Delft University of Technology

Funding Open Data

Welle Donker, Frederika

DOI
10.1007/978-94-6265-261-3_4

Publication date
2018

Document Version
Accepted author manuscript

Published in
Open Data Exposed

Citation (APA)
Welle Donker, F. (2018). Funding Open Data. In B. van Loenen, G. Vancauwenberghe, & J. Crompvoets (Eds.), *Open Data Exposed* (pp. 55-78). (Information Technology and Law Series; Vol. 30). TMC Asser Press. https://doi.org/10.1007/978-94-6265-261-3_4

Important note
To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright
Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy
Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

This work is downloaded from Delft University of Technology.
For technical reasons the number of authors shown on this cover page is limited to a maximum of 10.

Chapter 4
Funding open data

In: B. van Loenen, G. Vancauwenberghe & J. Crompvoets (eds.), Open Data Exposed, Information Technology and Law Series (ITLS, Volume 30, https://doi.org/10.1007/978-94-6265-261-3_4.

Frederika Welle Donker

Abstract Open government data are fast becoming entrenched in our society. However, even though open government data may be "free", it is not "gratis". It takes substantial human and financial resources not only to collect and maintain government data, but also to process the data to be suitable for distribution as open data. Those resources need to be funded. In this chapter, we identify potential funding models for open data. We also explore the costs of implementing open data policies, and the benefits of open data, both for the open data organisation and for society. We demonstrate that the once-off operational costs of open data supply are marginal compared to the total operational costs of the open data organisation. Open data leads to efficiency gains within the open data organisation and to societal benefits. However, to reap those benefits, it is essential that organisations switching to open data, receive compensation, at least in the short-term. the compensation may be found in a new *paid* role in the information value chain.

Keywords Open data • Open data funding • Financial sustainability • Costs and benefits of open data

F.M. Welle Donker
Delft University of Technology, Faculty of Architecture and the Built Environment, Knowledge Centre Open Data, the Netherlands
e-mail: f.m.welledonker@tudelft.nl

Contents

4.1 Introduction

Since the adoption of the G8 Open Data Charter[1], government organisations are increasingly under political and societal pressure to release their high-value data as open data[2]. However, without a sustainable open data business model there is a real risk that the update frequency and the quality of data may suffer or that the open data policy may have to be reversed. Especially government agencies that rely on income from licence fees for data will have to find alternatives to fund the fixed (sunk) costs of data and to offset revenue losses due to open data. Without some form of compensation, government agencies may only publish datasets with the least commercial value as open data, while retaining the more valuable data to minimise the risk to commercial revenues[3]. One of the challenges in this tension field between lost revenue due to open data and still maintain adequate data service quality, is to develop a sustainable business model for open government data providers which ensures the availability of quality open data in the long term.

This chapter provides a data provider perspective to open data by identifying and analysing the funding models that allow for open government data, the costs an

[1] Group of 8 2013.

[2] Welle Donker 2016.

[3] Rhind 2014.

organisation faces when switching to an open data policy, in addition to the direct benefits for the organisation and for the society, and other (in)direct effects. In Section 4.2, we will describe regimes and strategies for funding open data activities. Section 4.3 provides a summary of the findings of a literature review of open data cost-benefit studies. In Section 4.4, the actual costs of preparing for and publishing open data are described. We also describe the benefits of open data for the open data supplier. We conclude in Section 4.5 with a reflection on the fact that while data providers bear the direct costs, the benefits appear to befall mostly elsewhere.

4.2 How to fund open data?

The philosophy behind open government data regime[4] is that data collected by the public sector are a public good[5]. The data are collected to execute public tasks and are already paid for by the taxpayer. Users should, therefore, not have to pay again to (re)use the data that were collected anyway[6]. In this section, we address three ways of funding open data: (1) through the general revenue, (2) by taking a new role in the data value chain, and/or (3) by introducing a different pricing strategy for the data provided.

4.2.1 Funding open data through general revenue

With an open data regime, the government data provider is often funded from general revenue, and data are made available for (re)use free of charge and without restrictions according to open data principles. If the dataset were available free of charge, but with some restrictions imposed on its use and redistribution (e.g. mandatory source attribution), then a more appropriate term would be a zero-priced regime[7]. The expected benefits of open data (re)use by third parties are more transparency and accountability of the government, economic and societal value creation, cost savings, efficiency gains, and enhanced reputation[8]. The expectations are that with an open data regime, more companies, especially smaller companies and start-ups, will be able to reuse the data for value added information products as (high) licence fees are removed as a potential barrier. One may reason that as more value-added products will be produced, more revenue will flow back to the government in the form of taxes, such as value added taxes and company taxes[9]. Figure 4.1 shows the data flows and financing flows in an open data regime. In this funding schema, the open data provider will largely depend on political decisions to

[4] In literature preceding the term 'open data' this regime is referred to as 'open access model', see e.g. Onsrud 1992b. Since the Budapest Open Access Initiative in February 2002 (http://www.budapestopenaccessinitiative.org/), the term 'open access' is more often used to denote the provision of free online access to scientific publications and/or research outputs (cf. European Commission 2015).

[5] See e.g. Onsrud 1992b.

[6] See e.g. Pollock 2008; Uhlir (ed.) 2009.

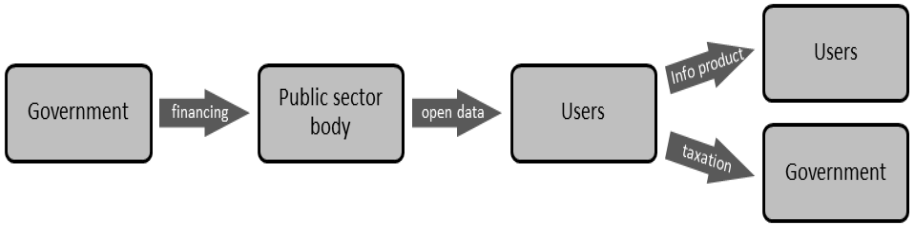
[7] Cf. Lateral Economics 2016.

[8] See e.g. Carrara et al. 2015.

[9] See e.g. Van Loenen 2009.

maintain adequate funding levels[10]. If funding for a data provider is reduced, the update frequency and quality of the datasets may have to be reduced. In addition, there are no guarantees that revenue raised from taxation will be returned to the appropriate public sector body[11].

Figure 4.1 Financing open data regime [*Source* Boers 2015, after Van Loenen 2006, p. 106



4.2.2 Funding open data by moving in the value chain

Public sector data suppliers can employ other strategies to fund open data provision: they may adopt a new role in the open data value chain. The philosophy is that the data is provided for free, but additional services associated to the data are available at a cost. In addition to the data suppliers' role, Deloitte LLP (2012) identified four emerging "archetype" roles for organisations within their open data value chain[12]:

1. **Aggregators**: organisations that collect and aggregate open data from multiple sources, sometimes combined with proprietary data. Such aggregation often occurs on sectorial or geographical level. The aggregated data may be used to present the data more efficiently, or to perform analyses. An example of an aggregator is the Spanish Infoempresa[13], or the British Open Opps[14].
2. **Enablers**: organisations that provide a platform, tools and technology for third parties to use open data. The enablers do not use the data as such but act as an intermediary between data holders and users by providing cost-effective and efficient solutions, and/or by coordinating feedback[15]. In addition to providing an open data platform, Enablers can offer additional services, such as consultancy.

[10] Onsrud 1992a.

