, and iv) marketing and delivery (Figure 3). Enabling technologies notably the Internet and software applications are supporting systems and the basis for the main value-creating functions. Much of the currently expanding re-use activity only started once low-cost ICT applications and networks became available.

Figure 3. The PSI re-use value chain



Source: OECD, 2006.

The first element of the PSI value chain is the creation or collection of the data itself (e.g. the actual measurement of geo-spatial data). At this stage public information can be considered as "raw material". Subsequently, in a second step the information created at local, national or international level is aggregated and organised in order to create a more comprehensive data set and to permit joint storage and retrieval.

Among the most important PSI producing public bodies are:

- Mapping agencies that produce geo-spatial and geographic data.
- Meteorological services that generate weather data.
- Statistical offices that generate comprehensive socioeconomic data.
- Company registrars that collect corporate financial data.
- Ministries of transportation producing traffic data, and
- Courts and other governmental institutions that provide legal and legislative information.

These institutions originally generate this information and data as part of their mandated role to fulfil their public task.

The third element of the value chain comprises functions such as data processing, editing, re-packaging or re-modelling. Editorial activities include the production of synopses, explanatory notes and search indexes. It includes a large variety of value-adding activities that depend on the end product or service. For instance, geo-spatial data can be used to produce location maps to find all manner of goods and services in all kinds of end-using devices, with the major part of added value increasingly coming from combinations with other information, such as demographic, traffic or environmental data. Similarly meteorological data is used to produce new combinations of services for mobile device users.

The final functions are marketing, distribution and delivery of information products and services. ICTs have not only augmented market reach, they have also transformed many traditional PSI activities, for example public sector publishing. Traditionally public sector bodies often tasked private companies with publishing material in physical formats, but the Internet has changed the nature of publishing, and on-line distribution is complementing and increasingly supplanting hardcopy publishing. PSI is also important for new wireless applications such as location-based services (LBS). The very large installed base of mobile phones, rapidly ascendant smart phones, and very rapidly growing base of wireless personal digital assistants, tablets, and netbooks has led to an explosion in LBS applications.

2.4. Structure

The changing scope and value chains for public sector information potentially change the availability, access and use of PSI, making it both more widely accessible and more readily combined to produce new information goods and services. Furthermore, the inherent democratic nature of the Internet and the potential to use trusted public data from known and reliable public sources means that many kinds of public sector information ranging from geo-spatial and meteorological information through to cultural information are likely to be increasingly combined and distributed to a very large number of end-users. Furthermore, the international dimension of access to and use of public sector information is increasingly important as the global reach of high-speed Internet connections make national data of increasing international use and international data of greater national and local relevance.

Given the pervasive availability of public sector information and content in digital form and the increasing use of ICTs by secondary users, public sector information is a valuable resource for the production of innovative value-added goods and services as well as a source of educational and cultural knowledge for the wider population. Furthermore, knowledge is a source of competitive advantage in the "information economy", and for this reason alone it is economically important that there is wide diffusion of public information. Benefits include development of new products built directly on PSI; development of complementary products such as new software and services; reduction of transaction costs in accessing and using such information; gains in the public sector itself; and the crossing of different information sources to provide new goods and services.

Governments also have basic commitments to enable citizens' access to public information and national cultural heritage such as paintings, monuments and books, and to ensure social inclusion. New communication tools, such as social networks, interactive Web sites and games may facilitate the diffusion of public sector information by reaching groups of people previously unlikely to directly access PSI or PSI-related services.

The next sections explore the aggregate economic dimensions of access to and use of PSI, and provides broad estimates of the size of markets and impacts of PSI, based on available quantitative analysis in the published literature and other sources, mostly subsequent to the year 2006.

The literature review is divided into two parts, the first covers general market studies and estimates of the value of PSI markets, the second estimates the size of the EU27 PSI market based on extrapolations from existing work. It is not exhaustive, in that it does not cover all of the PSI literature, particularly studies of implementation and legal aspects of PSI re-use. It is organised by country and to the extent possible by PSI area, as most studies are nationally based and either deal with all of PSI or some specific parts of it. All information sources are listed in the Bibliography at the end of this survey.

3. GENERAL MARKET STUDIES

3.1. Open access to public sector information

Why is open access to public sector information important in general and for innovation in particular? Knowledge and information flows underpin creativity and innovation, and the relative scope and scale of public sector information, particularly in small economies, make public sector information important sources of raw material for innovation. The public sector is a major, even the dominant, producer and custodian of information in many domains and easier access can drive innovation and new economic activity. Furthermore, only government and the public sector have the critical mass to create inclusive public platforms and scalable repositories in many areas (Cutler, 2007, Nilsen, 2010).

Improved access to and use of public sector information is of major importance for all economies (OECD, 2006, Vickery, 2010). It has increasingly taken centre stage from being a somewhat peripheral issue often confused with freedom of information, and extensive international work has been undertaken analysing and providing policy principles for the development and use of public sector information. But these principles have also taken into account that there are also limits to what can be released and that legal requirements and restrictions, including effective and secure management of personal information, confidentiality and national security concerns, and fundamental principles including democracy, human rights and freedom of information (see for example, OECD, 2006, 2008). This information ranges from weather and map information generated by governments through to public sector broadcasting archives, museums and art repositories where governments hold information on behalf of others. Free access to public sector information has been a cornerstone of US policy and this has been strengthened with the 2009 release of the US open government directive based on principles of transparency, participation, and collaboration (Office of Management and Budget, 2009).

3.1.1. Access, equity and pricing

Re-use of publicly funded information from government activities, academic and other research areas has potential for a wide variety of new and innovative combinations (Cook, 2010). The underlying rationale for this is not so much the predictability of these new combinations as their unpredictability. As Louis Pasteur supposedly said, 'In the fields of observation chance favours only the prepared mind'. In a similar vein, Drucker argued that 'Opportunity is where you find it, not where it finds you. The potential of a business is always greater than what is actualised'. Enlarging and systematically inviting serendipity can be argued to be an aim of government information policy, making access to public sector information an important cornerstone in a comprehensive digitally driven innovation policy (European Commission, 2010).

The supply of PSI at no charge is generally justifiable on grounds of economic efficiency where there are no clear obligations and risks related to nondisclosure. According to some, the arguments related to equity and 'user pays' are usually poorly conceived in the context of the public funding of PSI and the strenuous efforts devoted to the promotion of lifelong learning (Cook, 2010).

3.1.1.1. Diverse needs for better access are increasing

Our societies are also facing an increasing range and severity of 'wicked' social challenges (see Stanley, 2010). They are difficult to clearly define, have many interdependencies and multiple causes, are often unstable, have no clear solution and are socially complex. They range from environmental degradation, climate change, mental health

problems and youth employment and political engagement challenges in many countries. Solutions to these challenges also require better access to public sector information.

3.1.1.2. Geospatial and weather information in the United States

Two examples of the benefits and challenges to better access to and greater use of public sector information can be drawn from experience in the United States.

Geospatial information: The volume, quality and resolution of geospatial data are increasing exponentially, with sources of data expanding to include global positioning satellites, aerial photographs, distributed sensor networks, embedded devices, location-aware technologies, including mobile phones, and increasing contributions from IT-enabled social and commercial networks (National Research Council, 2003a). Challenges to exponentially increasing use include authenticating, storing, validating and distributing these data. Challenges for governments include national security concerns, working out the relations between data collected for government use and that from commercial providers, and deciding how to cover the costs of preparing data for public release. Furthermore, even in the United States, where the federal government's general policy is to make data available free of charge or at most at the cost of distribution, many state and local government organisations have continued to seek partial or total cost recovery, undermining benefits from the overall liberal policy to making PSI freely available with few licensing constraints (National Research Council, 2003a).

Weather information: The strengths of the US weather and climate system is seen as coming from the interplay of three major actors: The National Weather Service (part of the National Oceanic and Atmospheric Administration), responsible for protecting life and enhancing the national economy, and maintaining an extensive sophisticated infrastructure; academia, responsible for advancing science and educating meteorologists; and the private sector, responsible for creating products and services for commercial use and communicating with the public. Based on free access to meteorological information, this system has led to a flourishing set of weather and weather-related services that benefit the US public and economy. Furthermore these services are used extensively at global level contributing to global welfare, as well as being widely cited as an example of the benefits from free access to public sector information (National Research Council, 2003b).

3.1.2. Developing open access at sub-national level

In 2008–2009 the Australian state of Victoria conducted an inquiry into improving access to Victorian PSI. The potential for economic and social returns from PSI were seen as positive, that new commercial enterprises will emerge as access to PSI is improved, economic gains will occur through improved use of PSI and many governments and international bodies have taken steps to open up PSI (Economic Development and Infrastructure Committee, EDIC, 2009). The report discusses in detail efficiency improvements possible from better access including: commercial efficiencies from better use of public sector R&D; government efficiencies through better resource allocation and more informed policy and decision-making; greater innovation through the use of PSI, including "unexpected" innovation; and the potential for improved transparency and social engagement, including freedom of expression and improved democratic processes (EDIC, pp. 10-17).

