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The Sustainable Value of Open Government Data

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Abstract

Building on the promise of open data, government agencies support a continuously growing number of open data initiatives that are driven mainly by expectations of unprecedented value generation from an underutilized resource. Although data, in general, have undoubtedly become an essential resource for the economy, it has remained largely unclear how, or even whether, open data repositories generate any significant value. We addressed this void with a study that examines how sustainable value is generated from open data. Subsequently, we developed a model that explains how open data generate sustainable value through two underlying mechanisms. The first, the information sharing mechanism, explicates how open data are beneficial to forging informational content that creates value for society through increased transparency and improved decision-making. The second, the market mechanism, explicates how open data are beneficial as a resource in products and services offered on the market, as well as how open data are used to make processes more efficient or to satisfy previously unmet needs. We tested and validated the model using PLS with secondary quantitative data from 76 countries. The study provides empirical support to the conjecture that openness of data as well as the digital governance and digital infrastructure in a country have a positive effect on the country's level of sustainable value. Overall, the study provides empirical evidence in favor of nurturing open data culture and insights about the conditions that support turning it into sustainable value for the benefit of citizens, business organizations, and society at large.

Keywords: Open data, Government Data, Sustainable Value, Information Sharing Mechanisms, Market Mechanisms.

Maung Sein was the accepting senior editor. This research article was submitted on January 12, 2016, and went through three revisions.

1 Introduction

Data repositories have become a new source of economic and social value. The volume and variety of data continue to grow exponentially as new data sources become part and parcel of an ever-growing universe of data streams and data lakes. The abundance of available data and the so-called "big data" phenomenon have generated much interest in both practice and research communities, where some refer to data as the lifeblood of the economy and others compare data to strategic raw resources such as oil or gold (Abbasi, Sarker, & Chiang, 2016). In this paper, we focus on the value that the appropriation of government data creates around the world, and especially on the value-generation mechanisms of data.

We present the following anecdotal case of Zillow (zillow.com) in order to illustrate the generative potential of open government data (OGD) and to demonstrate how the reuse of open data outside the traditional buyer-seller relationship creates sustainable value.

> *Zillow is a successful real estate platform that provides consumers with free, impartial information about housing. Building on a living database of more than 110 million US homes, Zillow serves the full lifecycle of owning and living in a home, including buying, selling, renting, financing, and remodeling. Zillow has collected and combined various open data sources, such as tax data, home sale, rental listings, mortgage information, geographic data, and data on local land value, as well as historical property prices. The platform combines and analyzes different sources of data to create actionable insights for real estate buyers and sellers.*
>
> *One of Zillow's most popular offerings is its so-called "Zestimates", an advanced statistical predictive tool based on state-of-the-art machine learning algorithms that provide up-to-date information on home values and rental prices (Capgemini, 2013). Overall, real estate buyers and sellers use Zillow's digital content for free but interested service providers that operate in the real estate markets pay Zillow for premium information services and access to the thriving marketplace.*
>
> *In addition to the straightforward value that Zillow creates for the actors in real estate markets, it also creates sustainable value for society at large. While real estate markets are an essential sector of the economy, they can also be a source of vulnerabilities, as became evident during the financial crisis of 2008. Zillow renders enhanced transparency that is vital for market efficiency. Real estate market transparency also guards against real estate market bubbles that are accompanied by conspicuous levels of unsustainable private debt, which in turn result in an inevitable market crash that triggers a ripple effect of losses. Moreover, on a positive note, relevant, timely, and accessible information improves trust between multiple actors, mitigates waste, and reduces the risk of adverse behavior (JLL, 2016). Open access to real estate market information is vital to fostering a level playing field for homebuyers, sellers, and real estate professionals, ensuring that information asymmetry does not skew decision-making.*

The case of Zillow illustrates how data are giving rise to a new economy and how open data generate sustainable value for all. Governments generate and hold vast amounts of rich data that would normally be out of reach for private parties. It has repeatedly been argued that if these data become open, multiple different stakeholders could use them simultaneously for diverse purposes (Magalhaes & Roseira, 2017; Smith & Sandberg, 2018; Zeleti, Ojo, & Curry, 2016). Following the rise of the open data movement, vast amounts of open government data were made available through various portals and repositories. Subsequently, governments and international organizations around the world have voiced expectations that opening access to their data would facilitate the creation of significant benefits for society, organizations, and individuals (European Commission, 2017; European Commission, 2011; Kundra, 2012). Nonetheless, it has remained largely unclear how, or even whether, these repositories generate any value.

Data, in general, have undoubtedly become an essential resource for the economy. However, despite the increasing reliance of companies on external third-party data (Economist Intelligence Unit, 2013; Lindman & Kuk, 2015), there is still limited solid evidence in support of the predictions that trillions of dollars' worth of economic value will be generated annually through open data (Martin, Shah, & Birkhead, 2018; McKinsey, 2013). In this paper, the term open data refers predominantly to data that have been created or collected by governments for one purpose but are now made available to the public for other purposes. Open data have particular characteristics that can potentially explain the limited understanding of how such data generate value. Moreover, the lack of suitable conceptualizations and methods for measuring the value of shared and free resources such as open data may partly justify the extant dearth of scientific evidence about their value.

We addressed this void with the following overarching research question: *How is sustainable value generated from open data?* Subsequently, we developed a model that explains how open data generate sustainable value through two underlying mechanisms. First, the information sharing mechanism explicates how open data are used to create informational content that creates value for society through increased transparency and improved decision-making. Second, the market mechanism explicates how open data are used as a resource in products and services sold on the markets, how open data make processes more efficient, and how open data satisfy previously unmet needs. We tested and validated the model with secondary quantitative data from 76 countries.

The study offers two main contributions. First, we propose a theoretical framework that explains how open and free data resources generate value, and

second, we introduce a method for measuring and quantifying sustainable value, which goes beyond our extant currency-based value measures. Moreover, we submit that value generation through open data is based on creating an opportunity for anyone to reuse data beyond the organizational boundaries of the data custodian and the technical boundaries of the originating device or system. However, this opportunity can be seized only if the potential users are motivated and able to use the data for value-generation purposes. For example, motivated by the massive market and the growth potential, Zillow developed a viable commercial enterprise that leverages the heavy traffic of homebuyers and sellers that are drawn to the platform. Zillow continuously collects data from multiple open data sources as input for their housing valuation model. Naturally, Zillow must possess the required data analytics and data processing capabilities, as well as the means to build a platform that can effectively serve numerous users with different needs and diverse objectives.