[11] Van Loenen 2009.

[12] Deloitte LLP 2012.

[13] http://www.infoempresa.com Accessed May 2018.

[14] http://www.openopps.com Accessed May 2018.

[15] Schiff 2003.

An example of an Enabler is the Irish Connemara Programme[16] or the German GraphDefined[17].

3. **Developers**: organisations and individuals that design, develop and sell applications for end-users. Such applications, such as multi-modal route planners, typically use highly dynamic open data. Developers may also use open data to develop free applications as a calling card to show their capabilities to potential customers[18]. An example of an Open Data Developer is the Greek CropDiagnosis[19].
4. **Enrichers**: organisations (typically larger companies) that use open data to enhance their existing portfolio through better insight, efficiency gains or as a tool to sell other products. For example, Esri, a supplier of geo software, republishes government geographical open data in a more user-friendly way and in their propriety software format. Open data is used to promote their data-as-a-service platform[20].

The roles identified by Deloitte LLP (2012) may not all be suitable to all government bodies. It will depend on circumstances, national policies and cultural attitudes find a balance between the roles of public sector organisations and the private sector.

Over time, government agencies do change roles in the open data value chain[21]. For example, many European National Mapping Agencies are in the process of moving from a data supplier role towards an enabler role by developing platforms and tools and using their expert knowledge to facilitate access to their open data. Or as one of the data providers stated: "we are moving from being a data supplier towards being a data partner"[22]. For the Australian Bureau of Statistics, moving in the open data value chain was not by choice but by necessity as the private sector appeared to be reluctant to fill the gaps[23]. Changing roles may also provide new opportunities to fund open data operations. Where the data will be provided as open data, flowing on value adding services may generate new income streams that may be used to fund open data.

---

[16] http://www.connemaraprogramme.com/ Accessed May 2018.

[17] http://www.graphdefined.de Accessed May 2018.

[18] Welle Donker and Van Loenen 2016a.

[19] http://www.cropdiagnosis.com Accessed May 2018.

[20] http://www.esri.com/software/open/open-data Accessed May 2018.

[21] Welle Donker and Van Loenen 2016b, and Welle Donker et al. 2017a

[22] Welle Donker et al. 2017a, p.23.

[23] Welle Donker and Van Loenen 2016b

4.2.3 Funding open data through pricing strategies for government data

Within the archetype roles, government data holders can employ different pricing strategies to disseminate their fee-based data complementary to open data supply. Ferro and Osella (2013) identified a number of strategies an organisation can employ to raise revenue from open data.

The first pricing strategy is to employ a freemium/premium strategy: a (downgraded) version of the dataset is offered as open data (freemium), whereas the full dataset is available for a fee. The freemium version may be only a small sample of the dataset, a version with fewer attributes or at a coarser scale or may not be the most recent version. The Netherlands Vehicle Authority uses this strategy to offer its data both as open data and as a fee-based service. The premium version offers historical data as well as near real-time data and with a service level agreement (SLA) guaranteeing 24/7 access, whereas the freemium version is 24 hours old and comes without an SLA.

The second pricing strategy is the so-called open source like strategy: the data-provider supplies open data and raises revenue through offering supplementary and/or value added services based on the same open data, or with dual licencing.

The third pricing strategy a data provider may employ is to act as an enabler to facilitate access to open data using the so-called "razor & blades" approach. For instance, datasets are stored for free being accessible to everybody via APIs ("razor") while reusers are charged only for the computing power that they employ on-demand in as-a-service mode ("blades").

4.3 Open data costs and benefit studies

In order to support a movement from fee-based policies to open data, insight in the benefits and cost of open data operations are imperative. Often, the costs are used as one of the arguments against the implementation of open data. But actual research into the cost of open data is scant. Similarly, research into the benefits of open data is often limited to the benefits for society, not for the organisation bearing the cost.
In this section, we provide the results of a literature review of nearly 70 international cost-benefit studies into the effects of open government data[24].

Most of the international studies assess effects on a macro-economic level *ex ante*, i.e. before open data are made available. Thus, these studies often only consider the potential benefits of open data and not the initial and on-going

[24] Welle Donker and Van Loenen 2016b and Welle Donker et al. 2017b.

investment costs[25]. In addition, most macro-economic studies are carried out top-down. Such studies run the risk of over-estimating the benefits of open data, not least because they typically ignore substitution possibilities for other data to be used instead of open data[26]. There are a number of *ex post* case studies carried on a dataset level or per organisation, i.e. after open data are published. Such micro-economic studies often provide a better insight into the actual benefits and additional costs of supplying open data. However, bottom-up approaches built from micro-economic analysis risk underestimation op the open data benefits, not least because they tend to miss a wide variety of positive impacts, many of which are serendipitous[27]. In the next section, the costs and benefits of open data on organisational level are described.

4.3.1 What are the costs?

Where costs were identified, on organisational level these could be divided into three categories: adaptation costs, infrastructural costs and structural maintenance/ operational costs. Before data can be published as open data, the data needs to be scrubbed and adapted (adaptation cost). There needs to be an infrastructure available to publish the data (infrastructural cost). Even when an existing data infrastructure is used, there will be additional costs to meet the demands of open data. In addition, tools and apps have to be developed and the availability of open data needs to be promoted. Finally, there are costs to maintain and update the data, and there needs to be a facility to deal with questions of users (structural maintenance cost).

Other costs that were identified were the costs of dealing with the effects open data may have on the privacy of individuals, the costs of capacity building and the lost revenue due to open data.

4.3.2 Adaptation costs

To switch to an open data policy, an open data strategy will have to be developed. This means that stakeholders will have to be consulted and desired outcomes will have to be defined. A data inventory will have to be carried out to find out which candidate datasets may be suitable to be published as open data, and which adaptations may need to be carried out. The proposed open data policy needs to be

[25] Welle Donker and Van Loenen 2016b. See also Trapp et al. 2015.

[26] Omidyar Network 2014, p. 8.

[27] Omidyar Network 2014, p. 8.

checked by the legal department. Support for the change strategy has to be created within the departments that have to supply open data as they have to adapt their working procedures. In order to connect to open data policies of other organisations, it would pay to coordinate the proposed open data policy with other open data organisations. The time needed to develop a sound open data strategy should not be underestimated as the organisational culture has to be bended towards open data.

Other preparation costs to be considered are the costs to review and/or terminate existing agreements with third parties for data provision, e.g. a private company supplying aerial photography to a government agency or an engineering company developing a building information model (BIM) for a fly-over designed as part of public procurement for a new highway. Such third-party data or models are combined with government data, thus, the combined dataset contains third party data that may be subject to intellectual property rights. To offer the combined dataset as open data may require new licence agreements between the private company and the government agency. Such transaction costs to renegotiate existing agreements are part of the open data preparation costs. It may avoid potential lawsuits by companies claiming market distortion due to open data[28]. Once an open data policy is accepted, the proposed open datasets have to be made suitable to be published as open data. We do not consider the costs of collecting and processing the raw data to be part of open data costs as these costs are part of the normal operating costs of an organisation. However, the original datasets may have been collected for a specific goal, and may contain (third party) intellectual property rights, personal data or other sensitive data[29]. Therefore, candidate open data datasets need to be thoroughly checked for sensitive information, and adapted, either by anonymising or aggregating the dataset[30].