3.1.3. International initiatives

In addition to the EC Directive on PSI, the OECD Recommendation of the Council on for enhanced access and more effective use of public sector information provides policy guidelines to improve access and increase use through greater transparency, simpler licensing, enhanced competition and more liberal pricing (OECD, 2008). This Recommendation aims at

increasing economic and social benefits and returns on public investments through more efficient distribution, enhanced innovation, development of new uses, and market-based competition, taking into account legal requirements and restrictions including effective and secure management of personal information, national security concerns, and fundamental principles including democracy, human rights and freedom of information. The Recommendation encourages greater access and use regardless of IP ownership. And it recognises that strengthening the role of non-public sectors in developing and disseminating information may require changes in legislation, public sector organisation and budgets to support the collection and dissemination of public sector information.

The OECD Recommendation was based on findings that there were barriers and difficulties in expanding commercial and non-commercial re-use of public sector information and content. Continuing obstacles included: restrictive or unclear rules governing access and conditions of re-use; discouraging, unclear and inconsistent pricing of information when re-use of information is chargeable; complex and lengthy licensing procedures; inefficient distribution to final users; barriers to development of international markets; and the unclear role of public sector organisations as collectors, producers and disseminators of public sector information, particularly in competitive market areas.

3.1.4. Continuing barriers to measuring markets and benefits

Despite what are seen as increasingly self-evident and growing benefits from improved access at lower /no cost to users, there are conceptual and practical difficulties in measuring the benefits from public sector information and, to an equal extent, the size of related markets. Even in narrow, more easily defined areas such as geospatial information, these conceptual and practical difficulties remain. A considerable literature has also grown up on the difficulty of measuring the "real value" of geospatial information and the importance of establishing robust theoretical and empirical models of user networks. See for example, Genovese (2010), de Vries (2010) and Crompvoets (2010).

3.2. Studies of the European market

This section reviews available reports on the size and development of European markets, beginning with the two most important earlier large-scale attempts to collect new information, followed by more partial studies of the European market.

3.2.1. Total PSI in Europe. The PIRA report

The PIRA report (PIRA, 2000) was the first cross-European study to provide comparable information of the value of PSI markets and the contribution of PSI to economic activity. This was based on detailed estimates from a few countries extrapolated to all EU countries in 2000. The report results emphasised the importance of geo-spatial information, making up around one half of the total. They estimated a total value of PSI of EUR 68 billion, with a value of EUR 36 billion for geo-spatial information, with the spatial (geographic information) sector taking over 37% of the total investment in PSI in France, 41% in Sweden and over 57% in the United Kingdom (PIRA, 2000). The methodology is summarised in Box 1. A value of EUR 750 billion was estimated for the whole information sector in the US, despite the fact that it contains many activities unrelated to PSI. These estimates are not directly comparable but it was concluded that the US PSI market was considerably larger than the EU market, and given the rapid growth of commercial PSI re-use, and the capabilities of ICTs to exploit the potential of PSI, the economic value of public information resources has probably increased both absolutely and relatively since 2000.

Box 1. PIRA economic valuation methodology

The PIRA study provided the first extensive estimates of the economic value of PSI, but the methodology is not always straightforward. Furthermore, the study's structural design is conservative, so estimates may be below the actual economic value. The study identified two main estimates of the value of PSI: *i)* investment value and *ii)* economic value.

Investment value: government investment in the acquisition of PSI. In the PIRA study, the cost of acquiring the information gathered by the public sector provides a lower bound to the value of PSI.

Economic value: the part of national income attributable to industries and activities that are based on the exploitation of PSI (*i.e.* value added of PSI with respect to the economy as a whole and private sector expenditure on PSI).

In the absence of data on the value of PSI, PIRA used a combined estimate with *i)* data on the investment value of PSI, *ii)* estimates of the value added by PSI users and iii) private sector expenditure on PSI. Identification and combination of information on these items is difficult, and there are four additional potential sources of error:

- Estimating the value of PSI that is given away freely.
- The allocation of government agency receipts to intermediate and final users.
- Estimating the value of information supplied to intermediate users to give a final user figure.
- Using the relative size of national economies to extrapolate total EU PSI. Five EU countries were estimated directly (France, Germany, Portugal, Sweden, the United Kingdom and) and ten extrapolated.

Source: PIRA, 2000, and OECD, 2006.

3.2.2. Total PSI in Europe. The MEPSIR report

Following the PIRA report in 2000, the most comprehensive subsequent analysis of European PSI markets is the MEPSIR study (MEPSIR, 2006).[4] This study developed and tested a repeatable methodology for measuring PSI re-use and undertook a baseline measurement of PSI re-use in the European Union (EU25) and Norway, and a comparison with the United States. Public sector information covered: geographic information of all kinds; meteorological information; business information, including patent and trademark information and public tender databases; social data, including economic, employment, health, population, public administration, and social statistics; transport information; and legal information, including decisions of national, foreign and international courts, national legislation and treaties. It did not include scientific/research information or cultural content. Data was collected for the study from mid-2005 through early 2006 and estimates can be taken to represent the situation at the beginning of 2006.

The estimates used two different methodologies, in both cases based on detailed surveys of PSI suppliers and re-users. First estimates of the overall PSI market size were based on market estimates of respondents. Both public information/content holders and re-users were asked to estimate the size of the domestic market for the sub-domain(s) in which they were

[4] The PIRA and MEPSIR studies used entirely different approaches and estimating methods. The estimates of MEPSIR are based solely on the surveyed added value by all first-order re-users, focusing on how much added value can be attributed to PSI re-users. The total of PIRA encompasses all firms that are in one way or another related to PSI, based on broad estimates using national accounts data. PIRA takes the size of the information industry as an upper bound proxy for this market, particularly for estimating the US market.

active, excluding scientific and cultural information. Given the very large variation in estimated values, the median rather than the average was used as a base value, with the average regarded as an upper boundary. Based on the estimates of re-users (which tended to be more stable than those of public information/content holders) the overall market for public sector information in the European Union plus Norway was EUR 26.1 billion in 2006 (median value) with an upper boundary of EUR 47.8 billion (average value).

An alternative estimation of the overall size of public sector information markets was based on turnover proxies constructed from turnover and staff numbers collected in the surveys. The quality of these economic data was considered to be considerably higher than the more subjective estimates of market size. The overall market size is the sum of the turnover of all individual re-users, minus costs of acquiring public sector information from public content holders. The average for the minimum and maximum estimates by this method was EUR 27.6 billion, with an upper limit of EUR 46.5 billion.

The two estimation procedures for the EU25 public sector information market converged, with average turnover and median respondent estimates both around EUR 27 billion, with upper limit values of the order of EUR 47 billion and lower limit values around EUR 10 billion. The value of around EUR 27 billion was considered a conservative but realistic estimate, equivalent to 0.25% of European GDP, and this was used to estimate total PSI market sizes in individual countries.[5]

3.2.3. Geographical, meteorological and legal information

An in-depth survey across the EU27 presented a picture of generally dynamic growth in the geographical information, meteorological information and legal information sectors (MICUS, 2009). The study was based on a detailed survey of PSI holders and re-users, supplemented by case studies. The re-use of PSI is increasing in all three sectors; some of this re-use was directly attributed to the EC Directive, but the Directives impact varies.

The PSI Directive was seen to have its strongest impact in geographical information (GI). The GI market is growing, income of re-users is increasing (for 66% of respondents) and new re-user groups offer innovative applications. The Directive directly drives some of this growth, and other public sector holders aware of the Directive have introduced significant changes in their operations (reported by 54% of National Mapping and Cadastral Agencies). Many changes are technical, dealing with data formats and modes of delivery, and for example, GI is increasingly offered on Internet portals or via web services.

Re-users of GI confirm that holders have improved their services, particularly speed of delivery and the formats. Although they still complain about restrictive licensing and high prices, they also highlighted positive changes. The large majority (79%) of private re-users would like to access more public GI, but unfavourable pricing and licensing conditions are a continuing barrier. GI is also increasingly available from private sources, and in some areas it is considered that PSI holders should consider reviewing their range of public tasks.

In the meteorological information sector the market for private weather services is also growing. The volume of meteorological data procured from the public sector between 2002

[5] The study gathered data for the US in exactly the same way as in each European country. The amount of data gathered for the US is thus of a different level than the data for all of the European countries combined, and was not robust enough to compare with the estimates of market size for the EU25 plus Norway. Nevertheless, it appears that the number of re-users per public content holder is higher in the US, and the US scored high on Accessibility, Accountability and Non-discrimination, as may have been expected from the more open approach to PSI access taken in the US.

and 2007 had increased for 74% of the companies; 80% of National Meteorological Services reported increasing income and re-users confirmed very significant increases in income. Nevertheless on the supply side, the study suggests that relatively few PSI holders had changed their data policies based on changes in their national legislation. Furthermore, there are relatively few European firms in the sector despite the importance of weather and climate.

Meteorological sector re-users complain first and foremost about pricing, transparency and licensing, and complaints about discriminatory activities are particularly high. As in the other sectors, the large majority of re-users would like to obtain more PSI from holders, but in many cases re-users gather information from other free public sources, such as the US weather services, and would like to see unrestrictive licensing.