Furthermore, we propose that while the nature of the value generated through open data may vary depending on the particular use case, the value is sustainable only if the data are used and reused again and again to create long-lasting value that benefits society at large. Building on Hart and Milstein (2003), we define sustainable value as *a contribution that simultaneously delivers both short and long-term economic, social, and environmental benefits*. Accordingly, the generated value can simultaneously benefit (1) private companies through new funding or profits; (2) citizens who gain utility from the provided information, products or services; and (3) society through happier and healthier citizens, better living environments, and more efficient and sustainable economic markets.

The remainder of the paper is structured as follows. First, we explore the unique characteristics of open data as a resource. Second, we discuss and conceptualize sustainable value. Third, we introduce the research model and present the respective hypotheses. Fourth, we discuss the research design and proceed to data analysis and results. Finally, we discuss the findings, including research implications and future research directions, and we conclude with a few overarching conclusions.

2 Open Data as a Strategic Resource

Digital data are potent infrastructural resources that can be used as a shared means to produce many ends. Infrastructural resources satisfy the following three criteria: (1) they are nonrivalrous (i.e., they can be shared and used by many at the same time at no or low additional cost); (2) they have productive value (i.e., they are often used as a resource for the production of something of interest and are rarely consumed directly); and (3) they are versatile (i.e., they can be used as an input for a wide range of goods and services) (Frischmann, 2012). Given that multiple stakeholders can use digital data simultaneously for different purposes at low marginal costs of dissemination, increased availability of data creates an opportunity for positive synergies and higher levels of value creation across the board (Nilsen, 2010).

Open data are inherently a nonexcludable resource—that is, no one can efficiently exclude others from using them. Accordingly, when digital data become open, they become "digital commons" that serve as a shared resource and a public good (Hess & Ostrom, 2006). However, traditional economic valuation methods are not adequate for assessing digital commons, because data are in abundance rather than scarce and because there is no resource-based competition given the ease of replication, low marginal costs, and instant global distribution. Consequently, whereas open data indeed represent a potent resource, they are not sufficient for driving successful ventures unless the companies using them can also differentiate themselves from others in the market to become economically sustainable (Lindman & Kuk, 2015).

Accordingly, while open data essentially represent a nonexcludable resource, the goods and services that result from their use are proprietary and thus can have sustainable economic value. For example, Zillow uses open data to create a vibrant platform that provides valuable high-grade and free market information to homebuyers and sellers, while at the same time also selling premium services to commercial entities that are interested in this market. It is imperative to highlight that successful data-driven companies, such as Zillow, primarily add value when they complement open data with their own proprietary data sources and use the enriched data in combination with their specialized algorithms and technical infrastructures for the development of digital content, products, and services.

In order to identify the primary characteristics of open data, we reviewed the growing number of papers and industry reports that offer insights into the nature of the open data construct. Papers from the demand perspective frame data openness as unrestricted availability combined with accessibility and technical interoperability of data (e.g., Lindman & Tammisto, 2011; Tammisto & Lindman, 2012). Papers from the supply perspective frame data openness in a similar fashion but add the legal dimension of openness (e.g., Davies, 2010). A considerable number of papers that discuss the economic, regulatory, administrative, and technical enablers and barriers of open data initiatives also provide further insight about the nature and the characteristics of open data (Conradie & Choenni, 2014; Eckartz, Hofman, & Van Veenstra, 2014;

Halonen, 2012; Janssen, Charalabidis, & Zuiderwijk, 2012; Martin, Foulonneau, Turki, & Ihadjadene, 2014; Mayer-Schönberger & Zappia, 2011; Verhulst, Noveck, Caplan, Brown, & Paz, 2014; Zuiderwijk & Janssen, 2014a).

To conceptualize open data, we build on Jetzek's study (2016), which proposes the concept of liquid open data as a multidimensional construct consisting of two main dimensions: data openness and data liquidity. Each of these dimensions is broken down into subdimensions. The data openness dimension reflects the characteristics of the open access ideology—i.e., that data should be available, affordable, and shareable. Accordingly, the data openness dimension consists of the strategic, economic and legal subdimensions. These subdimensions offer different affordances to potential users. The strategic dimension offers the affordance of availability, which allows individuals to access data repositories that are not their own. The economic dimension offers the affordance of affordability, which reduces the economic barriers to acquiring access to data. The legal dimension offers the affordance of shareability, which allows individuals to reuse the data for commercial purposes without adverse consequences.

Similarly, the data liquidity dimension reflects the technical characteristics that are commonly associated with big and open data—i.e., that data should be interoperable, usable, discoverable, and accessible. Accordingly, the data liquidity dimension consists of the conceptual and technical subdimensions. The conceptual dimension offers the affordance of interoperability that provides one with the means to interconnect different data sets and to access them from any other services or systems. The technical dimension offers the affordances of usability, discoverability, and accessibility and ensures that it is easier and less time consuming to harness the data.

Considering that the objective of this study is to create a measurable construct of open data, we suggest a simplified version of the open data construct that is presented in Jetzek (2016). Subsequently, instead of a layered approach, which is more suitable in a theory development setting, we conceptualize open data as a unified construct that provides a basis for developing a holistic measure of data openness. We thus propose seven key measurable characteristics or dimensions of open data, each reflecting a separate affordance of liquid open data (see Table 1).

Building on these characteristics, we define openness of data as the degree to which data are *available, affordable, and sharable, published in a usable and interoperable format, and made both discoverable and accessible*. It is important to note that openness of data is not a binary construct, because there can be a spectrum of values for each of these characteristics. We suggest that data openness can be measured for each of the characteristics, as discussed in Section 6.

Table 1. Seven Characteristics for Measuring the Openness of Data (Adapted from Jetzek, 2016)

Characteristic	Description
Available	Data are widely available to stakeholders outside organizational boundaries.
Affordable	Data are affordable and economic barriers are reduced or eliminated.
Shareable	Data are published with open licenses and other legal barriers are reduced.
Interoperable	Data that originate from diverse sources are published with standard identifiers using open data models that explain syntax and semantics.
Usable	Data are accurately, timely, and consistently published in machine-readable formats using open standards with metadata for improved usability.
Discoverable	Data or metadata are published in a central repository and are easily discoverable via a web search or through linkages to other data (linked data).
Accessible	Data are published with multiple, secure access possibilities, including bulk download, web services, and open APIs.