To comply to the open data principles, data formats may have to be transformed from a native proprietary format to an open source format. The datasets also need to be checked for errors, metadata have to be created and/or completed, according to metadata standards, and data documentation may have to be written. It could also be argued that the described (meta)data quality checks should be part of good data management protocols anyway[31]. Publishing data as open data will then only require

[28] See e.g. Gerechtshof Den Haag 2014.

[29] Other sensitive data may be data which may pose a threat to the national security or public safety, data containing business and/or manufacturing data that was provided to the government organization in confidence, or data that may be environmentally sensitive data, e.g. related to breeding sites of rare species (cf. Aarhus Convention 1998, pp. 6-7).

[30] see further Chapter 7 of this volume.

[31] As proposed by the Dutch National Institute for Public Health and the Environment (RIVM) in their concept of an ‘automated open data washing’ process, see Van Loenen et al. 2016.

ticking off the dataset as "suitable for open data". With the tick, the dataset is automatically linked to a central open data portal[32].

The option of making the data suitable as linked data could be considered at this stage. The added value of linked data lies in the improved findability and reusability of the data as linked data conforms to a common data format, known as the Resource Description Framework (RDF)[33]. The extra quality controls required for linked data leads to a higher level of data quality. However, the benefits of linked open data (improved findability and higher data quality) also means that server / cloud storage costs will be higher as there will be more data traffic, and the linked data requires more storage capacity[34].

Open data preparation costs will vary depending on the size and type of organisation, the number of open datasets and the type of data. For organisations whose core task is to provide data, e.g. Meteorological Institutes, the preparation costs will be lower than for organisations with less experience in data supply, such as municipalities[35]. From our literature review, open data preparation costs range from €20,000 to €100,000 per organisation once off[36].

4.3.3 Infrastructural costs

In addition to the administrative preparation costs, there are once-off costs related to the data infrastructure in preparation of open data. Web services, data portals and/or data platforms have to be established and/or adapted. Software may have to be purchased or open source software may be used. In both cases, staff will need to be trained to use the software. In addition, APIs, apps and tools will have to be developed to create user-friendly interfaces. As a switch to open data generally increases the data traffic, extra servers and data storage capacity will be required. The open datasets may be stored on separate servers as air gap security[37] to protect other non-open datasets of the organisation, or the open datasets may be stored in the cloud. In both cases, extra capacity is required for uploading, invoking and downloading data.

---

[32] Van Loenen et al. 2016.

[33] See further Chapter 9 of this volume.

[34] http://business.data.gov.uk/companies/ Accessed May 2018.

[35] De Vries 2014.

[36] Welle Donker et al. 2017b.

[37] Air gapping is a security measure, in which a given system is totally isolated - electronically and physically - from other networks, especially those that are not secure.

Apart from the need to build developer capacity within the organisation, resources have to be invested into adequately training and staffing a helpdesk to be able to assist users with respect to technical questions. Users come from a variety of backgrounds and possess different technical skills or may not have sufficient data literacy skills to use open data[38].

To ensure that the open data supply matches user demands, it pays to involve the potential user in the preparation phase. This will require awareness raising activities to engage the potential users and maybe create a coordination unit.

The infrastructural costs vary per organisation. From our literature review, the additional once-off infrastructural costs are estimated to be €10,000 (Enschede, a Dutch municipality of approximately 150.000 inhabitants)[39] to €5,000,000 (Danish Address Data)[40]. It should be noted that for Danish Address Data, the technical and human investment costs were estimated to be around €2M in 2010[41]. However, the actual investment costs were higher due to the establishment of a completely new IT infrastructure for a new register and distribution service. These investment costs cannot, therefore, be solely attributed to open data[42].

A government organisation may choose to invest in developing an open data platform and hosting open data in-house but could also elect to outsource these activities to a private company (e.g. Transport for London) or to use existing government open data centres and/or open data platforms. Although outsourcing may be an attractive option to government organisations with little data supply expertise, outsourcing comes with financial and control costs[43] and potential loss of control[44].

4.3.4 Maintenance and operational costs

Once the datasets are published as open data, they need to be updated regularly and maintained. Should the dataset become redundant, the dataset needs to be archived. These processes are part of the operational costs of the organisation. Other operational costs relate to maintaining / updating the necessary infrastructure. There should be sufficient funding available in the organisation's budget to carry out these

[38] Cf. Johnson et al. 2017; Welle Donker and Van Loenen 2016b.

[39] De Vries 2014.

[40] Lind 2014.

[41] DECA 2010.

[42] Lind 2014.

[43] Johnson et al. 2017.

[44] World Wide Web Foundation 2017.

operational costs. In a changing political landscape, this may not be a certainty for all government organisations.

In addition to the regular operational costs, there are extra promotion and support costs. Apart from adequately staffing a helpdesk to assist users with technical questions, the availability and the potential of the open data should be actively promoted. This will require marketing costs as well as organising hackathons, workshops, seminars, preferably in coordination with other open data suppliers. Organising open data contents or challenges where developers are offered prize money for developing innovative solutions to societal issues may be beneficial[45]. Although promotion costs are optional, it is necessary to continually invest in actively promoting open data initiatives to ensure social inclusion[46] and in open data portals so they remain fit for purpose[47].

From our literature review and case studies, the organisation's maintenance and operational costs of open data are between €10,000 and €200,000 per annum, depending on the type of organisation and the open data on offer. One study showed that the extra costs of open data supply are, in general, marginal compared to the annual budget of the organisation), and between 0.0 per cent to a max of 0.14 per cent of the total number of FTEs dedicated to open data activities[48]. It should also be noted that in practice, the extra costs due to open data supply are difficult to isolate from the normal operational costs of the organisation as many organisations do not maintain a separate ledger for open data.

4.3.5 Cost: Loss of revenue due to open data

In the researched case studies, we found that for public sector information holders whose core task was to supply data, the loss of revenue due to open data was noticeable, but this loss often only represented a relatively small percentage (2 to 6 per cent) of the total income basis of the organisation[49]. For organisations that rely for a large percentage of their income on fee-based data, the switch to open data is harder to compensate. The UK Ordnance Survey for instance, received 69 per cent of their trading revenue from direct licences in the financial year 2016-2017[50]. In their own words: "The impact of open data both directly and indirectly would lead to

[45] PwC and Uscreates 2015.

[46] See e.g. the Open Data Barometer reports, 2nd to 4th editions.

[47] Sasse et al. 2017.

[48] Algemene Rekenkamer 2014, p. 13. Most often, this percentage is 0.0 as most organisations do not allocate extra FTEs to open data activities.

[49] De Vries et al. 2011; Welle Donker and Van Loenen, 2016b; Welle Donker et al. 2017a.

[50] Ordnance Survey 2017, p. 48.

a significant loss of commercial revenue and consequent pressure on Ordnance Survey costs and service levels"[51].

Special programme funding for Trading Funds

On 22 November 2017, the UK Cabinet Office announced a new Geospatial Commission to maximise the value of all UK government data linked to location and to create jobs and growth. The Geospatial Commission will be supported by £40 million of new funding in each of the next two years, drive the move to use data more productively - unlocking up to £11 billion of extra value for the economy every year. The new Commission will draw together a number of Trading Funds with a view to improve access to, links between, and quality of their data, and to investigate the possibility of making more data available for free and without restriction (https://gov.uk/government/news/chancellor-to-unlock-hidden-value-of-government-data, accessed May 2018). The Geospatial Commission's first task will be to explore how to open up the Ordnance Survey MasterMap data to UK-based small businesses in particular, either under an Open Government Licence or via an alternative mechanism. However, as at Aril 2018, a policy has yet to be formulated, and there are no guarantees for funding after 2019.