The market for legal and administrative information is growing; holders reported a 40% average increase in the period 2002-07. Half of holders indicated that they have changed their data policy since 2002, one third of them confirming that changes have been brought about by legislation. The majority (79%) offers legislative and administrative information free of charge on the Internet. The majority of re-users have recorded increasing income, and those that add value to PSI reported exceptional growth rates. In contrast to other sectors of PSI, many re-users criticise the lack of information on what legal and administrative information is accessible and where to find it. This can be explained by decentralized jurisdictional organization, but it could also be due to the structure of the re-using side.

Comparable trends in the PSI market can be observed in all three sectors. Unmet market demand for more PSI is significant, as re-users in all three sectors reported undiminished buying interest. It was recommended that PSI holders focus on crucial issues of licensing and pricing, and provide greater support for PSI re-use. The study further recommended that regular market monitoring be introduced at European level, for example the volume of data delivered and the income of PSI holders where data is not free.

3.2.4. Environmental impact assessment markets

The EU27 market for Environmental Impact Assessments (EIA) and Strategic Environmental Assessments (SEA) was surveyed in detail in 2009 (Craglia et al., 2010). These assessments are required by European Law to assess the potential impacts of projects and plans. The main outcome of the analysis is that practitioners still face problems in using spatial data for the preparation of environmental impact reports. These mainly relate to finding and accessing quality data, and as a consequence, there is an increase in cost and time to produce reports. The additional burden is quantified, as well as potential savings that could be achieved if problems connected with the use of spatial data were removed.

The key finding is that this market is worth EUR 1 billion per year across Europe, and that improving accessibility of the information required for these studies could save up to EUR 200 million. The analysis focused on national-level assessments. Including sub-national assessments could increase these values by a factor of 10, saving EUR 2 billion annually.

The detailed cross-European survey of the preparers of EIA/SIA reports indicated that the main suppliers of spatial data are local authorities/local governments and environmental protection agencies (73%) followed by mapping agencies (52%). In addition 44% of respondents produce their own data; other sources include national and regional bodies and private companies including Google Earth (Craglia et al., 2010, p. 24). The survey clearly shows the continuing reliance of these reports on public sector sources.

The survey also highlighted the continuing challenges in using spatial data. The most frequent problems practitioners face relate to finding the data (59%) and low data quality

(58%) (Craglia et al., 2010, p. 26). These are followed by problems accessing the data (53%), integrating it (53%) and cost (48%). Only 4% indicated having none of these problems. Clearly, improved access at lower cost to higher quality data would facilitate the development of higher quality and more appropriate EIA/SEA reports.

3.2.5. Summary

Overall, the review of aggregate studies and analysis shows that improved access to and use of public sector information is of major importance for all economies. It has increasingly taken centre stage from being a somewhat peripheral issue often confused with freedom of information, and there has been extensive international analysis and development of policy principles for better use of public sector information. Benefits from better access include: commercial efficiencies from better use of public sector R&D; government efficiencies through better resource allocation and more informed policy and decision-making; greater innovation through the use of PSI, including "unexpected" innovation; and the potential for improved democratic processes and social engagement. Free access to public sector information has been a cornerstone of US policy and this was strengthened with the 2009 release of the US open government directive.

Despite increasingly self-evident benefits from improved PSI access at lower /no cost to users, there are conceptual and practical difficulties in measuring benefits and, to an equal extent, the size of related markets, even in narrow, more easily defined areas such as geospatial information. Nevertheless a number of early aggregate studies set the scene for measuring PSI markets and impacts across the EU. The PIRA report (2000) gave very large estimates of the size of the European PSI market by including a wide variety of non-PSI related activities, and it also emphasised the importance of geo-spatial information. The MEPSIR study (2006) of the EU25 PSI market provided an estimate around EUR 27 billion, with upper and lower limit values of EUR 47 billion and EUR10 billion.

More recently an in-depth survey across the EU27 presented a picture of generally dynamic growth in the geographical information, meteorological information and legal information sectors through 2008. Unmet market demand for more PSI is significant, and it was recommended that PSI holders focus on crucial issues of licensing and pricing and provide greater support for PSI re-use. In the sub-area of environmental impact assessment studies the market was worth EUR 1 billion per year in 2009, with improved access to information saving up to EUR 200 million per year; including sub-national assessments could increase values by a factor of 10.

3.3. National studies

3.3.1. Denmark

In 2009 the Danish government launched the "Open Data Innovation Strategy" (ODIS) to provide easier access to public data as a digital "raw material" for businesses. Denmark is advanced in data collection and digitisation and has considerable public sector information resources. A study quantifying the value of open government data used interviews and workshops to identify areas in selected industries (banking, insurance, energy, tourism, pharmaceutical and retail) where expanded access to public data could lead to quantifiable commercial benefits and efficiency gains (Zangenberg & Company, 2011). However, it is clearly recognised that some of this potential will only materialise when small and innovative firms or individuals begin to use the data in new ways.

In the banking sector, banks are working with the tax authorities (SKAT) and clients to give banks access to clients' payroll and pension data from the state eIncome register. Banks estimate that this extra information alone is potentially worth over DKK 500 million per year

(EUR 67 million @ 0.1343 EUR/DKK in 2010[6]) in efficiency gains and reduced losses. In addition, a variety of data on customers' employment conditions, etc. is of interest. The total potential is estimated to be billions of DKK. There are however issues with the scope of customer consent and customers' real capacity to refuse consent. The insurance industry already extensively uses available analysis from Statistics Denmark, but pointed to a number of areas where more detailed data could be used, for example for more accurate risk assessment. The industry could use detailed data to help customers to ensure they have the appropriate coverage, and certain personal data could be used to reduce fraud. However, there are the same privacy concerns as for the banking industry.

The energy sector considered that it could benefit considerably from increased access to data on residential occupants, their age, gender, income, etc. coupled with information on housing age, construction, insulation, energy, etc. These data could be used to offer high value energy-saving measures; possibly combined with funding and investment incentives. The energy industry estimates that in conjunction with the construction industry the potential annual market for energy improvements is DKK 4-20 billion (EUR 0.54-2.7 billion) for Denmark alone. For the EU27 the market could potentially be worth EUR 29-143 billion if the same assumptions are made for the EU27 as for Denmark.

For the pharmaceutical/healthcare sectors better patient data for example can provide better ways of identifying and selecting patients for the early phases of clinical trials for new drugs, reducing the number of drugs selected for costly "Phase 3" clinical testing. However there are privacy and ethical considerations regarding access to, and use of, these data. For many established industries access and use of public sector information is part of their established strategies. For the tourist industry increased access to public data can be used to build the domestic market, for example by providing digitised cultural heritage information on the spot on any mobile device. On the other hand, the "bricks and mortar" retail industry did not appear to be able to extract more commercial benefits from public sector information as it already uses the very detailed analysis and aggregated data sets from Statistics Denmark.

In the administrative sector the municipal organisation KOMBIT has been set up to better use public information to improve the performance of the municipal sector. It is suggested that the use of sophisticated "business intelligence" tools could yield considerable gains for the public sector including facilitating and streamlining municipal operations.

One of the main results of this analysis is to intensify efforts to provide access to "unproblematic" data that has yet to be opened up for re-use.

3.3.2. France

There is relatively little data on PSI reuse in France. SerdaLAB undertakes an annual study of the professional digital information market: a large part of the information in this market is supplied by the public sector (legal, environmental, economic and financial data) (SerdaLAB, 2009, 2010). This market was estimated at EUR 1.54 billion in 2007 and 1.57 billion in 2008, with relatively slow growth estimated for 2009 and 2010. Although based on surveys it is the most complete data available. On the PSI supply side the major government institutions providing and charging for PSI include:

- Institut Géographique National (IGN): estimated 2009 revenues EUR 2 million;
  Cadastre (DGFiP): estimated revenues EUR 0.9 million;
- Institut national de la statistique et des études économiques (INSEE) only charges for the base "SIRENE" and for services related to delivery of data;

[6] Exchange rates are taken from OECDStatExtracts, Financial Indicators (MEI): Exchange rates (USD monthly averages) accessed at: http://stats.oecd.org/Index.aspx

- Institut national de la propriété industrielle (INPI);
- Service Hydrographique et Océanographique de la Marine (SHOM);
- Météo France;
- Direction de l'information légale et administrative (DILA): estimated 2009 revenues EUR 0.9 million.

Their total revenues are low overall, due in part to restrictive pricing and licensing conditions in the past. However, these have changed successively to more pro-user policies, and a radical new policy is being put in place in 2011. This policy is designed to open up data sources for re-use at no charge and with easy licensing mechanisms and conditions.

A new body, "Etalab", was created by public decree in February 2011 (Etalab, 2011, and announcement 30 June 2011). It is directly under the authority of the Prime Minister and has the aim of creating a unique public information access portal (data.gouv.fr). The aims are to improve and simplify access to all public information to the benefit of users and to encourage re-use. With this initiative, France joins other countries with single government portals and simplified access, including the United States (data.gov, May 2009) and the United Kingdom (Data.gov.uk, September 2009).