3 Value Generation in a Networked Economy

Despite growing interest in the marvels and consequences of openness and the big data phenomenon, we find scant evidence in support of the link between the openness of data and sustainable value creation. Furthermore, in addition to the familiar bilateral market-based transactions, today we also witness a growing volume of value-generating many-to-many informal network-based exchanges that are not recorded by the prevailing valuation methods (Bowman, 2015; Viscusi, Castelli, & Batini, 2014). Hence, the current predominant monetary and market-based measurements capture only part of the real value that is being generated in the networked economy (Benkler, 2006). This deficiency, which is not confined to value generation through open data, highlights the need for broadening the scope of research on IT value assessment beyond the established financial and economic frameworks (Grover & Kohli, 2012).

The current discourse on value generation establishes the lack of methods for identifying the intangible value that is simultaneously captured by many stakeholders. In welfare economics, the concept of social welfare serves as an indicator of societal-level value to describe a construct that is much broader than gross domestic product (GDP), which is still the most commonly used country-level measure of value. While GDP mainly measures market-based economic activity, it disregards many of the determinants of social value, such as the environment, freedom, health, and education. These determinants are valued by almost all communities as a source of sustainable existence and well-being (Fleurbaey, 2009; Michaelson, Abdallah, Steuer, Thompson, & Marks, 2009; Stiglitz, Sen, & Fitoussi, 2009). For example, traffic jams may increase GDP because of the increased use of gasoline, and even traffic accidents may increase GDP because they result in more "activity" in the markets. However, neither improve quality of life. In contrast, companies (such as INRIX.com or Waze.com) that reduce traffic congestion through the provision of real-time traffic information to commuters simultaneously increase market activity and improve well-being through reduced commuting time, less stress, and lower levels of pollution.

The central proposition in Moore's (1995) public value framework is that public resources should be used to increase value, not only in an economic sense but also more broadly, in terms of what is valued by citizens and communities. Therefore, public value refers to the added value in the public sphere, which may include the state, the market, and the civil society (Benington, 2011.) In the same vein, the management and strategy discourse uses the term "shared value" to refer to combined social and economic values. Shared value refers to the "policies and operational practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates" (Porter & Kramer, 2011, p. 66). Consequently, societal needs are as important as economic needs in understanding and defining markets.

The case of Zillow is a good example of how the private sector can generate public value. Zillow enhances the transparency and the overall efficiency of the respective real estate markets. Subsequently, in addition to the direct economic value that Zillow delivers to buyers and sellers of real estate, Zillow also generates sustainable value at a social level by maintaining enhanced market transparency that the public sector cannot provide. The enhanced market transparency helps to stabilize the markets, guard against market bubbles, reduce the risk of adverse behavior by scrupulous actors, and mitigate information asymmetries, which in turn helps nurture sustainable and equitable real estate markets for the benefit of all.

While there is a consensus about the desirability of basic civil norms, such as healthcare, dignity, and justice, there is no agreement about the role of the market versus the role of the state in nurturing and upholding these norms (Donaldson & Walsh, 2015). Subsequently, we witness social responsibility-driven legislation and public debate concerning central propositions about the purpose, accountability, control, and success of business organizations. Competitive markets are very successful at proliferating products and services to satisfy the changing desires of personal consumption, but they are less capable of catering to more complex, profound, and enduring social aspirations (Benington, 2011). Accordingly, governments are expected to cater to social and environmental needs and face a multitude of wicked challenges, such as global warming, demographic changes accompanying an aging population, and increasing demands for new services. The perceived and enforced dichotomy between the market and the state has become a stumbling block that hinders integrative and sustainable solutions to societal problems. Open data can thus be perceived as an attempt by governments to provide private companies with access to valuable resources, which they can use to address societal challenges while still caring for their bottom lines.