4.3.6 What are the benefits?

The literature review showed that in all cases the benefits to costs ratio was positive, i.e. the benefits outweighed the costs, ranging from a 1.12-1: to a 181:1 ratio[52]. The studies showed that the additional costs of transforming data to publish as open data are marginal compared to the total information supply costs required of the organisation. Table 4.1 provides an overview of the studies where a benefit to cost ratio was either provided or could be calculated.

Table 4.1: overview literature study where a benefit to cost ratio was provided or could be calculated [*Source* The Author]

Year	Reference	Focus	Ratio benefits : costs	Reflection
2000	Pira Int. et al. Report.	EU15	**Benefits**: EUR 68 B/yr **Costs**: EUR 9.5B/yr **Ratio**: 68:9.5 ≈ 7.16:1	Based on extrapolation of some case studies for EU15 and by including the film industry in the USA economic value
2006	OFT –	UK	**Potential benefits**: GBP 1.1 B/).	

[51] Ordnance Survey 2017, p. 25.

[52] Welle Donker et al. 2017b.

Year	Reference	Focus	Ratio benefits : costs	Reflection
	CUPI Report		**Costs:** loss of revenue of data holders (GBP 400 M/yr); extra regulation costs (max. GBP 0.7 M/yr). **ratio:** 1,100:401 ≈ 2.74:1	
2009	Lazo – value weather forecasts	USA	**Benefits:** aggregated value USD 31.5B/yr. **Costs:** USD 5.1B/yr (by public & private sector). **Ratio:** 31.5: 5.1 ≈ 6.2:1	Based on a national survey with > 1,500 respondents to determine where, when and how often weather forecasts were requested, and user's perception, use and valuation of the information.
2008 & 2011	Pollock economic PSI reports	UK	**Benefits**: GBP 1.6-2.0B/yr. to 4.5-6B/yr **Costs**: GBP 400 to 550M/yr. **Ratio**: 3.37:1 to 12.6:1	
2010	Coote & Smart – value of GI to LPS delivery	local UK	**Ratio:** 2.5-3.75:1	benefits mostly due to higher productivity and ca. 1,500 extra FTE staff in industry due to better access to PSI of local authorities.
2010	DECA Danish Address Data	Denmark	**Benefits:** Direct economic effects EUR 62M (2005-2009), & EUR 14M in 2010; societal benefits ca. EUR 57M incl. EUR 5M in saved transaction costs. **Costs:** EUR 2M data transformation costs (once-off) + EUR 0.2M /yr distribution costs. **Ratio:** 70:1	EUR 1.3M of once-off costs paid by municipalities, remainder by DECA. 30% of benefits for public sector, 70% for private sector. Evaluation after 8 years of open address data in Denmark
2011	Houghton – CBA of data provision	Australia	**Benefits:** ABS: direct AUD 4,97M/yr; wider impact ca. AUD 25M/yr GA: direct transaction costs savings ca. AUD 375,000/yr. Wider impact ca. AUD 15.5M/yr. Est. total benefits: AUD 17.5M/yr. **Costs:** ABS: nett AUD 3.53M/yr; GA: nett 1.3 M /yr. **Ratio:** ABS: 25:3.53 ≈ 7:1; GA: 17.5:1.3 ≈ 13:1	Cost-benefit analysis of Australian Bureau of Statistics (ABS) and Geoscience Australia (GA) topographic data.
2011	Oslo Economics Report	Norway	**Benefits**: OTD: NOK 70M for private sector on short-term and consumer surplus up to NOK 73.5M; REV: NOK 75M short term and consumer surplus up to NOK 84M; TR: no short term impact (currently no reusers) and consumer surplus up to NOK 44M; Juris: societal benefits of free	Investigation into the potential impact of publishing certain key datasets in Norway as open data. Open Topographic Data (OTD) + open Real Estate Values (REV) data + open Trade Register (TR) + open jurisprudence data (Juris). Only lost revenue quantified as costs. Named but not

Year	Reference	Focus	Ratio benefits : costs	Reflection
			access **Costs**: OTD: NOK 70M (lost revenue); REV: NOK 75M (lost revenue); TR: NOK 35M (lost revenue); Juris: transformation costs (not quantified). **Ratio**: 1.12:1 (consumer surplus: lost revenue).	quantified: extra costs to deal with questions, undermining of Norge Digitalt (NSDI public-private partnership) cooperation, data transformation costs, lost revenue of legal data intermediaries.
2011	OSTP – OOS	Canada	**Benefits Smart Bay**: CAD 2,225/yr **Costs Smart Bay:** CAD 7.1M **Ratio:** 1:3.19after 1 year; 1.57:1 after 5 years.	Case study of open oceanographic observation (OOS) data in Canada. Government investment of CAD 2M was once-off with an extra subsidy of CAD 5M over 5 years. There is no long-term financing
2011	Pham – commercial GPS use	USA	**Benefits**: Economic value of GPS (commercial products/services, productivity gains and cost savings) USD 68-122B/yr or 0.5-0.9% of US GDP. **Costs**: Investment costs in GPS constellation by US government: USD 35B + structural costs USD 1M/yr. **Ratio**: 1.88-3.88:1	Report described potential costs created by LightSquared, a company planning to build a nationwide 4G-LTE wireless broadband network utilizing spectrum allocated for Mobile Satellite Service) Such operations are expected to adversely affect the quality of GPS signal transmission and reception. If this were the case, the economic costs would be USD 96B/yr due to lost revenue from GPS-products, hardware and sunk investment costs and R&D. In case of 50% disruption, this would amount to USD 48 B/yr.
2013 - 2015	Effects of open Topography follow-up studies.	Netherlands	**Benefits**: 700 man-hours saved by data-holder, ca. EUR 875,000/yr (1st year); nett investments by companies EUR 9M 2nd year) + additional EUR 4.4M (3rd year) **Costs**: EUR 250,000/yr nett (lost revenue) **Ratio**: 3.5:1	Based on small surveys of users and interview data holder. General effects are more users in the private sector. Assumed that use within public sector remains stable 1 man-hour = EUR 125
2013	Deloitte – market assessment of PSI	UK	**Benefits:** est. societal benefits GBP 5M; lower transaction costs public sector GBP 50 M/yr. **Costs:** GBP 413M/yr loss of revenue. **Ratio:** 143:50 ≈ 2.86:1	Evaluation of CUPI report, published simultaneously with Shakespeare Review (2013) Benefits are raw estimates based on anecdotal evidence of societal benefits in the health and transport sectors.
2013	Assessing value of open OS data	UK	**Benefits:** GBP 10.2-24.1M/yr. **Costs**: loss of revenue (OS licence fees) + GBP 3.72M/yr negative effect on exports. **Ratio**: 10.2-24.1:3.72 ≈ 2.74-6.48:1.	The biggest reusers of OS data are Google, etc. It is impossible to determine the economic value of such companies. Societal benefits not included in this report.
2014	Open data	Australia	**Benefits:** 1.0% GDP of	based on G20 open data (public