3.3.3. Germany

In Germany a considerable amount of analysis has been undertaken exploring how PSI markets could be reshaped to provide better services at lower costs (Fornefeld, 2009). It is based on arguments that a dynamic PSI market has high availability, low prices and is demand-oriented. Furthermore, market value increases for each application and additional function. For complex data combinations for example of statistics and geographical data, the value of the source data is increased by a factor of five, and with information-based services like mapping, geocoding, and analyzing tools or applications, this factor may be ten.

The German market for geo-information increased rapidly from EUR 1 billion in 2000 to EUR 1.7 billion in 2009, with 50% of demand driven by the navigation market. Because of early unmet demand, for example in securing public sector map data, private alternatives have emerged, with much of the new geo-information market based on “free” private data (Fornefeld, 2011, but note that the market size estimate is relatively low compared with that for the Netherlands in Castelein, et al. 2010 below).

There are extensive barriers to PSI reuse in Germany according to the analysis. On the side of PSI holders these include insufficient market transparency, lack of knowledge about how markets work, and a tendency to overestimate product prices. In the meteorological market, for example, the government overpriced data due to initial development costs and underestimated potential market growth, encouraging development of parallel private infrastructures.

This analysis estimated German government PSI revenues to be very low, around EUR 0.16 million in 2007 from three main areas: legal information, vehicle information, and meteorological data (Fornefeld, 2009). Areas such as cartography, statistics, medical information, geo-information, and environmental information provided little revenue, despite high potential for statistics and cartographic information. Other analysis in 2010 suggested that data is increasingly available from some PSI sources, and PSI revenues were somewhat higher around EUR 3.2 million from meteorological data (DWD) and geographical data (SenStadt), with lesser amounts from statistics (Destatis) and maps (BKG) (POPSIS, 2011). Overall, exploiting the potential PSI market in Germany was seen to require lower pricing and less restrictive licensing agreements.

3.3.4. Netherlands

There is a range of information on the size and structure parts of the PSI market in the Netherlands, including a detailed study of the geospatial sector (see Castelein, et al., below). For example, the narrow meteorological re-use market (2010) was around EUR 10 million, estimated from the turnover of around 45 re-users, 5 dedicated to pure meteorological services, the rest using meteorological information in their products (De Vries, 2011, POPSIS, 2011). The market is relatively stable, having grown steadily over the past 10 years due to the very liberal re-use policy of the Royal Netherlands Meteorological Institute (KNMI), which charges very low re-use facilitation costs and has no licensing restrictions.

There are also considerable revenues generated from other PSI suppliers charging for various activities (Te Velde, 2011). Revenue estimates for these bodies for 2009 include:

- KvK (Chamber of Commerce): EUR 30 million (out of an estimated total budget of EUR 165 million).
- Cadastre: EUR 17-22 million (out of a total budget of EUR 230 million) – the remaining EUR 200+ million is derived from 'legal tasks' related to its monopoly position in cadastral information.
- CBS (Statistics Netherlands): EUR 16 million (out of a total budget of EUR 205 million).

Thus the Netherlands' government revenues from sales of PSI from these four bodies were around EUR 68 million in 2009-10, in relative terms around one-third of the United Kingdom's GBP 400 million estimated for the UK Office of Fair Trading report (2006). Nevertheless, the Netherlands has been a country that has been fairly effective in generating PSI sales revenue (data from POPSIS, 2011).

If these values for the Netherlands are pro-rated to the whole EU27, the value for EU27 government revenues from direct PSI sales are of the order of EUR 1.408 billion. The equivalent values for the EU27 based on the UK estimate and 2009 exchange rates would be approximately EUR 3.386 billion. Nevertheless the UK values look to be high for the EU27, as the UK has had a different system of Crown Copyright and an efficient and simple licensing system (see section on the United Kingdom below), which has helped to generate government revenues that are probably considerably higher than the average for Europe.

Ongoing analysis of Public Sector Bodies that are providing PSI also suggests that the PSI revenues across Europe are relatively low. The United Kingdom is an upper range outlier, and the Netherlands is also on the high end of countries in terms of revenues collected from the sale of PSI by public sector bodies (PSB) (POPSIS, 2011). In most cases revenues are less than 1% of PSB expenditures and they are a maximum of one-fifth of expenditures in a few cases (the United Kingdom in general, the Netherlands agencies discussed above, the Austrian Federal Office of Meteorology - BEV, Spanish legal data – CENDOJ). There is also recent evidence that increasing access and lowering prices dramatically has positive impacts on the number of users and development of new uses, and that changing access and pricing policies provides opportunities for reviewing the role of public tasks in the generation and distribution of PSI and implementing other changes to make PSI more accessible (see POPSIS, 2011).

3.3.5. Norway

Norway has recently reviewed the market potential, benefits and costs of increased availability of public data (Norway, 2011). It is argued that a central feature of the use of digital data is that costs are largely fixed, and the greater the use, the lower the average cost of production and delivery. If the marginal cost of data publication is virtually zero, all pricing

beyond marginal cost normally gives a welfare loss. Gains occur through increased innovation and improved and new services based on public data. Increased economic activity and employment in turn generate increased tax revenues. Furthermore, more efficient production and reuse will make better use of public resources, improve interactions between the public sector, businesses and citizens, and society generally, and support democracy.

Increased availability also involves costs. These are associated with preparation of systems for collecting, storing, publishing and distributing data. There may also be additional costs for support services due to higher demand. On the other hand, the need for computing resources in the public sector may be reduced due to activities being transferred to the private sector. There may also be increased indirect costs, for example, compensating public entities by budgetary transfers to maintain necessary activities, restructure public enterprises or there may be costs in preventing misuse of public data.

Obstacles to increased availability of public data include:

- Technical and financial constraints: There may be new costs for individual stakeholders or a different cost distribution that may outstrip expected benefits.
- Cultural barriers: Traditional public sector functions can be challenged.
- Legal provisions. Increased availability of public data should in principle not be in conflict with general social considerations and the need for protection of citizens

Market potential was analysed for map, property, business and court-related data. First, market effects depend on accessibility, and access can be improved if data is free, digitised, restrictions on use relaxed, etc. Second, if data acquisition is a large part of production costs, free data will potentially reduce the final price of products. Third, effects depend on the competitive environment. If competition is weak, free data may mainly increase the profits of established data processors, but if competition is strong and there are low entry barriers, free data will encourage new entries and end users will also benefit. Fourth, the effects depend on price-sensitivity of demand. If price sensitivity is high, a small price decrease may generate higher demand, if it is low, even large price reductions will have little effect.

Data are already largely available either free or at reasonable price in all of the four data areas examined. Direct market effects of making data free will usually be via lower prices and higher demand. Furthermore, it will also increase the likelihood of innovations and new long-term market development. The Norwegian study makes two quantitative estimates of the impact of better access to public sector information.

3.3.5.1. Valuing time saved

The first estimates the value of simpler and more efficient information flows in terms of time saved for individual work and leisure activities. It is assumed that each individual on average saves 2 hours per year through better access to public information. Converted to the adult population over 20 years of age, time-savings are some 7.2 million hours per year. Assuming that half of the savings are work-related and half for private activities, and that work-related time savings are valued at wages and salaries before tax and leisure time is valued at earnings minus taxes, the annual surplus is NOK 260 million (EUR 32.5 million @ 0.1249 EUR/NOK) in 2010.

3.3.5.2. Effects of free data on processors, distributors and end-users

If public data is provided free, organisations that process, distribute and disseminate data will have reduced costs, which normally benefit customers and users. On the supply side, revenue streams to established distributors will be reduced. For example, the Norwegian Mapping Authority had revenues from the distribution of maps, geographical data and

property information of NOK 72 million in 2009. If map data is freely available some "pure" distributors may also have reduced revenues, and will have to change their business models. On the demand side, direct effects on end users are likely to be greater than the simple reduction of input costs. For example, assuming linear demand with a demand elasticity of -1 a price reduction of 10% increases demand by 10%. Consumer surplus will increase by NOK 73.5 million, i.e. NOK 3.5 million more than the reduction in government map data revenues. In addition, free map data may lead to considerable gains from new market entrants, new operators, and new technology based.

3.3.6. Spain

The Spanish Government launched the Aporta project (www.aporta.es) in 2009 with the aim of encouraging PSI re-use in Spain. This sector was seen to have considerable potential for growth, employment and development of new services and products with high added value. As part of this work the "infomediary" business sector was analysed in 2011 for the year 2010 (see **(**Proyecto Aporta, 2011). For the purposes of the study the sector was defined as "the set of companies that create applications, products and/or added-value services for third parties, using public sector information", including business/economic, legal, geographic /cartographic, meteorological, social data/statistics and transport data **(**Proyecto Aporta, 2011). Some 230 infomediary companies were identified from various sources (databases from awareness campaigns, industry and civil society associations, and public administration agencies) to provide what was considered to be a comprehensive overview of Spanish PSI activities. Quantitative surveys and qualitative interviews and focus group methods were used to measure their economic activity:

- Business turnover directly associated with infomediary activities is EUR 550-650 million, 35-40% of the total company activity of EUR 1.6 billion. Infomediary turnover is equivalent to the video game software development segment and the online advertising segment.[7] Some 5,000-5,500 employees are involved in PSI re-use activities in the companies analysed.
- In the most recent year the number of clients increased, especially for companies with foreign customers; over 45% have EU customers and 20% have clients outside of the EU.
- Activity by re-use field: business/financial 37.6%, geographic/cartographic 30.5%, legal 17.0%, transport 5.2%, social data/statistics 1.9%, meteorological 1.1%, others 6.7%.
- The re-used information comes mostly from national agencies, but half of the companies also reuse international information.
- The main clients are companies, self-employed and some public administration activities.
- Companies use electronic means as major distribution channels for products and services. Free-access and password-access models coexist with other business models, such as revenues from advertising incorporated in their product portals/websites, and payment models. Companies generally have a high technological level and innovation is in processing and analysis applications.
- Re-use policies are valued, particularly to improve the quality and accuracy of information, improve understanding of the legal framework, and expand the amount and scope of information generated.