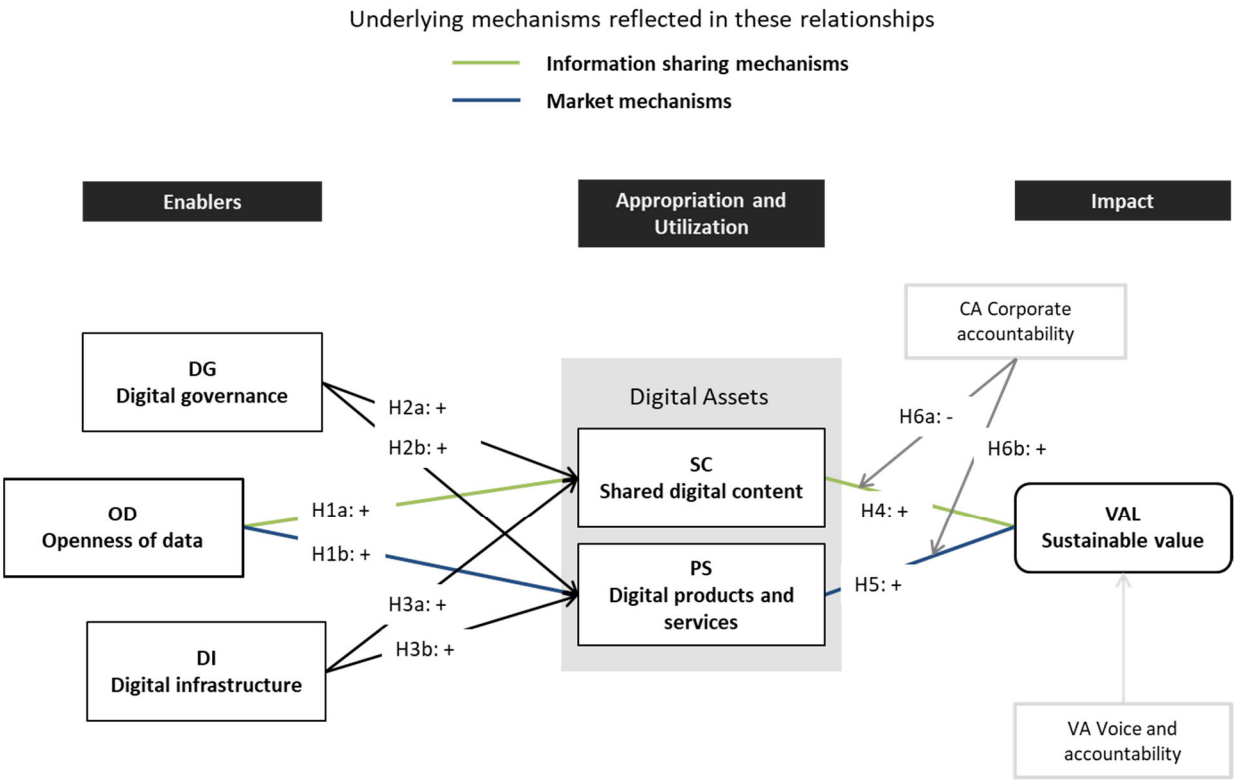


Figure 1. Research Model

4 Research Model and Hypotheses Development

The research model in Figure 1 aims to explain how sustainable value is generated from open data. Two value-generating mechanisms provide the logical link between the open data enablers on the one hand and the resultant sustainable value on the other. This is the basis for the research model. The mechanisms-based research model is instrumental for the subsequent design of the empirical tests of the relationship between the variables (Avgerou, 2013). Specifically, we use mediation analysis to investigate the effect of the mechanisms as intermediating variables that lie in the causal path between the independent and dependent variables. Following Kohli and Grover (2008), we identify not only the relevant mechanisms/mediators but also the right conditions for value generation through open data. Therefore, in addition to open data, we have also included explanatory variables that function as enablers for data-driven value generation, such as the digital leadership of government, robustness of the data protection regulatory framework, the affordability of network infrastructure, and the availability of skills in a country.

Overall, the research model hypothesizes the following relationships. The independent variable "openness of data" (OD) positively influences the two mediating variables that reflect the underlying value-generating mechanisms. The first mediating variable is "shared digital content" (SC), and the second is "digital products and services" (PS). Subsequently, we also propose that the extent of "shared digital content" and "digital products and services" in a country positively influence the dependent variable "sustainable value" (VAL). Although each of the mediating variables reflects an inherently different mechanism, they all serve as digital asset generators. A digital asset is any piece of digital content, product, or service that holds value through expected future benefits.

In addition, we identify two enabling explanatory variables, "digital governance" (DG) and "digital infrastructure" (DI), which reflect the societal context or conditions of the digital environment in different countries. The explanatory variables reinforce the effect of "openness of data" on the two mediating variables. Furthermore, the moderating variable "corporate accountability" (CA) is used to examine whether the accountability of companies indeed influences the generation of sustainable value through open data. This moderating variable can provide an indication of whether it is indeed possible for governments to "outsource" some of the broad societal problems to private companies. Such outsourcing happens when the provision of open data creates an opportunity for private companies to conduct a profitable business activity that coincides with doing social good, such as addressing public health issues or environmental degradation.

Finally, to control for other country-specific influences on sustainable value, we use a broad control variable, "voice and accountability" (VA), that reflects the extent to which citizens of a country benefit from civil freedoms, such as the right to elect the government, freedom of expression, freedom of association, and a free media, as defined by the World Bank. We include this variable to account for the widely recognized influence of untainted country governance on value creation. The following subsections present the individual variables and the respective hypotheses about the relationships between them in further detail.

4.1 Openness of Data

As data constitute an infrastructural resource, most of the value to be obtained from data is captured through the downstream use of the digital asset—i.e., digital content, products, or services. Considering that it is not possible for data owners to foresee every possible use of their data, we argue that open and freely disseminated data, available to everyone, help society gain as much use and value as possible from the data. This use can result in informative shared digital content or new data-driven products and services that are sold in economic markets. We propose that openness of government data positively influences the extent of available "shared digital content" and the extent of new "digital products and services".

H1a: Openness of data positively influences shared digital content.

H1b: Openness of data positively influences digital products and services.

4.2 Digital Governance

Governments play a key role in catalyzing digital development by creating the right environment. Governments have the power to shape institutions that form "the rules of the game in a society or, more formally, the humanly devised constraints that shape human interaction" (North, 1990, p. 3). Basic trust is required for any transaction. Trust is also an essential factor in determining the cost of transactions (Granovetter, 1985). Therefore, it is necessary to ensure that the same norms, principles, and values that underpin physical markets are employed in digital markets. This is necessary to instill confidence that the publication and use of open data are regulated and that personal data are not being unethically or unlawfully used.

Elements of what we can conceptualize as "digital governance"—work structures, organizational behavior, governance, and the regulatory environment—influence the motivation of individuals and organizations to generate value through data. Apart from producing, disseminating, and using data themselves, the public sector must also promote data-driven innovation and growth through governance and leadership (Andrade, Hemerly, Recalde, & Ryan, 2014). Governments should foster an environment supportive of innovation and an ICT-friendly government policy to stimulate the use of data for value generation purposes (Bilbao-Osorio, Dutta, & Lanvin, 2014). Moreover, basic to the success of a data-driven society is the protection of personal privacy and freedom. Privacy and security issues are major and growing challenges for organizations that want to generate value through data, especially when combining multiple large data sets (Chatfield, Reddick, & Al-Zubaidi., 2015). Governments and regulators will need to frame data protection policies that safeguard the privacy of citizens and thus create the foundation for trust (Beardsley et al., 2014).

We operationalized "digital governance" as a second-order variable that comprises the effect of the digital leadership of government and the regulatory data and privacy protection framework, which together reflect the governance aspect of a societal context in a country (cf. Table 3). We propose that "digital governance" positively influences the creation of shared digital content and the development of digital products and services.

H2a: Digital governance positively influences shared digital content.

H2b: Digital governance positively influences digital products and services.

4.3 Digital Infrastructure

Efficient use of data calls for both good basic network infrastructure and the availability of relevant skills. "Digital infrastructure" is defined as a collection of technological and human components that contribute to the functioning of an information system, enterprise or economy (Henfridsson & Bygstad, 2013; Tilson, Lyytinen, & Sorensen, 2010). The advent of shared network infrastructures has enabled individuals, groups, and organizations to co-create services and applications (Tilson et al., 2010). Due to the increasing digitization and the exponential growth of data, the need to provide high-speed broadband to all segments of the population has gained even more importance in recent years (Bilbao-Osorio et al., 2014). Robust high-speed Internet networks and a workforce with relevant skills and education have thus been mentioned as the most important macrolevel enablers in a digital infrastructure (Bilbao-Osorio et al., 2014).