Year	Reference	Focus	Ratio benefits : costs	Reflection
	for G20 targets		Australia AUD 15.4 B/yr & potential economic value of all OD: up to AUD 64M/yr. Aggregated direct and indirect value AUD 25M/yr (summary of earlier studies). **Costs:** AUD 8-10 B/yr **Ratio:** 15.4:9 ≈ 1.7:1 (this report) 25:9 ≈ 2.88:1 (earlier studies).	sector and private sector data, and scientific data).
2014	Value of free map & property data	Norway	**Benefits:** NOK 32-174M/yr (ca. NOK 90M/yr) **Costs**: ca NOK 30M/year **Ratio**: 3:1	The potential effects of free map and property data (now fee-based data)
2015	CBA of OD Challenge Series	UK	**Benefits** (expected): in coming 3 years: 17 to 141 extra jobs; GBP 5.3-10.8M in Gross Added Value (GAV); GBP 161-302M wider societal and economic effects. **Costs**: GBP 1.2M, incl. price money and support. **Ratio**: 4.42-9:1 (GAV); 134-251:1 (wider impact).	
2016	Impact of real-time traffic information	Netherlands	**Benefits**: Ca. EUR 1B due to more effective use of infrastructure and cleaner environment **Costs** (for transport sector): Ca EUR 5.5M **Ratio**: 181:1	Only considers costs & benefits for transport sector, costs of making real-time traffic information by public sector not included
2017	Value of TfL's open data	London	**economic benefits:** travellers: up to GBP 115M/yr City of London: GBP 14M/yr TfL: internal efficiencies (unspecified) **Costs**: ca. GBP 1M **Ratio**: 130:1	Cost-benefit study into Transport for London real-time open data.

Although the literature review showed that the benefits of open data are manifold, in practice, it is not easy to monetise the (wider) economic benefits of open data as many of the derived applications are services free of charge themselves. Although these "free" services do not generate revenue from prices paid by end-users, these applications provide a real value to the end-user. Lateral Economics (2016) estimated the value added associated with open data to vary between 0.4 and 1.4% of gross domestic product (GDP)[53].

The direct benefits named in the literature review were, efficiency and effectiveness gains, higher data quality due to more feedback, improved access to data, lower transaction costs, the development of value added services or

[53] Lateral Economics 2016.

complementary products, more investments and job creation, improved consumer and public services[54]. From our research, it also appeared that supplying open data had little effect on the revenue from supplementary fee-based services, as some companies actually preferred the premium version of the data with a guaranteed service level. In some cases, revenue from supplementary services, e.g. requests for tailor-made products even increased slightly[55].

The indirect effects named in literature, were more use by a broader range of users including citizens, more research and education projects, an improved image of the data provider, lower expenditure per household, positive effect on the trade balance, 'societal' benefits (often unspecified), more-informed decisions by citizens, less corruption and better fraud detection, improved working conditions, welfare gains, avoided costs and damages and a more competitive market.

In the micro-economic studies, the benefits outweigh the costs. The benefits of opening the Danish Address Data were estimated to be €63 million in the period 2005-2009[56]. In the Netherlands, the effect of open topographic data was estimated to be €11.5 to 14.5 million in 2013[57], at least €9 million in 2014[58] and €13.6 million in 2015[59]. The effect of opening the Dutch National Digital Elevation data was estimated to be €5.5 million of direct investments by companies, which should have led to about €1.65 million of tax revenue[60]. In the UK, open data of Transport for London (TfL) generates annual economic benefits and savings of up to £130M for travellers (between £70M and £95M per annum in time saving and lower information costs[61], and £20M per annum as a result of more journeys on buses after using open data journey planners), and for the City of London (circa £14M due to extra consumer spending and over 700 jobs created). TfL itself has also benefited from open data in two ways. Firstly, there are internal efficiency gains as TfL does not have to develop apps themselves, spend money on marketing campaigns, and the pressure on the Contact Centre has reduced significantly. Secondly, through the partnerships with companies such as Waze and Google, TfL reciprocally receives

[54] Welle Donker et al. 2017b.

[55] Welle Donker and Van Loenen 2016b.

[56] DECA 2010.

[57] Bregt et al. 2013.

[58] Bregt et al. 2014.

[59] Grus et al. 2015.

[60] Bregt et al. 2016.

[61] This includes £5M per annum in cost savings for passengers who previously subscribed to SMS alerts and the value of new real-time alert services.

back significant data in areas it does not itself collect, e.g. crowd-sourced traffic data[62]. Table 4.2 shows the direct and indirect benefits of TfL's open data.

Table 4.2 Benefits of TfL open data for travellers, London and TfL [*Source* Deloitte LLP 2017, p. 5]

TfL Passengers and Other Road Users	London	Transport for London
Saved time for network passengers • Passengers are able to *plan their journeys better with apps* that use TfL's open data to provide them real-time information and advice on how to adjust their routes. • This provide *greater certainty* on when the next bus/tube will arrive *and saves time* – estimated at between *£70m and £90m pa*.	**Gross Value Added** • A number of companies use and re-*use TfL data commercially, generating revenue*, many of whom are based in London. • We estimate that the total *Gross Value Add* from using TfL data by these companies directly and across the supply chain and wider economy is between *£12m and £15m GVA pa*.	**Savings from not having to produce apps In-house** • With over *13,000 registered developers* currently, TfL is allowing the market to develop innovative new transport apps and services. • This creates potential cost savings for TfL of not having to build apps itself or through co-developing with third party developers.
Saved time for other road users • The availability of data on road works and traffic incidents can feed into Sat Navs, driving software and apps that can allow private and commercial drivers to adjust their routes to avoid congestion. • This saves time and can reduce emissions as less time is spent waiting in traffic queues and journeys are shorter.	**High value Job creation** • TfL open data is estimated to *directly support around 500 jobs* that would not have existed otherwise. • Many of these jobs are in sectors associated with *high productivity*.	**Savings from not having to Invest In campaigns and systems** • The publication of open data gives passengers information directly, *reducing the pressure on the Contact Centre*. • Undertaking an equivalent campaign to make available this information could cost £1m – open data allows TfL to make available the same data at a much reduced cost, *expanding customer reach and improving transparency*. • The cost for TfL of publishing open data is estimated at around £1m annually, suggesting a *significant return on investment*.
Savings made from moving from SMS alerts • Passengers are able to switch to using free apps or free web services for real-time data that use TfL's open data. • This creates a cost saving for those who previously subscribed to fee-based SMS alerts, estimated to worth up to *£2m pa*. The *use value of new real time alert services* is estimated to be up to *£3m pa*.	**Wider Job creation In the supply chain** • A further *230 indirect jobs in the supply chain and wider economy* have also been created.	**Leveraging value and savings from partnerships** • Through partnerships with major data and software organisations, TfL *receives back significant data on areas it does not itself collect data* (e.g. crowdsourced traffic data). • This allows TfL to undertake *new analyses and improve its operations*.
Better Information to plan Journeys, travel more easily and take more Journeys • Passengers are now able to better plan journeys, enabling them to use TfL services more regularly and access other services. • This can result in more journeys on the network. Conservatively the *value of these journeys* is estimated at up to *£20m pa*.		
Plus Improved customer satisfaction from having accurate and reliable Information available Instantly	**Plus supporting the wider UK Digital Economy In London and other cities**	**Plus new commercial opportunities arising from open data**

4.3.7 Costs saved due to open data

Although a switch from fee-based data to an open data regime will entail a loss of revenue, there are also direct cost savings for the organisation. Data quality will improve, due to the quality assurance check needed for open data and due to more feedback from users. Transaction costs related to administrative costs for invoicing and account managing, as well as the costs related to managing a licence and compliance regime, can significantly decrease[63], in addition to less pressure on a helpdesk[64]. In addition, with the availability of open data, the organisation will be

[62] Deloitte LLP 2017.