[7] Source: "Annual Report on Digital Contents in Spain 2010", ONTSI. Data for 2009: total video content industries EUR 8.0 billion, video games (software) 8% (EUR 640 million), online advertising 8.2% (EUR 656 million), see www.ontsi.red.es

- Areas identified for improvement include standardization of formats, standardization and improvement in the regulation of licenses for re-use, and pricing of information.

3.3.7. United Kingdom

The United Kingdom has undertaken extensive review and reorganisation of its public sector information resources. The National Archives produces an annual report outlining developments and the future agenda (The National Archives, 2011). In addition there is a growing body of independent economic analysis (see Pollock et al. 2008, Pollock, 2009, 2011a, 2011b). Recent developments in the United Kingdom followed earlier work including that of the Power of Information Taskforce (Power of Information Taskforce, 2009). This called for action in six areas where it believed that significant improvements could be made to government use of digital technologies including: freeing up the UK's mapping and address data for use in new services; and ensuring that public sector information is made as simple as possible for people to find and use.

Transformation of the UK PSI set-up has been based on increasing recognition that PSI delivers benefits for the knowledge economy and reinforces the relationship between the public sector and citizens (The National Archives, 2011). There is also increasing recognition of the international dimension of PSI. Included among objectives of national policy are to promote awareness that the value of PSI is not defined by national boundaries, and to operate internationally, sharing best practice developed in other jurisdictions.

Information and data produced by the government and the public sector represents the single largest and most diverse source of information in the UK. PSI encompasses a wide range of information, including national and local legislation, statistics, local planning, transport, education, local services and tourist information. It has been estimated that 15-25% of information products and services are based on information produced or held by the public sector (The National Archives, 2011, estimated from PIRA, 2000).

As part of the drive to expand the use of PSI, the transparency agenda (May 2010) in part aims to realise significant economic benefits by enabling businesses and non-profit organisations to build innovative applications and websites using public data. In developing its new strategy, the UK drew on the work on public sector information in Australia and New Zealand, both of which have launched policies designed to open up government and make PSI more readily available for re-use. The UK developed the Open Government Licence for PSI whereas Australia and New Zealand have adopted Creative Commons model licences. The main reason for this difference was that existing Creative Commons licences did not extend to the licensing of works protected by the database right.[8]

3.3.7.1. Estimating welfare gains

Pollock has estimated the welfare gains to UK society (overall economic gains across the whole economy) from opening up access to digital, non-personal PSI for use and reuse (Pollock, 2011a). These estimates build on previous analysis to provide a simple estimate of gains (Pollock, 2009, Pollock et al., 2008). The estimate for the gains from 'opening up', that is moving to marginal-cost pricing (effectively zero pricing), for digital public sector information is calculated using the formula Gains = $2/5F\lambda\varepsilon$ (where F is revenues under average cost pricing, λ the multiplier and ε the elasticity of demand). Using total income data from sales of PSI of GBP 400 million in 2006 (Office of Fair Trading, 2006), estimates were: upper end estimates of gains from opening up access of approximately GBP 4.5-6 billion per year (EUR 5.05-6.73 billion per year @ 1.1232 EUR/GBP), and middle range estimates of

[8] The Open Government Licence and a more liberal approach to PSI access and pricing replaced the previous Click-Use Licence operated by the National Archives.

approximately GBP 1.6-2 billion per year (EUR 1.80-2.25 billion per year).[9]

Pollock (2011a) points out that there is a wide range of benefits to be gained from opening up access to PSI. These include development of new products built directly on PSI; development of complementary products such as new software and services; reduction of transaction costs in accessing and using such information; gains in the public sector itself, etc. (see also Koski, 2011 for benefits to using firms). He also points out that it is economically attractive in the UK to shift from largely unsuccessful user funding models to "updater" funding (Pollock, 2011b). For example, companies updating their company data pay higher levies, or increased fees are paid by construction activities that change land surveys. These updater funding mechanisms would need to be supplemented with some extra government or external funding where updater funding is not feasible, but the extra funding involved is estimated to be relatively small, and very small compared with the additional benefits from greater economic activity overall (see also section 3.3.4 above).

Although the UK PSI access and licensing system remains somewhat different from that in other EU27 countries, estimates of the positive impacts of removing barriers to access are likely to be realistic proxies for removing barriers across the EU27 even in the absence of similar revenue streams in other countries to make comparable estimates. In the UK, barriers have been due to price and licensing conditions, as well as poor interoperability, different data formats, lack of knowledge of what is available etc., partly compensated by an efficient licensing system and centralisation of access procedures. In other countries, lower pricing and easier access may be negatively offset by different licensing systems across national institutions, lack of information, poor interoperability etc. Thus the results from the Pollock studies may be reasonable proxies for welfare benefits from free access across the EU27.

3.3.8. United States

In the United States, the White House issued the Open Government Directive in December 2009 (Office of Management and Budget, 2009). This directed executive departments and agencies to take specific actions to implement the principles of transparency, participation, and collaboration and established deadlines for action. The directive made it a requirement that each department or agency make its information available online in open format, which could be retrieved, downloaded, indexed and searched by commonly used web search applications. Agencies were encouraged proactively to use modern technology to disseminate useful information, rather than to wait for specific requests under the Freedom of Information Act (USA) 1966. In April 2010, every Federal department published an Open Government Plan to make operations and data more transparent, and expand opportunities for citizen participation, collaboration and oversight.

3.3.9. Summary

A range of detailed national studies shows growing markets and new applications. For example in Denmark the banking, insurance and energy sectors indicated that better access to

[9] The definition of PSI in Pollock's study is fairly wide. It comprises digital information (data that was not necessarily originally collected in digital form, but can be made available in digital form) whose marginal cost of production/dissemination may be taken to be zero. It covers non-personal information, which either contains no personal information or is at a level of aggregation and anonymisation so that personal (private) information cannot be identified. It includes but is not restricted to: company information, vehicle registration, physical property, intellectual property, meteorological data, geospatial information, hydrographic information, socioeconomic statistics, environmental data, official gazettes, transport statistics and the like. Public sector information includes any piece of 'information' produced or held within the public sector, but the focus is on relatively large and coherent information sets, and does not include scientific or cultural information in general.

PSI could be of significant value, with the energy industry estimating that in conjunction with the construction industry the potential national market for energy improvements drawing on various government data sources is EUR 0.54-2.7 billion. The German market for geo-information increased rapidly from EUR 1 billion in 2000 to EUR 1.7 billion in 2009, and in Spain the PSI reuse sector was shown to be equivalent to the online advertising sector, with two thirds of reuse revenues derived from business and geographic data.

For the United Kingdom welfare gains to the whole economy of moving to marginal cost pricing and easier access were estimated to be worth at the upper end EUR 5.1-6.7 billion per year, with middle range estimates of EUR 1.8-2.25 billion. Although the UK PSI access and licensing system remains somewhat different from other EU27 countries, UK estimates of the positive impacts of removing barriers to access are likely to be realistic proxies for values across the EU27, due to the general nature of disincentives to use, lack of information, poor interoperability etc. that have stifled easy use of PSI in EU27 countries. At a different level there are quantifiable benefits in time saved in work and leisure activities from making information flows simpler and more efficient. In Norway for example, time-savings of as little as 2 hours per person per year was conservatively estimated to be worth around EUR 32.5 million in 2010.

In contrast, government revenues from sales of PSI are in general low, with the Netherlands and the United Kingdom being generally more effective in generating PSI sales revenue. If values for the Netherlands are pro-rated to the whole EU27, the value for EU27 government revenues from direct PSI sales are of the order of EUR 1.41 billion. The equivalent values for the EU27 based on UK data would be approximately EUR 3.39 billion. However, the UK copyright system and an efficient and simple licensing system have generated government revenues that are probably considerably higher than the EU27 average.

In most cases sales revenues are relatively low, usually less than 1% of their expenditures and a maximum of one-fifth of expenditures in a few cases. There is also recent evidence that increasing access and lowering prices dramatically has positive impacts on the number of users and development of new uses, and that changing access and pricing policies provides opportunities for reviewing the role of public tasks in the generation and distribution of PSI, and implementing other changes to make PSI more accessible.