The ability to unlock value from new IT innovations is dependent on having access to a supply of willing and able workers with the required skills (Tambe, 2014). The availability of skilled workers affects the ability of organizations to create shared digital content and digital products and services. Therefore, continuous honing of workers' skills has never been more important for sustaining the competitiveness of organizations as well as society at large (Bilbao-Osorio

et al., 2014). The gap between the supply and demand for skilled data analytics professionals has become evident and is predicted to continue growing (Andrade et al., 2014). In fact, the growing shortage of skilled workers is becoming a key barrier to realizing the potential benefits of big data in organizations (Chatfield, Shlemoon, Redublado, & Rahman, 2014).

We operationalized "digital infrastructure" as a second-order variable that comprises the effect of affordable access to high-speed networks and the level of access to a highly skilled workforce, which together reflect the infrastructural element of the societal context in a country (cf. Table 3). We propose that digital infrastructure positively influences the creation of shared digital content and the development of digital products and services.

H3a: Digital infrastructure positively influences shared digital content.

H3b: Digital infrastructure positively influences digital products and services.

4.4 Shared Digital Content

The emerging literature on open data shows that much of the value from open data is generated in value networks rather than through conventional market-based transactions (Jetzek, Avital, & Bjørn-Andersen, 2014). In general, a significant share of the generated value nowadays stems from an information-centered economy that inhabits a networked Internet-based environment (Benkler, 2006). However, a significant part of the generated value is not captured by the extant theories, such as transaction cost economics (Williamson, 1985; 1996), that do not account for the nature of alliances and complementors in value networks (Morgan, Feller, & Finnegan, 2013).

In value networks, benefits are generated neither by mastering the invisible hand of the market and its prices nor by mastering the visible hand of government, but rather by mastering collaboration and facilitating reciprocal gains that materialize through synergies between multiple independent actors. For example, the real estate company Zillow creates valuable information and shares it for free on a platform that attracts many home buyers and sellers. Although Zillow does not get any direct income from this shared information, the presence of the home buyers and sellers on the platform attracts third-party service providers that are willing to pay Zillow for premium services and access to the thriving marketplace. The case of Zillow illustrates how information sharing can create a multitude of positive externalities that are not all directly reflected in monetary measures such as profits or GDP. Therefore, companies and governments that equate value only with financial transactions miss a significant part of the value that is generated through shared digital content.

In this context, the difference between data and information is noteworthy. While data refers to recorded (captured and stored) symbols and signal readings that mean little or nothing to people in and of themselves, information refers to meaningful strings of data that can be used by people in purposeful ways, such as input for decisions and actions (Liew, 2007). We conceptualize data as the raw material from which content is created, and we conceptualize digital content as data that have been processed to become digestible information. The relationship between data and digital content can be portrayed as a data value-chain, where data serve as the raw material that is used to produce desirable digital content of interest. Digital content can improve decision-making, motivate people to act, or reduce information asymmetry. The value created is reflected in direct economic value, better health of citizens, better living conditions, a more informed and educated society, and a more sustainable environment. We propose that the mediating variable "shared digital content" positively influences country-level "sustainable value".

H4: Shared digital content positively influences sustainable value.

4.5 Digital Products and Services

The market mechanism undoubtedly plays a role in facilitating the transformation of open data to value. The market mechanism is "the one mechanism that economists relate most of their analysis to—their master mechanism, so to speak" (Hedström & Swedberg, 1998, p. 3). The market mechanism refers to the monetary exchange between buyers and sellers within an open and understood system that is designed to produce an efficient distribution of goods and services. The market mechanism aligns the needs of two parties, the buyer and the seller, and is thus essentially bilateral. The "object" that facilitates the transaction between the two parties is the currency or the price of the good or service in question. In free markets, we can assume that the transaction generates value for both parties because both willingly take part in the transaction. Moreover, the markets provide producers with signals that indicate when and what kind of new products or services are needed (i.e., products in high demand). Market mechanisms are thus capable of providing developers with signals and processes that enable them to market new data-driven products and services to prospective customers.

New data sources that become publicly available will be used by companies for commercial purposes. However, in order to create and maintain a competitive advantage, these companies often combine open data with proprietary data and analytics. The combination of open and proprietary resources results in differentiated products and services that can be used to capture a market share and yield a revenue stream.

Moreover, we observe an increased prevalence of companies that use data not only to create revenue but also to generate sustainable social value. For example, INRIX (inrix.com) produces data-driven products and services that help to route traffic efficiently and avoid congestion. In addition to the obvious savings of time and money, direct and indirect impacts on sustainable value can happen through a reduction of unproductive time spent by commuters, a greener and more sustainable environment, and reduced stress and pollution-related health issues.

Naturally, other applications of open data may offer different contributions to sustainable value, but what they all have in common is the use of the publicly available resource (i.e., open data) and the market mechanism to produce digital goods and services that the market consumes and rewards. We propose that the mediating variable "digital products and services" positively influences country-level "sustainable value".

H5: Digital products and services positively influence sustainable value.

4.6 Corporate Accountability

Governments seek ways to enhance social services for their citizens while simultaneously strengthening national economic competitiveness through the public-private cocreation of value. Cocreation of value materializes when different stakeholders join to create something of value that no individual stakeholder could have created on their own (Grover & Kohli, 2012). Although the underlying mechanisms at play in such collaborative settings require further investigation (Sarker, Sarker, Sahaym, & Bjørn-Andersen, 2012), it is evident that corporate accountability plays a key role in the public-private cocreation of value (Porter & Kramer, 2011). In other words, companies need to shift their primary focus from how to extract value from society towards how they can create operational synergies that contribute to the betterment of society. Subsequently, we argue that public-private cocreation of value depends on the extent to which companies are accountable. Accordingly, we propose that the effects of "shared digital content" and "digital products and services" on "sustainable value" are moderated by "corporate accountability".

First, we propose that while dissemination of shared digital content positively influences sustainable value, the positive effects of increasing access to shared content are stronger in countries exhibiting less accountability of private institutions (i.e., a negative moderation effect). When citizens in countries with less accountable corporations get access to new sources of information—regarding, for instance, workers' rights or environmental protection—they become more aware of the current situation and are thus able to put social pressure on the corrupt or unaccountable companies. We argue that this pressure has an impact on the behavior of companies and strengthens the positive influence of digital content on the generation of sustainable value. Therefore, using this logic, the impact of increasing shared content dissemination is likely to be less pronounced in countries where companies already adhere to various standards and regulations, because these companies are already held accountable to governments, shareholders, and other stakeholders.