[63] De Vries et al. 2011, p. 9.

[64] Deloitte LLP 2017.

able to operate more efficiently and effectively, although these benefits cannot always be easily quantifiable directly.

The much-lauded benefits of open data, especially the societal benefits, will not be directly evident to all data suppliers. For the data supplier, the costs of open data will outstrip the direct short-term benefits, especially in the preparation stage of open data and for organisations whose core tasks do not include data supply. However, once open data policies are implemented and the operational costs have become part of the organisation's regular budget, the benefits will outstrip the costs, even though the benefits cannot always be quantified. The fact that personnel can be reassigned to other tasks or that data can be used by other departments within an organisation is not always directly recognised by the organisation to be part of efficiency and effectiveness gains.

It is debatable whether reuse of open data by companies will lead to the predicted extra taxation revenue for the government. Firstly, in practice, many of the derived applications are services free of charge themselves or specifically developed for internal use within a private company. Although these "free" services do not generate revenue from prices paid by end-users, these applications provide a real value to the end-user. But this value cannot be taxed. Secondly, open data are used by multinationals and are used cross-border. There may also be a fear that 'open data could be immediately "swallowed up" [⋯] by big global companies such as Microsoft and Google" and not benefit the national economy[65]. Even if sufficient revenue was raised through taxation to cover the costs of open data activities, there are no guarantees that the tax revenue will be returned to the data provider, and not be used for other government tasks, such as health care. There are sufficient indications though that open data lead to job creation, both directly (e.g. app developers) as indirectly (flow-on effects of services based on open data)[66], which in turn, should lead to tax revenue and costs saved on social benefits for the government.

4.3.8 What are other effects of open data?

All researched micro-economic studies show that there is a significant increase in data traffic and the number of downloads, not only by companies but also by citizens. The open data suppliers in the reviewed studies indicated that the type of requests changed after the introduction of open data: from requests for data or

[65] Michael Fallon, UK Minister for Business and Enterprise, cited by PASC, 2014.

[66] See e.g. Deloitte LLP 2017, Berends et al. 2017; Carrara et al. 2015.

questions related prices and licence conditions, the data suppliers now receive more questions related to the contents of the data and requests for other data.

The actual effects on public sector efficiency gains and effectiveness gains are barely quantified in the studies. In the UK, Transport for London (TfL) estimated the efficiency gains to be between £0.75M and £1.5M per annum due to savings of not having to develop apps in-house, not having to invest in marketing and systems, and through leveraging value and savings from partnerships[67]. In the Netherlands, organisations providing open data indicated that they had received fewer requests under the Public Information Access Act, which would indicate lower transaction costs. For example, the Dutch Education Service (DUO) indicated that the implementation of an open data policy in 2011 had led to a 60 per cent reduction of formal requests under the Public Information Act. This meant that DUO expected to save around 4.5 FTE[68]. The Dutch National Institute for Cultural Heritage expected that municipalities would save around seven minutes per application (required for spatial planning applications) due to the fact that the data were available as open data[69]. In many of the reviewed case studies, the efficiency gains could not be solely contributed to open data as the organisations had introduced other cost-saving measures and an improved ICT infrastructure around the same time.

There was evidence of improved data quality due to the fact that the data had been subjected to a quality assurance check. In addition, the organisations received more feedback from more types of users. For instance, in Denmark more feedback was received after the Address Data were added to the OpenStreetMap maps[70].

Effects such as an improved image, more transparency and less corruption were mentioned, but no indicators to assess these effects were supplied, let alone quantified. Such effects are hard to perceive, for example, because the infrastructure is not sufficient to do so[71]. There is anecdotal evidence in that open data can have a positive effect on detecting and combatting corruption[72], especially in developing countries [73].

[67] Deloitte LLP 2017.

[68] Kronenburg et al. 2012.

[69] Kronenburg et al. 2012.

[70] Lind 2014.

[71] Davies 2013.

[72] See e.g. Eaves 2010

[73] See e.g. Heusser 2012 and Khalil et al. 2015.

4.4 Conclusion

This chapter provided a data provider perspective to open data by identifying and analysing the funding models that allow for open government data, the costs an organisation faces when switching to an open data policy, in addition to the direct benefits for the organisation and for the society, and other (in)direct effects.

4.4.1 Open data funding

Government data providers fund their open data activities mostly from their own operational budget. Government organisations may receive finances to fund their operational budget out of general revenue (i.e. by all tax payers), or receive income through other sources, such as mandatory register fees. The central government may pay the open data supplier compensation to offset losses in revenue die to open data, either as a project (e.g. the UK's Geospatial Commission) or on an on-going basis (e.g. the Netherlands' Kadaster). If the budget is not sufficient to cover the open data costs, then two alternatives are available: moving in the information value chain or implementing pricing strategies.

Information value chain
We found that government organisations can – and often do – change their role in the open data information value chain. Our research suggests that open data results in new roles in the information value chain. Before open data, organisations were primarily data supplier or aggregators; now they are becoming enablers of open data by developing tools and/or platforms to facilitate users. The new role may provide a new funding option to support open data through supplementary fee-based services. For example, companies had seen the potential of data supplied as open data but prefer to use the data with a service level agreement guaranteeing 24/7 access and/or more attributes[74]. The issue of moving in the information value chain may raise questions about the role of government in relation to that of the market, however, outsourcing such tasks may also raise questions related to costs[75] and long-term sustainability[76].

[74] This was the case for the Netherlands Vehicle Authority, where data with more attributes and 24/7 access are available as a fee-based service. The Dutch National Data Warehouse for Traffic Information supplies data with more attributes under reciprocal 'data-for-service agreements.

[75] Johnson et al. 2017.

[76] World Wide Web Foundation 2017

Pricing strategies
To generate revenue from open data, pricing strategies can be employed. The most common pricing strategy is to employ a freemium/premium strategy: the dataset is offered as open data (freemium), often a downgraded version of the full dataset, whereas the full dataset is available for a fee (premium). Where organisations have implemented open data in addition to fee-based services, there have been no negative effects on the fee-based services. In a number of cases, revenue from fee-based services has even increased.

Another pricing strategy employed is to provide open data for free, and provide fee-based supplementary services, such as advice or tailor-made products based on the open data.

4.4.2 Open data costs and benefits

The costs of providing data in an open data version may be significant, especially in the short term, and such costs are often used as an argument against open data. Although these costs should not be downplayed, research shows that, although a shift to open data requires additional investments, the benefits will appear not long after. In most of the researched cases, the on-going operational costs of providing open data are marginal compared to the total operational costs of the organisation.

Our literature review and researched case studies showed that providing open data will not necessarily lead to losses in revenue for organisations in the long term. Although it emerged that open data have led to internal efficiency gains for the organisation providing open data[77], in practice, it is difficult to quantify internal efficiency gains solely due to open data. Organisations continuously implement measures to increase efficiency and open data can play an important role.

The direct effects of open data for users are also efficiency and effectiveness gains. Again, these effects are difficult to quantify. There is evidence that open data have economic effects, such as extra jobs and extra services based on open data. These direct and indirect effects benefit the society at large. For example, open (real-time) transport information leads to more informed journey planning and to more effective use of the infrastructure. Thus, there may be less congestion on the roads, leading to reduced CO_2 emissions and to reduced air pollution.