Overall, exploiting the potential in the PSI market is seen to require lower pricing and less restrictive licensing agreements. Countries including France and the United Kingdom have radically overhauled their PSI access systems, and other countries including Denmark, Norway and Spain have made access easier and less costly. There are gradations in the approaches used to improving access and facilitating reuse depending on where countries are positioned in their PSI re-use policies. Policy strategies include: opening up PSI that has been difficult to access and reuse, for example because it is not available in interoperable digital form, information lists are not available, etc.; reviewing restrictions on access and use and amending unnecessary restrictions; reviewing the public task, for example in the area of selling value-added services, and redefining this as appropriate; facilitating access to third party rights holders' material where rights holders are in agreement (e.g. libraries, broadcasting archives).

A number of countries have also stressed the international dimensions of PSI access, both in accessing international data, and developing international markets for national data.

3.4. Geospatial information

3.4.1. Australia

An Australian study of the aggregate economic impacts of spatial data on the national economy suggested that spatial data and high precision positioning systems can increase productivity by billions of Australian dollars across a range of industry sectors (ACIL Tasman, 2008, see also Australian Government, 2009). The study was carried out to: quantify the economic impact of spatial information in the 2006-07 year; estimate the cost of inefficient access to data and identify the factors operating to create these inefficiencies; consider the future prospects for spatial data to contribute to economic, social and environmental development goals. The report was based on detailed case studies in 22 sectors (including agriculture, forestry, fisheries, property and business services, construction, transport, electricity, gas and water, mining and resources, resource exploration, communications, government). For each sector, two conservative scenarios of the direct impact of spatial information were estimated. These direct impacts were applied to a computable general equilibrium model to calculate the aggregate impact of spatial information on the economy.

It is conservatively estimated that spatial information industry revenue in 2006-07 could have been of the order of AUD 1.37 billion annually and industry gross value added around AUD 682 million. The economic footprint of spatial information is considerably larger as spatial information activities are found in other parts of the economy (including government, non-profit research, other industries) outside of the narrow spatial information industry. Furthermore, spatial information is increasingly being used in most sectors of the economy where it is having a direct impact on productivity. Using computable general equilibrium modelling the study found that in 2006-07 the accumulated impact of these direct impacts contributed to a cumulative gain of AUD 6.43-12.57 billion in Gross Domestic Product (GDP), equivalent to 0.6-1.2% of GDP (including the spatial information industry itself), increased household consumption by between AUD 3.57-6.87 billion on a cumulative basis, increased investment by between AUD 1.73-3.69 billion on a cumulative basis, and had positive impacts on trade and real wages.

Other benefits were expected to increase significantly as spatial information systems are further integrated into the operation of water markets, carbon markets, natural resources management and environmental management and monitoring programmes. High using industries included property and services, construction, mining, transport and agriculture. These areas were seen to be major sources of the national economic benefit from spatial information. Further gains might be expected as spatial information penetrates other large sectors including retail and trade, recreation and other services, and finance and insurance (see also Koski, 2011).

The costs of inefficient access to data were estimated to have reduced the direct productivity impacts in certain sectors by 5-15%. It is estimated that this could have resulted in GDP and consumption being around 7% lower in 2006-07 than they might otherwise have been. Increased adoption and new applications in existing sectors could increase the direct impacts in some sectors by up to 50% over the medium term. However a larger impact is likely to be in new applications in a wider range of industries. The scale of the future contribution will be driven by the policy environment in respect of data access and skills development, further innovation in existing and new applications, increased awareness in government and industry and, most importantly, new innovations.

3.4.2. Netherlands

Analysis in the Netherlands (Castelein, et al., 2010) aimed at defining the geo-information sector and measuring its economic value in terms of turnover, employment, activities and market size. The economic value of the Dutch geo-information sector in 2008 was estimated at EUR 1.4 billion, or 0.23% of national GDP, and the Dutch geo-information sector is a fast developing sector with high potential. The work was inspired by earlier US research suggesting that the geo-technology sector is likely to be one of the three most important employment growth sectors in the 21st century (Gewin, 2004). The study also draws on other recent studies including the Australian (ACIL Tasman, 2008) and New Zealand (ACIL Tasman, 2009) studies.

The analysis is based on a detailed survey of the Dutch geo-information sector combined with data from two complementary research projects on government and research geo-information activities. This provided a picture covering the private, government and research sectors working on primary geo-information products and services. The economic value would be greater if a broader definition of the geo-information sector were used, particularly if primary geo-information activities carried out in other sectors such as real estate, transport and logistics, banking and the ICT sector were included. The low share of consumer market activities in the survey data also suggests that the estimated sector size is conservative.

The most common private sector geo-information products and services in 2008 were more 'traditional' geo-activities such as cartography, geodata management and GIS analysis. The main activities of government employees were data collection, management and distribution, followed by systems design, field collection and management activities. In the government sector there is still a strong focus on the data itself. In 2008, around EUR 100 million was spent on R&D on geo-information products and services with around 45% in the public sector and 55% in the private sector.

The authors conclude that their definition and survey methodology provide a good basis for measuring the value of the national geo-information sector. They suggest carrying out comparable studies in other countries to increase awareness of the geo-information sector as a sector of economic importance and to stimulate further development and innovation.

3.4.3. New Zealand

Land Information New Zealand and others commissioned a report on spatial information in the NZ economy in 2009 (see ACIL Tasman, 2009). The study was based on detailed sector analysis, and wider productivity benefits were estimated using a large-scale, computable general equilibrium model. The report estimated that as a direct result of the uptake of spatial technologies New Zealand's real GDP increased by NZD 1.2 billion in 2008 through productivity-related gains as a result of the increasing adoption of modern spatial information technologies since 1995. This is equivalent to slightly more than 0.6% of GDP or GNP. GDP impacts would have been higher if resource availability had been estimated. The report points out that spatial information has innumerable applications, and that impacts from applications and use could increase as it spreads to other sectors of the economy that are not yet major users such as mining, manufacturing, business and other services.

One of the main challenges was seen to be freeing up access to data, so that greater productivity gains are realized by encouraging innovation, as users find new ways of translating spatial information to solve problems and develop new products. Other (non-productivity) benefits linked to the increasing use of spatial information are probably worth a

multiple of this.[10] A range of barriers to the adoption of spatial information have constrained uptake and limited the ability to reap extra benefits. Past and current barriers notably include problems in accessing data, inconsistency in data standards, and a general lack of skills and knowledge relating to modern spatial information technology. Had these key barriers been removed it is estimated that New Zealand could have benefited from nearly NZD 500 million in extra productivity-related benefits due to wider and better use of spatial information, generating at least NZD 100 million in government revenue.

A government intervention representing the best 'value-for-money' is the release of basic government spatial data (i.e., enabling access at marginal cost, which would be zero where it is made available over the Internet). A broader intervention building an effective Spatial Data Infrastructure would lead to the highest benefits overall. The report estimates the benefit-to-cost ratio of such an intervention to be at least 5:1 where extra costs are NZD 100 million with only one years' benefits counted.

3.4.4. United Kingdom

In the United Kingdom, a "supply-side" assessment estimated the market size and growth potential for geographic information (GI) products and services (Coote and Rackham, 2008). The market size in calendar year 2007 was estimated to be GBP 657 million, or 0.06% of GDP, not taking into account human resource capital in customer organisations. This was broken down between: software GBP 152 million, services GBP 223 million, data GBP 254 million, hardware GBP 28 million. The figures were believed to be accurate to +/- 10%. The report was prepared by compiling detailed desk research, particularly company reports, supplemented by industry interviews and other sources. It did not attempt to value the contribution of the industry to the UK economy.

In terms of future growth prospects, the major market drivers include the integration of GI into mainstream ICT applications, public sector initiatives such as INSPIRE and the Location Strategy, and emergence of consumer market geospatial tools, such as Google Earth. They suggest that future prospects are very much dependent on the path of commercial and consumer market development.

A more recent study for England and Wales by the same group focused on local government applications (Coote and Smart, 2010, Schmid, 2010). It is considerably narrower in terms of geographical coverage but it gives additional results for the wider impacts based on using economic modelling to assess the overall economic benefits from using geospatial applications in local government and local public service delivery. The approach was similar to that used in the Australian and New Zealand studies, with case studies and economic impacts of geospatial information used to estimate benefits in a computable general equilibrium model at regional and national levels. Real output of local government was estimated to have increased by GBP 232 million as a result of productivity benefits associated with the adoption of geospatial applications in local government and public service delivery. GDP was estimated to be GBP 323 million higher in 2009, equivalent to around 0.02% of GDP. This was projected to grow rapidly to 2015 and with better policies the contribution would almost double to around 0.04% of GDP.

[10] New research also shows clear firm-level benefits from free or marginal cost pricing across countries (Koski, 2011). Analysis of re-users of geographical information in architectural and engineering activities and related technical consultancy in 15 countries in the 2000-2007 period shows that firms grew about 15% more per annum in countries where public sector agencies provide fundamental geographical information for free or at marginal cost, compared with countries with cost-recovery pricing. Positive growth comes one year after switching to marginal cost pricing but growth is higher with a two-year lag; and SMEs benefit most from cheaper information.