H6a: The positive effect of shared digital content on sustainable value decreases with increased corporate accountability.

Second, we argue that while the generation of commercial digital products and services positively influences sustainable value, this effect will be stronger in countries with more accountable private sectors (positive moderation effect). Overall, companies are more likely to practice social responsibility when they adhere to standards and regulations that hold them accountable for their actions. Thus, the positive impact of having new digital products and services on sustainable value is more pronounced in countries where corporate accountability is strong, as companies in those countries are more likely to produce data-driven goods and services that not only generate profits but also contribute to other elements of sustainable value.

H6b: The positive effect of digital products and services on sustainable value increases with increased corporate accountability.

4.7 Sustainable Value

While we conceptualize sustainable value at the societal level, we recognize that all societal-level value is eventually captured by individuals that benefit from a more livable environment, more wealth, and better physical and psychological health. Thus, the macrolevel value reflects the accumulated sum of microlevel activities that simultaneously contribute value to citizens, business organizations, society at large, and the environment.

We define sustainable value as *a contribution that simultaneously delivers both short- and long-term economic, social and environmental benefits* (Hart & Milstein, 2003). This definition of sustainable value represents the contemporary shift from the previously dominant economic value ordination towards an emphasis on proactive, concerted efforts of businesses, governments, and the overall community to address social challenges in generative and holistic ways that engender social, environmental, and economic value for all stakeholders and future generations (van Osch & Avital, 2010). Given that sustainable action refers to "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, Chapter 2, p.

1), sustainable value is inherently focused on long-term consequences for society and the environment. Therefore, if value-generation activities cause deterioration of markets and communities or cause recurrent harm to citizens or the environment, they are unlikely to be sustainable.

5 Methodology

5.1 Research Design

The research model presented in Section 4 is based on a careful analysis of selected open data initiatives, interviews with producers and users of open data, an analysis of the popular press, and a review of state-of-the-art research. However, when challenged with the task of designing an empirical study that statistically estimates whether openness of data is a relevant enabling factor for societies aiming to stimulate the generation of sustainable value, we faced two difficult decisions.

First, it must be acknowledged that it is incredibly challenging to trace the value that governments, companies, and individuals receive from using open data. Obviously, we do not know how societies would have fared without access to the data that have already been opened, and experimentation is not an option in this context. Moreover, given the nature of open access, it is very difficult to identify all the users and usage of multiple sources of data (working at the organizational or even the individual level). Accordingly, given the underlying circumstances, we study the differences between countries at different stages of maturity of open data, with a cross-country correlational approach. Performing this type of variance analysis is beneficial, because it allows us to account for the fact that, in some cases, data have been open for many years (long before the mainstream open data initiatives started). We simply look at the state of each variable in each country in the year 2013, with the aim of uncovering whether countries in the more advanced stages of open data initiatives are systematically showing superior performance, which is here conceptualized as sustainable value.

Second, we needed to determine how to measure the level of sustainable value in different countries. While previous macrolevel analyses have attempted to estimate the overall economic value of open data (see, e.g., de Vries et al., 2011, Houghton, 2011; McKinsey, 2013; Vickery, 2011), none of them have attempted to capture the intangible or social dimensions of value that are recognized to be of even more importance than the economic value (cf. McKinsey, 2013). McKinsey (2013) highlighted the importance of various less tangible benefits from open data to consumers (e.g., being able to make better decisions on what school to choose for your children or where to buy a house). The inclusion of the social dimensions of value required that we create a construct that reflects unobservable phenomena such as the value of a good education. Latent variables offer the ability to operationalize theoretical, but unobservable, phenomena. Subsequently, building on the foundational work of Stiglitz, Sen, and Fitoussi (2009), we operationalized sustainable value as a latent variable and used different country-level indicators to reflect its multidimensionality.

Table 2. Regions and Countries in the Sample

Region	Count
Africa	18
Asia	13
Central America	2
Europe	20
Middle East	10
North America	2
Oceania	2
Total	**76**

Table 3. Construct Definitions and Data Sources

Construct	Description	Source
OD Openness of data	Reflects the openness of data that are available online without technical restrictions to access, link, and stream across systems, provided for free and under an open access license, based on a sampling method.	Open Data Barometer http://www.opendataresearch.org/barometer
DL Digital leadership of government	Reflects the extent of digital leadership, based on a questionnaire that investigates whether the government is promoting ICT use and leading by providing a good example.	World Economic Forum Global Information Technology Report http://www.weforum.org/reports/global-information-technology-report-2013/
DP Regulatory data and privacy protection frameworks	Indicates how effectively existing regulatory frameworks promote privacy and data protection, based on a questionnaire.	Web Index http://thewebindex.org/
AN Affordability of high-speed networks	Reflects how affordable it is (relative to income) to get high-speed network access for most of the population, based on objective measures.	International Telecommunication Unit (ITU) http://www.itu.int
AS Availability of a skilled workforce	Reflects the availability of skilled workers in a country and how easy it is to reach and retain this workforce, based on a questionnaire.	World Economic Forum Global Competitiveness Report http://www.weforum.org/ reports/global-competitiveness-report-2013-2014/
SC Shared digital content	Reflects the level of informative digital content that is freely shared online by various stakeholders, based on a sampling method.	Web Index http://thewebindex.org/
PS Digital products and services	Reflects the extent of innovative digital business models, products, services, and processes, based on a questionnaire.	World Economic Forum Global Information Technology Report http://www.weforum.org/reports/global-information-technology-report-2013/
CA Corporate accountability	Indicates the extent to which private businesses follow private and public rules and regulations that are conducive to accountability and good practices, based on a questionnaire.	World Economic Forum Global Competitiveness Report http://www.weforum.org/ reports/global-competitiveness-report-2013-2014/
VAL Sustainable value	Reflects the degree of a contribution that simultaneously delivers both short and long-term economic, social and environmental benefits in society. Based on objective data taken from various sources.	World Bank http://data.worldbank.org/ United Nations Human Development Index http://hdr.undp.org/en/content/human-development-index-hdi Yale Center for Environmental Law & Policy (YCELP) and the Center for International Earth Science Information Network (CIESIN) at Columbia University http://epi.yale.edu/
VA Voice and accountability	Captures perceptions of the extent to which a country's citizens can participate in selecting their government, as well as freedom of expression, freedom of association, and free media. Index from World Bank.	World Bank http://info.worldbank.org/governance/wgi/index.-aspx#reports

5.2 Data Collection and Operationalization of Research Variables

Developing a societal-level model was a natural choice given that the context of this investigation was society-wide use and exploitation of open data. Due to the extensive nature of such a model, it was not feasible to collect primary data. Accordingly, we opted to collect secondary macrolevel data. We collected a full sample of country-level data from various data providers for all of the 76 countries that were included in the Open Data Barometer 2013, published by the Open Data Institute (Davies, 2013). The sample represents a variety of countries in different regions of the world, as shown in Table 2. The sample includes measures for all variables for all countries in the sample for the year 2013. Table 3 provides an overview of construct descriptions and origins of data, and individual item measurements are provided in Table A1 and Table A4 in the Appendix.