[77] Cf. De Vries et al. 2011, Koski 2015, Deloitte LLP 2017.

4.4.3 Overall conclusion

We discussed the outcomes of an extensive literature review of cost-benefit studies and open data impact studies. Many of these studies focussed on the potential benefits of open data without taking into account the actual costs of providing open data. More recent case studies show that the benefits outstrip the costs of open data. However, these benefits befall to society at large, whereas the costs are borne by organisations.

It is essential though that, especially in the short-term, there is a compensation to off-set the extra investments. It is also essential that open data users are actively involved in the government's open data activities. Their feedback provides an important contribution to prioritising which data should be available as open data, improving the quality of the data and of the data services. When open data leads to partnerships, open data (mixed and reciprocated by the partner's data), a true open data ecosystem can take seed.

References

The Aarhus Convention. UN/ECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (1998) UNECE (United Nations Economic Commission for Europe). https://www.unece.org/env/pp/treatytext.html Accessed May 2018.

Algemene Rekenkamer (2014) Trendrapport open data [Trend Report Open Data]: 30. http://www.rekenkamer.nl/Publicaties/Onderzoeksrapporten/Introducties/2014/03/Trendrapport_Open_data Accessed May 2018.

Berends J, Carrara W, Engberts W, Vollers H (2017) Re-using Open Data. A study on companies transforming open data into economic & societal value. Brussels, Capgemini Consulting: 2016. https://www.europeandataportal.eu/sites/default/files/re-using_open_data.pdf Accessed May 2018.

Bregt AK, Castelein W, Grus L, Eertink D (2013) De effecten van een open basisregistratie topografie (BRT) [The effects of an open Key Register Topography (BRT)]. Wageningen: 40. http://edepot.wur.nl/278625 Accessed May 2018.

Bregt AK, Grus L, Eertink D (2014) Wat zijn de effecten van een open basisregistratie topografie na twee jaar? [What are the effects of an open Key Register Topography after two years?] Wageningen, Wageningen University: 49. https://www.wur.nl/en/Publication-details.htm?publicationId=publication-way-343935333331 Accessed April 30, 2018

Bregt AK, Grus L, Van Beuningen R, van Meijeren H (2016) Wat zijn de effecten van een open Actueel Hoogtebestand Nederland (AHN)?, Onderzoek uitgevoerd in opdracht van het Ministerie van Economische Zaken [What are the effects of an open Digital Elevation Model Netherlands (AHN)? Research carried out for the Ministry of Economic Affairs]: 53. http://edepot.wur.nl/393158 Accessed May 2018.

Carrara W, Chan WS, Fischer S, Van Steenbergen E (2015) Creating value through open data. Study on the impact of re-use of public data resources. Brussels, Capgemini Consulting: 112. doi:10.2759/328101

Coote, A, and Smart, A (2010) The Value of Geospatial Information to Local Public Service Delivery in England and Wales - Summary (pp. 8): Consulting Where Ltd and ACIL Tasman.

Davies T (2013) Open Data Barometer. 2013 Global Report Web Foundation and Open Data Institute: 45. http://www.opendataresearch.org/dl/odb2013/Open-Data-Barometer-2013-Global-Report.pdf Accessed May 2018.

De Vries M (2014) Wah kos'dah dan? Onderzoek naar de incrementele kosten van aan Open Data doen [What is it going to cost? Research into the incremental costs of doing open data]**:** 60. http://open-overheid.nl/open-overheid/open-data-wah-kos-dah-dan/ Accessed May 2018.

De Vries M, Kapff L, Negreiro Achiaga M, Wauters P, Osimo D, Foley P, Szkuta K, O'Connor J, Whitehouse D (2011) Pricing of Public Sector Information Study. Models of Supply and Charging for Public Sector Information (ABC) Final Report. Brussels, Deloitte Consulting**:** 403. https://ec.europa.eu/digital-single-market/en/news/pricing-public-sector-information-study-popsis-models-supply-and-charging-public-sector. Accessed May 2018.

DECA [Danish Enterprise and Construction Authority] (2010) The value of Danish address data: Social benefits from the 2002 agreement on procuring address data etc. free of charge**:** 8. http://danmarksadresser.dk/file/389579/Value_Assessment_Danish_Address_Data_UK_2010-07-07.pdf Accessed May 2018.

Deloitte LLP (2017) Assessing the value of TfL's open data and digital partnerships. London: 28. http://content.tfl.gov.uk/deloitte-report-tfl-open-data.pdf Accessed May 2018.

Deloitte LLP (2012) Open Growth: Stimulating demand for open data in the UK. A briefing note from Deloitte Analytics. London, Deloitte Touche Tohmatsu Limited**:** 12. https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/deloitte-analytics/open-growth.pdf Accessed May 2018.

Eaves, D (2010) Case Study: How Open data saved Canada $3.2 Billion https://eaves.ca/2010/04/14/case-study-open-data-and-the-public-purse/. Accessed May 2018.

European Commission (2015) Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020, EC Directorate-General for Research & Innovation**:** 9. https://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-pilot-guide_en.pdf, Accessed May 2018..

Ferro E, Osella M (2013) Eight business model archetypes for PSI re-use. "Open Data on the Web" Workshop Shoreditch, London**:** 13. http://www.w3.org/2013/04/odw/odw13_submission_27.pdf Accessed May 2018.

Gerechtshof Den Haag (2014) Falkplan-Andes tegen de Staat der Nederlanden. zaaknummer 200.138.491-01. ECLI:NL:GHDHA:2014:3702

Group of 8 (2013) G8 Open Data Charter, https://www.gov.uk/government/publications/open-data-charter/g8-open-data-charter-and-technical-annex. Accessed May 2018..

Grus L, Bregt A, Eertink D (2015) De effecten van open data BRT na 3 jaar [The effects of open data BRT after 3 years], Wageningen University and Kadaster**:** 7. http://library.wur.nl/WebQuery/wurpubs/495331 Accessed May 2018.

Heusser FI (2012) Understanding Open Government Data and addressing its impact (Draft Version).

Johnson PA, Sieber R, Scassa T, Stephens M, Robinson P (2017) The Cost(s) of Geospatial Open Data, Transactions in GIS 21(3):434-445. doi:10.1111/tgis.12283

Khalil S, Saffar W, Trabelsi S (2015) Disclosure Standards, Auditing Infrastructure, and Bribery Mitigation, Journal of Business Ethics 132(2):379-399. doi:10.1007/s10551-014-2321-6

Koski H (2011) Does Marginal Cost Pricing of Public Sector Information Spur Firm Growth? Keskusteluaiheita Discussion Papers, 28 September 2011 no. 1260. Helsinki, ETLA - The Research Institute of the Finnish Economy**:** 20. http://www.etla.fi/wp-content/uploads/2012/09/dp1260.pdf Accessed May 2018.

Kronenburg T, Monasso T, Boschker E, Thaens M (2012) De waarde van open data. Keuzes en effecten van open-datastrategieën voor publieke organisaties. [The value of open data. Choices and effects of open data strategies for public organisations]. Den Haag, ZENC research carried out for the Ministry of the Interior and Kingdom Relations: 109.