3.4.5. Summary

The geospatial industry and the impacts of use of geospatial information across the whole economy have received considerable attention, due to the importance of geospatial applications in a myriad of different applications, and its major share in total PSI reuse. The most comprehensive estimates of the impacts of geospatial information have been undertaken in Australia and New Zealand, where general equilibrium models based on detailed sector case studies were used to calculate aggregate economic impacts. The structural features of these two economies are somewhat different from those of the EU27 countries but the overall impacts analysis provides a comprehensive basis to provide estimates fro the EU27.

In Australia it was conservatively estimated that spatial information industry revenue in 2006-07 could have been of the order of AUD 1.37 billion annually, and the economic footprint of the spatial information industry is larger, as spatial information activities are undertaken in other parts of the economy. Based on general equilibrium modelling the economic impacts (aggregate impacts across the whole economy of the application and use of spatial information, including the sector itself) is considerably larger and contributed a cumulative gain of AUD 6.43-12.57 billion to GDP, equivalent to 0.6-1.2% of GDP, with concomitant cumulative gains in other economic variables. Other benefits were expected to increase significantly as spatial information systems are further integrated into market operations. The costs of inefficient access to data were estimated to have reduced the direct productivity impacts. Similar results were obtained for New Zealand where as a direct result of the uptake of spatial technologies across the whole economy, New Zealand's real GDP increased by NZD 1.2 billion in 2008 through productivity-related gains, equivalent to slightly more than 0.6% of GDP.

Using a different approach, the economic value of the Dutch geo-information sector in 2008 was estimated at EUR 1.4 billion, or 0.23% of national GDP based on detailed surveys covering private, governmental and research sectors, but not including geo-information activities outside of the core primary geo-information products and services. In comparison, a more restricted United Kingdom "supply-side" assessment estimated the market size for narrowly defined geographic information products and services in calendar year 2007 to be GBP 657 million.

4. ESTIMATING EU27 MARKET SIZE AND OTHER ECONOMIC VARIABLES

4.1. Market size and aggregate economic impacts

4.1.1. Estimating market size and aggregate economic impacts from Australian spatial data

Based on Australian estimates of spatial information industry revenues of 0.15% of GDP in 2006-07 and broader accumulated impacts of spatial information applications equivalent to 0.6-1.2% of GDP (ACIL Tasman, 2008), the estimating approach was simply to pro-rate these GDP-based estimates to give estimates of spatial information for the EU27 in 2009. For the simple estimating method see Vickery, 2011, using data from EUROSTAT, 2011.[11] The EU27 spatial information industry size is EUR 17.7 billion, and the expanded size of the economic impacts of the spatial information industry is in the range of EUR 70.85-141.7 billion. It is assumed that the geospatial market is about one half of the total PSI-related market, and that one-half of the PSI-related market comes from PSI itself. [12] The total value of the narrow EU27 PSI industry is thus of the order of EUR 18 billion, and the expanded economic impacts from the use of PSI are of the order of EUR 70-140 billion.

The same pro-rating procedure was repeated using national and EU27 data for (a) computer services spending, and (b) ICT spending by government from WITSA (WITSA, 2009). This gives the following estimates for the EU27 in 2006-07: (a) PSI market EUR 27.0 billion (computer services spending, WITSA, 2009), (b) EUR 25.8 billion (ICT spending by government, WITSA, 2009). Averaging these data with the GDP-based estimates above gives an EU27 PSI market of EUR 23.25 billion. The expanded economic impacts from the use of PSI for the EU27 are: (a) EUR 126.9–248.1 billion, (b) EUR 120.9–236.4 billion. Averaging these results with the GDP-based estimates above gives an EU27 expanded economic impacts estimate of EUR 106.2–208.7 billion, with a mid-point of EUR 157.5 billion.

4.1.2. Estimating market size from the Netherlands geo-information sector

The core geo-information sector in the Netherlands was estimated to be 0.23% of GDP in 2008 (Castelein, et al., 2010), and these estimates were used to calculate EU27 values.

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[11] The same pro-rata estimation technique was used in the MEPSIR study (MEPSIR, 2006), but in the opposite direction. In MEPSIR, the size of the total EU25 plus Norway market was estimated from detailed survey data, and the ratio of the PSI market to GDP was then used to estimate national markets as the survey-based data for individual countries, particularly the more subjective estimates of market size, showed very wide ranges of values.

[12] Spatial information makes up about one half of all PSI according to various estimates (see e.g. PIRA, 2000, MEPSIR, 2006), and it is assumed that around one-half of spatial information and related commercialised information is derived from government sources, and that the same ratio applies to other areas of PSI. These estimates assume that there are similar systemic, interoperability and accessibility barriers for all to access all kinds of PSI, and that PSI markets are broadly similar in terms of their incentives and barriers to exploitation.

Note that recent analysis in Spain provides somewhat different estimates of proportions, but gives very similar results in terms of the ratio of spatial information to the whole PSI-based market. Geographical/cartographic re-use made up 30.5% of the "infomediary" market (the PSI re-use market) and estimated activity associated with PSI reuse was around 35-40% of the total turnover of infomediary companies, giving approximately the same ratio when estimating market size and other variables based on geospatial information (see Proyecto Aporta, 2011).

Applying the same assumptions as for Australia (above), GDP-based estimations from the Netherlands data give an EU27 geo-information sector of EUR 27 billion and a PSI-based market of EUR 27 billion. The wider economic impacts were not estimated in this study.

The same pro-rating procedure was repeated using national and EU27 data for (a) computer services spending, and (b) ICT spending by government from WITSA (WITSA, 2009). This gives the following estimates for the EU27 in 2008: (a) PSI market EUR 42.1 billion (computer services spending, WITSA, 2009), and (b) EUR 28.7 billion (ICT spending by government, WITSA, 2009). Averaging these estimates with the GDP-based estimate above gives an EU27 PSI market of EUR 32.6 billion in 2008.

Averaging the Netherlands value (EUR 32.6 billion) with the Australian value (EUR 23.25 billion) gives an estimated EU27 PSI market size around EUR 27.9 billion in 2008. Various studies have reported growth rates for PSI markets in the range of 6-18% per year (Castelein, et al., 2010, Coote and Smart, 2010, Fornefeld, 2011, MICUS, 2009). Taking 7% per year as a lower estimate, the EU27 PSI market would have grown to around EUR 32 billion by 2010 provided that PSI markets continued growing at earlier rates and were not dramatically affected by the recession.

4.1.3. Estimating aggregate economic impacts from NZ spatial information

Productivity-related benefits from the use and re-use of spatial information in New Zealand were approximately 0.6% of GDP (NZD 1.2 billion) in 2008. Removing barriers and improving the infrastructure could have added another NZD 500 million (ACIL Tasman, 2009). Applying these data to EU27 2009 GDP (EUROSTAT, 2011), gives approximately EUR 71 billion in productivity-related gains in 2009 based on improvements in the use of spatial information, plus a potential addition of a further EUR 28 billion if barriers were removed and the spatial information infrastructure improved. This makes about EUR 99 billion in total. This assumes that the size of the spatial information industry remains relatively stable. This is probably an underestimate given the rapid growth rates reported for this industry.[13]

As above, spatial information makes up about one half of all PSI according to various estimates (see e.g. PIRA, 2000, MEPSIR, 2006), and it is assumed that around one-half of spatial information and related commercialised information is derived from government sources. Using GDP-based estimates the size of EU27 benefits from PSI are around EUR 70 billion, with an extra EUR 25-30 billion if barriers are removed and the data infrastructure is improved. These estimates assume that there are similar systemic, interoperability and accessibility barriers for all kinds of PSI, and that PSI markets are broadly similar across countries in terms of the incentives and barriers to exploitation.

The same pro-rating procedure was repeated as for Australia using national data for (a) computer services spending, and (b) ICT spending by government from WITSA (WITSA, 2009). This gives the following estimates for the EU27 in 2008 of the expanded economic impacts (productivity gains) from the use of PSI for the EU27: (a) EUR 154.8 billion (computer services spending, WITSA, 2009), and (b) EUR 159.7 billion (ICT spending by government, WITSA, 2009). Averaging these data with the GDP-based estimates above gives an estimate of the expanded economic impacts (productivity gains) for the EU27 of EUR 128.5 billion.

[13] Castelein et al. (2010) estimate a growth rate of 17% in 2008 in the Netherlands. Other estimates have also shown high growth of geospatial information markets. See Fornefeld (2009, 2011) for estimates of market size and growth for Germany, and MICUS (2009) for growth across Europe.

Averaging the New Zealand value (EUR 128.5 billion) with the Australian value above (EUR 157.5 billion) gives an aggregate economic impact of PSI-related applications and use for the EU27 of EUR 143 billion for 2008. There could be approximately EUR 56 billion of additional gains if barriers were removed and the data infrastructure was improved as described in the New Zealand study. That is, if PSI was opened up, the infrastructure worked better and barriers were removed (including difficult access and access restrictions, inappropriate data standards, lack of skills and knowledge in key applications), aggregate direct and indirect economic benefits for the whole EU27 economy could have been of the order of EUR 200 billion (1.7% of GDP) in 2008.