The variable "openness of data" (OD) is operationalized as a reflective variable with seven dimensions, as proposed in Section 3. We could only collect data for five of these dimensions but given that this is a reflective construct and the dimensions are highly correlated, we conclude that the level of openness of central government data in individual countries is sufficiently measured.

The variable "digital governance" (DG) is operationalized as a second-order composite variable consisting of two equally important but unrelated dimensions, created from the first-order variables "digital leadership of government" and "regulatory data and privacy protection frameworks".

The variable "digital infrastructure" (DI) is operationalized as a second-order composite variable consisting of two equally important but unrelated dimensions, created from the first-order variables "affordability of high-speed networks" and "access to a skilled workforce".

The mediating variable "shared digital content" (SC) is operationalized as a reflective construct with two dimensions, the first measuring the extent of shared informative content created by various organizations and the second measuring the extent of shared informative content created by government agencies.

The mediating variable "digital products and services" (PS) is operationalized as a reflective construct with two dimensions, the first measuring the extent of new digital business models, products, and services in a country and the second measuring the extent of new digitally enabled work processes.

The dependent variable "sustainable value" (VAL) is operationalized as a reflective latent variable, using the logic that in countries with relatively higher sustainable value we can expect to find a balance among all of the following elements: higher incomes (economic value), better health and education (societal value as defined by the UN), and more sustainable environment. The measure highlights that all these dimensions need to be present and in balance in order to have high sustainable value. Thus, this variable spans beyond a simple monetary measure.

The moderating variable "corporate accountability" (CA) is operationalized as a first-order formative variable. To measure corporate accountability, we use four indicators from the World Economic Forum (WEF), which together form an index constructed to reflect corporate accountability. To enforce the same method, we used the sum-scores weighting scheme in SmartPLS 3.2.3 to ensure all indicators had the same weights.

Finally, the variable "voice and accountability" (VA) is a control variable that reflects the extent to which a country's citizens benefit from civil freedoms, such as freedom of expression, freedom of association, and a free media, as defined by the World Bank.

6 Data Analysis and Results

6.1 Measurement Model

The partial least squares (PLS) method was used in the analysis for two main reasons. First, we preferred to test the entire structural model, as opposed to a reduced version thereof using some form of linear regression. While a structural model contains formulas representing the relation of every dependent variable to its independent variables, the reduced form exhibits the net, or overall, relation between the dependent variable and the ultimate independent variable (Tsang, 2006). The reduced model is simpler but also shallower than the structural model, as the reduced model does not include the mediating variables (Tsang, 2006).

Second, various technical reasons led us to use PLS-SEM rather than CB-SEM. PLS is the primary choice for analyzing secondary data because it does not emphasize model fit (Henseler & Sarstedt, 2013). Moreover, the research model includes two second-order formative variables as well as both mediating and moderating relationships. This model specification indicates high model complexity that would benefit from analysis with PLS (Hair, Ringle, & Sarstedt, 2011; Ringle, Sarstedt, & Straub, 2012; Sarstedt, Ringle, Henseler, & Hair, 2014). Finally, we are working with a small set of cross-country data, including data that are not normally distributed. Since PLS is based on a series of OLS regressions, it has minimal demands regarding sample size and generally it achieves high levels of statistical power (Hair et al., 2011). Regarding the

sample size, a common rule of thumb in PLS is to use ten observations per predictor, where the sample size is the larger of the following two possibilities: (1) the block with the largest number of indicators, or (2) the dependent variable with the largest number of independent variables impacting it (Chin, 1998; Hair et al., 2011; Marcoulides & Saunders, 2006). In our case, constructs are made from a maximum of five indicators, and each of the mediating variables has four direct paths pointing towards them.

However, as pointed out by Marcoulides and Saunders (2006), it is necessary to consider other characteristics of the data and model to ensure sufficient sample size to achieve adequate statistical power. We first built the research model according to state-of-the-art knowledge and afterward collected data to test the model. Next, we performed data screening. All sources had a good reputation, and the same methodology was applied to all countries for each indicator. Missing data and departures from normality influence sample size requirements of a study and potentially deteriorate power (Marcoulides & Saunders, 2006). There were no missing data, and all rows showed a reasonable degree of normality: kurtosis $\leq |1.15|$, skewness $\leq |0.70|$, except for the following measures. First, "open data licenses" and "bulk downloads" exhibited a high level of kurtosis (3.15 and 6.58, respectively) and skewness (2.07 and 2.27, respectively) indicating a long tail with the bulk of the measures clustering in the lower end of the tail (i.e., most countries perform poorly, with few notable exceptions). Second, "network affordability" measures had very high kurtosis (15.52 and 68.37, respectively) and skewness (-3.63 and -8.12, respectively), indicating that, relative to income, most countries have similar costs of network access, but a few developing countries have markedly higher relative costs, making network access much less affordable. As the PLS method does not require all indicators to be normally distributed, we kept these four measures. Table A2 in the Appendix shows averages and other descriptive statistics of all indicators. We conclude that a sample size of 76 provides adequate power to draw inferences from the underlying research model, given that both factor intercorrelations and factor loadings are high (see Tables 5 and 6, and Table A3 in the Appendix).

We used the SmartPLS 3.2.3 software to estimate and evaluate the path model and applied the path weighting scheme. Recommendations by Hair et al. (2011; 2012; 2014) and Sarstedt et al. (2014) provide guidance to evaluate the PLS estimates for the overall model. As shown in Table 4, the R^2 values for all endogenous constructs are substantial or at least acceptable (Hair et al., 2011). In addition to the evaluation of R^2 values, the predictive relevance of the model is assessed through blindfolding procedures to obtain cross-validity redundancy measures for each construct (Chin, 1998). The results suggest a good predictive relevance of the model, given that all Q^2 are well above zero (Geisser, 1975; Stone, 1974; Hair et al., 2011). The calculated values for omission distance d=7 are shown in Table 4.