Lateral Economics (2016) Permission granted: The economic value of data assets under alternative policy regimes. A Lateral Economics report for the Open Data Institute 40. https://www.scribd.com/doc/309810679/Permission-granted-The-economic-value-of-data-assets-under-alternative-policy-regimes#download Accessed May 2018.7

Lazo, J. K., Morss, R. E., & Demuth, J. L. (2009). 300 Billion Served. Sources, Perceptions, Uses, and Values of Weather Forecasts. *Bulletin of the American Meteorological Society, 90*(6), 785-798. doi: doi:10.1175/2008BAMS2604.1

Lind M (2014) Addresses and Address Data. Socio-economic benefits of Open Address Data experiences in Denmark State of the Map France. Paris, OpenStreetMap France (OSM-FR). http://www.slideshare.net/slideshow/embed_code/33158858 Accessed May 2018.

Manyika J, Chui M, Groves P, Farrell D, Van Kuiken S, Almasi Doshi E (2013) Open Data: Unlocking innovation and performance with liquid information, McKinsey Global Institute**:** 116. http://www.mckinsey.com/insights/business_technology/open_data_unlocking_innovation_and_performance_with_liquid_information Accessed May 2018.

Nesta, ODI and Icarus (2015) Lessons from the Open Data Challenge Series**:** 28. http://opendatachallenges.org/wp-content/uploads/2015/11/LESSONS-from-the-ODCS-Report2.pdf Accessed May 2018.

OFT [Office of Fair Trading] (2006) The commercial use of public information (CUPI)**:** 183. http://www.oft.gov.uk/shared_oft/reports/consumer_protection/oft861.pdf/ Accessed May 2018.

Omidyar Network (2014) Open for Business: How open data can help achieve the G20 growth target. A Lateral Economics report commissioned by Omidyar Network**:** 84. https://www.omidyar.com/sites/default/files/file_archive/insights/ON%20Report_061114_FNL.pdf Accessed May 2018.

Onsrud HJ (1992a) In support of cost recovery for publicly held geographic information, GIS Law 1(2):1-7

Onsrud HJ (1992b) In support of Open Access for publicly held geographic information, GIS Law 1(1):3-6

Ordnance Survey (2017) Ordnance Survey Limited Annual Report & Accounts 2016−17**:** 68. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/636813/ordnance-survey-annual-report-2016-2017-web.pdf Accessed May 2018.

Oslo Economics. (2011). Markedspotensial ved økt tilgjengeliggjøring av offentlig data [Market potential of increased availability of public data] (pp. 123).

OSTP [Ocean Science and Technology Partnership]. (2011). Lessons learned from OOS in Canada: Preliminary Assessment of OOS Value (pp. 19).

PASC [Public Administration Select Committee] (2014). Public Administration Committee - Tenth Report. Statistics and Open Data: Harvesting unused knowledge, empowering citizens and improving public services. http://www.publications.parliament.uk/pa/cm201314/cmselect/cmpubadm/564/56402.htm, Accessed May 2018.6.

Pham, ND (2011) The Economic Benefits of Commercial GPS Use in the U.S. and The Costs of Potential Disruption (pp. 19): ndp consulting. http://www.gpsalliance.org/docs/GPS_Report_June_21_2011.pdf. Accessed May 2018.

Pira International Ltd, University of East Anglia and KnowledgeView Ltd (2000) Commercial exploitation of Europe's public sector information - Final report. Pira International Ltd, European Commission Directorate General for the Information Society**:** 132.

Ploos van Amstel, W (2016) Gebruik actuele verkeersdata levert mogelijk 1 miljard op [Use of real-time traffic information may generate 1 Billion]. *De Laatste Meter*. http://www.delaatstemeter.nl/kennisnetwerken/gebruik-actuele-verkeersdata-levert-1-miljard-op/. Accessed May 2018.

Pollock, R (2011) Welfare gains from opening up Public Sector Information in the UK (pp. 4): University of Cambridge.

Pollock R (2008) The Economics of Public Sector Information, University of Cambridge**:** 50. https://rufuspollock.com/papers/economics_of_psi.pdf, accessed May 1, 2018

PwC and Uscreates (2015) Nesta and the Open Data Institute Open Data Challenge Series. Final Report: 32. http://opendatachallenges.org/wp-content/uploads/2015/10/Nesta-Final-report-26.10.15.pdf Accessed May 2018.

Rhind D (ed.) (2014) What is the Value of Open Data? Proceedings of an APPSI Seminar on 28 January 2014. London

Sasse, T, Smith, A, Broad, E, Tennison, J, Wells, P and Atz, U (2017) Recommendations for Open Data Portals: From Setup to Sustainability. Brussels: Capgemini Consulting & Open Data Institute.

Schiff F (2003) Business models of news web sites: a survey of empirical trends and expert opinions. First Monday [Online] 8, nr. 6 - June 2 2003: 27. http://dx.doi.org/10.5210/fm.v8i6.1061.

Trapp N, Schneider UA, McCallum I, Fritz S, Schill C, Borzacchiello MT, Heumesser C, Craglia M (2015) A Meta-Analysis on the Return on Investment of Geospatial Data and Systems: A Multi-Country Perspective, Transactions in GIS 19(2):169-187. doi:10.1111/tgis.12091

Uhlir PF (ed.) (2009) The socioeconomic effects of public sector information on digital networks. Towards a better understanding of different access and reuse policies - Workshop Summary. Washington, National Academies Press, 13: ISBN 978-0-309-13968-7

Van Loenen B (2009) Developing geographic information infrastructures: the role of access policies, International Jornal of Geographical Information Science 23(2):195-212. doi:10.1080/13658810701851412

Van Loenen B, Welle Donker F, Ploeger H (2016) RIVM open data Delft, Knowledge Centre Open Data: 71.

Vennemo, H, Ibenholt, K, Magnussen, K, Moen, E, and Riis, C (2014) Verdien av gratis kart- og eiendomsdata [Raise revenue with free Mapping and Property Information] (K.-o. moderniseringsdepartementet, Trans.) (pp. 69): Vista Analyse.

Welle Donker F (2016) From Access to Re-use: a user's perspective on public sector availability. Architecture and the Built Environment. Delft, Delft University of Technology. Ph.D dissertation: 278. http://repository.tudelft.nl/islandora/object/uuid%3A56e48c89-6d06-4ae3-8033-2e913ee09bee?collection=research, Accessed May 2018.

Welle Donker F, Van Loenen B (2016a) How to assess the success of the open data ecosystem? International Journal of Digital Earth: 1-23. doi:http://dx.doi.org/10.1080/17538947.2016.1224938

Welle Donker F, Van Loenen B (2016b) Sustainable Business Models for Public Sector Open Data Providers, JeDEM Journal of eDemocracy & Open Government 8(1):28-61. https://doi.org/10.29379/jedem.v8i1.390

Welle Donker F, Crompvoets MJ, Van Loenen B (2017a) Adapting National Mapping & Cadastral Agencies business models to open data supply: the survey results. Leuven, Knowledge Centre Open Data**:** 36

Welle Donker F, Van Loenen B, Korthals Altes WK (2017b) Maatschappelijke kosten-batenanalyse open data. [Societal cost-benefit analysis open data]. Delft, Kenniscentrum Open Data**:** 128. https://pure.tudelft.nl/portal/en/publications/maatschappelijke-kostenbatenanalyse-open-data(b34165f8-7a62-431f-8b20-6120cafc6ae8).html Accessed May, 2018.

World Wide Web Foundation (2017) Open Data Barometer 4th edition - Global Report 36 https://opendatabarometer.org/doc/4thEdition/ODB-4thEdition-GlobalReport.pdf Accessed May 2018