4.1.4. Estimating total welfare gains from open access to PSI in the UK

Estimates of gains from opening up access to digital, non-personal, public sector information are based on estimates for the UK (Pollock, 2011a). The estimated ranges were pro-rated to the EU27 economy to give an approximation of the size of the annual gains from moving from an average cost / cost recovery pricing model to marginal cost pricing for digital public sector information (for the simple estimating method see Vickery, 2011, GDP data from EUROSTAT, 2011). The values for the EU27 for 2009 can be estimated to be EUR 38.1–50.8 billion for the upper range of estimates, or alternatively EUR 13.5–16.9 billion for middle range estimates. These ranges assume that the pricing models across Europe are similar to the United Kingdom (average cost / cost recovery pricing in many cases) and the average structure of public sector information and related markets are similar to those in the United Kingdom.

The same pro-rating procedure was repeated as for Australia using national data for (a) computer services spending, and (b) ICT spending by government from WITSA (WITSA, 2009). This gives the following estimates of total welfare gains of moving to open access models across the EU27 in 2009: (a) EUR 29.1–38.9 billion for the upper range of estimates and EUR 10.4–12.9 billion for the middle range estimates (computer services spending, WITSA, 2009), (b) EUR 38.8-51.7 billion for the upper range estimates and EUR 13.8-17.2 billion for the middle range estimates (ICT spending by government, WITSA, 2009).

Averaging these data with the GDP-based estimates above gives an upper range of welfare gains for the EU27 of EUR 35.3-47.1 billion, and an upper range value of EUR 40 billion is adopted in this survey.

4.1.5. Summary

The results presented in this part of the survey are based on the most viable aggregate studies available estimate plausible values for the PSI market, the potential gains from freeing up access, and estimating the wider economic impacts that could accrue from using PSI across the economy. National estimates were pro-rated to give EU27 totals, based on national : EU27 ratios for GDP, computer services spending, or ICT spending by government.

In the case of estimates based on geospatial data, it is assumed that the geospatial market/impact is about one half of the total PSI-related market/impact, and that one-half of the PSI-related market/impact comes from government PSI itself. Both assumptions are conservative. Geospatial information may be considerably less than one half of all PSI, and governments are the basic source for probably more than one-half of all PSI-like activities. Furthermore, estimated values within and across different sources were reasonably comparable, suggesting that the averages presented in this part of the review provide reasonable estimates of the economic features of PSI markets and the impacts of PSI use.

For PSI market size, the values for the Netherlands and Australia geospatial markets were used to give an estimated EU27 PSI market size around EUR 27.9 billion in 2008.

Studies that report growth rates for various PSI markets have estimated this at 6-18% per year. Taking 7% per year as a lower estimate, the EU27 PSI market could have grown to EUR 32 billion by 2010 provided that PSI markets continued growing at earlier rates and were not dramatically affected by the recession.

For the aggregate economic impacts, the values for Australia and New Zealand were used to give an aggregate economic impact of PSI-related applications and use for the EU27 of EUR 143 billion for 2008. There could have been approximately EUR 56 billion of additional gains if barriers were removed and the data infrastructure improved as outlined in the New Zealand study.

The values for individual calculations are comparable for the two countries, and averages are intuitively reasonable. It is however to be urged that similar studies using general equilibrium modelling or similar techniques be undertaken in European countries to confirm these results. It is further suggested that estimates based on studies of consumer surplus be undertaken to provide a more comprehensive picture of the benefits from better access to and use of public sector information.

For welfare gains from moving from an average cost / cost recovery pricing model to marginal cost pricing for digital public sector information gives an EU27 upper range of EUR 35.3-47.1 billion, and the value of EUR 40 billion is adopted in this survey. Although the UK PSI access and licensing system remains somewhat different from other EU27 countries, UK estimates of the positive impacts of removing barriers to access are likely to be a realistic proxy across the EU27, due to widespread disincentives to use, lack of information, poor interoperability etc. that have stifled easy use of PSI in other EU countries.

4.2. Other estimates

4.2.1. Estimating market size and productivity gains from UK geographic information markets

Estimates based on a UK supply-side assessment of the geographic information market (Coote and Rackham, 2008) are considerably smaller, with a GDP-based EU27 market size of EUR 7.2 billion. This would give a very narrow version of the PSI market of the order of EUR 7 billion (cf. estimates based on the Netherlands and Australia above). The more recent study for England and Wales of local government geospatial applications (Coote and Smart, 2010) would give overall productivity benefits equivalent at EU27 level to around EUR 2.7 billion, rising to the equivalent of around EUR 5.3 billion in 2009 values in 2015.

4.2.2. Estimating market size from German geo-information data

Estimates based on the size of the German geo-information market are also considerably smaller (Fornefeld, 2009, 2011). Based on the estimated size of the German market of EUR 1.7 billion in 2009, this would give a narrow GDP-based version of the EU27 PSI-based market of around EUR 8.3 billion. However the German geo-information market is acknowledged as being relatively small due to difficulties in obtaining public sector map data, and this biases downwards estimates of the total PSI market.

4.2.3. Estimating market size from Spain PSI sector data

Estimates based on the economic activity of the Spanish "infomediary" sector **(**Proyecto Aporta, 2011) are also considerably smaller. Based on the surveyed value of turnover generated from PSI-based sales of Spanish firms selling direct PSI-based goods and services of EUR 550-650 million, this would give a narrow GDP-based version of the EU27 PSI reuse market of around EUR 6.7 billion. This value is based on a survey and secondary

market data of all companies identified as being engaged in direct re-use in Spain, and provides a core estimate of the narrow re-use market.[14] However, the indirect effects and the footprint of PSI products and services may well be larger both in Spain and at EU27 level.

4.2.4. Estimates of aggregate time savings in Norway

Comparing time savings in Norway with the EU27 by a simple GDP-based pro-rata calculation gives an estimate of the effects of savings from improved time allocation due to the ability of individuals to have better access public information. The annual surplus of time saved in Norway through better access to public information is estimated as 2 hours per citizen per year (Norway, 2011). This gives a surplus estimated at EUR 32.5 million = 0.01181% of Norwegian GDP. Converted to the EU27 using the ratio between Norwegian and European GDP, this makes EUR 1.395 billion across the EU27 in terms of the total annual value of individual time saved in simply performing very few activities in a way that uses time more effectively.

4.2.5. The European environmental impact assessment market

Environmental Impact Assessments and Strategic Environmental Assessments are required by European Law to assess the potential impacts of projects and plans at national level. Assessments are largely based on publicly held geo-spatial data or on information originally derived from public sources. This market has been estimated to be worth EUR 1 billion per year across Europe at national level (Craglia, et al., 2010). It is estimated that improving the visibility and accessibility of the information required to undertake these studies could save up to EUR 200 million per year on assessments at national level. Including sub-national assessments the numbers could be 10 times higher, i.e. a European market of EUR 10 billion, and potential savings from better information of EUR 2 billion.

4.2.6. Improved access to research results across the EU27

A body of analytical work is developing aimed at estimating the economic benefits derived from open access to research results (see Houghton 2009, Houghton and Sheehan, 2009, OECD, 2005). The potential impacts have been estimated in detail using a modified Solow-Swan model (see Houghton and Sheehan, 2009). The analysis allows estimates of the increase in returns to R&D due to increases in accessibility and efficiency arising from Open Access to research results.

It is estimated that with a 20% return on R&D and a 5% increase in accessibility and efficiency from Open Access, recurring annual gains from the effect of one year's R&D for the EU27 are of the order of EUR 4.8 billion for Government Expenditures on R&D (GERD) and EUR 1.1 billion for Higher Education Expenditures on R&D (HERD) (Table 2, Houghton, 2011). This makes approximately EUR 6 billion of recurring annual gains in total, or 2% of public R&D expenditures (GERD plus HERD) for benefits captured from government expenditures. Business expenditures could be expected to be of approximately the same order of magnitude. These are recurring annual gains from the effect of one year's R&D, so if the change that brings increases in accessibility and efficiency (*e.g.* a shift to open access publishing) is permanent they can be converted to growth rate effects.

[14] See details in section 3.3.6 above.

Table 2. EU27: Increase in returns to R&D due to increases in accessibility and efficiency arising from Open Access

EU27

GERD	Rate of return to R&D				
EUR 236,553 million	20%	30%	40%	50%	60%
Per cent change in accessibility and efficiency	Recurring annual gain from increased accessibility & efficiency (million)				
1%	951	1,426	1,902	2,377	2,853
2%	1,911	2,867	3,823	4,778	5,734
5%	4,849	7,274	9,699	12,123	14,548
10%	9,935	14,903	19,870	24,838	29,806

HERD	Rate of return to R&D				
EUR 56,024 million	20%	30%	40%	50%	60%
Per cent change in accessibility and efficiency	Recurring annual gain from increased accessibility & efficiency (million)				
1%	225	338	450	563	676
2%	453	679	905	1,132	1,358
5%	1,148	1,723	2,297	2,871	3,445
10%	2,353	3,530	4,706	5,883	7,059

Source: Houghton, 2011.

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