Table 4. All Variables

Construct	Type	Measure	#	R^2	Q^2
OD Openness of data	Exogenous	Reflective	5		
DG Digital governance (second order)	Exogenous	Formative	2		
DL Digital leadership of government	Exogenous	Reflective	3		
DP Regulatory data and privacy protection frameworks	Exogenous	Reflective	3		
DI Digital infrastructure (second order)	Exogenous	Formative	2		
AN Affordability of high-speed networks	Exogenous	Reflective	2		
AS Accessibility of a skilled workforce	Exogenous	Reflective	3		
SC Shared digital content (Mediating)	Endogenous	Reflective	2	0.659	0.624
PS Digital products and services (Mediating)	Endogenous	Reflective	2	0.763	0.740
VAL Sustainable value (Dependent)	Endogenous	Reflective	4	0.765	0.659
CA Corporate accountability (Moderating)	Exogenous	Formative	3		
VA Voice and accountability (Control)	Exogenous	Single			

Table 5. Quality Criteria for Formative Variables *p < 0.1, **p < 0.05, ***p < 0.01

Variable	Indicators	Factor loading	Weight	t-value	VIFs
DG (second order): Digital governance	Digital leadership of government	0.804	0.622	23.306***	1.093
	Regulatory data and privacy protection frameworks	0.804	0.622	23.306***	
DI (second order): Digital infrastructure	Affordability of high-speed networks	0.778	0.643	25.753***	1.046
	Accessibility of skilled workforce	0.778	0.643	25.753***	
CA: Corporate accountability	Accountability of corporate governance	0.905	0.393	33.511***	3.374
	Interests of minority shareholders reflected in boards	0.931	0.393	33.511***	3.459
	Strength of investor protection	0.679	0.393	33.511***	1.279

Table 6. Quality Criteria for Formative Variables *p < 0.1, **p < 0.05, ***p < 0.01

Variable	Indicator	Factor loading	AVE	Composite reliability	Chronbach's alpha
OD Openness of data	Affordable	0.970	0.814	0.956	0.941
	Shareable	0.793			
	Usable	0.968			
	Discoverable	0.928			
	Accessible	0.836			
DL (first order) Digital leadership of government	Government success in ICT promotion	0.957	0.906	0.967	0.948
	Importance of ICTs to government vision of the future	0.928			
	Government procurement of advanced technology products	0.970			
DP (first order) Regulatory data and privacy protection frameworks	Cybercrime legal protection framework	0.847	0.679	0.864	0.763
	Enforcement and protection from cybercrime	0.832			
	Personal data protection framework	0.791			
AN (first order) Affordability of high-speed networks	Affordability of fixed broadband per capita income	0.949	0.813	0.896	0.782
	Affordability of bandwidth per MB	0.851			
AS (first order) Accessibility of a skilled workforce	Training of workforce	0.904	0.843	0.915	0.815
	Retaining skilled workforce	0.921			
	Attracting skilled workforce	0.908			
SC Shared digital content	Availability of third-party generated content on the web	0.974	0.946	0.972	0.944
	Availability of government-provided content on the web	0.971			
PS Digital products and services	ICT-enabled new services and products	0.988	0.885	0.939	0.871
	ICT-enabled new organizational forms	0.987			
VAL Sustainable value	GDP per capita (ln)	0.914	0.864	0.962	0.948
	Life expectancy at birth	0.940			
	Expected years of schooling	0.936			
	Environmental performance index	0.929			

In the model, we have one first-order formative/composite variable and two second-order formative/composite variables (Sarstedt, Hair, Ringle, Thiele, & Gudergan, 2016). One of the concerns regarding measures of formative constructs is multicollinearity across the indicators of each construct. As two of the measures in the "corporate accountability" construct showed a high degree of collinearity, we dropped the first measure; thus, the final construct consists of three indicators. Afterward, all variance inflation factors (VIFs) were below the recommended value of 5.00 (Hair et al., 2011). Statistics of the formative variables are shown in table 5. All indicators are described in Table A1 in the Appendix.

Table 6 shows the quality criteria values for the reflective measures. Item reliability is deemed adequate, with most reflective factor loadings exhibiting high values of well above 0.8, while the smallest loading of 0.794 is still well above the commonly suggested threshold value of 0.7 (Hair et al., 2011; 2014). Average variance extracted (AVE) of all reflective measures is clearly above the recommended level of 0.5 (Fornell and Larcker, 1981), which confirms satisfactory convergent validity. The composite reliability of reflective measures is good, with values between 0.864 and 0.972, and the internal consistency (Cronbach's alpha) in all cases is above the recommended threshold of 0.7 (Hair et al., 2011).

Discriminant validity of all measures is established given that the square root of each endogenous construct's AVE is greater than the variance shared by each construct and its opposing constructs (Hair et al., 2011; 2012; 2014; Henseler, Ringle, & Sinkovics, 2009) (see Table 7). Furthermore, all measures have the highest loadings on their own construct (see Table A3 in the Appendix).

Table 7. Discriminant Validity (Fornell-Larker criteria): First-Level Model

	OD	DL	DP	AN	AS	SC	PS	VAL	CA	CA*SC	CA*PS
OD	**0.902**										
DL	0.612	**0.952**									
DP	0.616	0.290	**0.824**								
AN	0.301	0.008	0.396	**0.901**							
AS	0.553	0.722	0.446	0.210	**0.909**						
SC	0.774	0.239	0.717	0.475	0.504	**0.973**					
PS	0.638	0.745	0.569	0.307	0.809	0.650	**0.988**				
VAL	0.729	0.294	0.732	0.514	0.593	0.809	0.670	**0.930**			
CA	0.566	0.601	0.511	0.187	0.798	0.508	0.728	0.566	**0.954**		
CA * SC	0.174	-0.05	-0.052	-0.035	0.059	0.079	0.017	-0.060	0.137	**1.000**	
CA * PS	0.052	-0.11	-0.121	-0.062	-0.015	0.000	-0.118	0.007	-0.020	0.610	**1.000**

6.2 Structural Model

Figure 2 provides the estimation results of the structural model. All measures were standardized before running the algorithms. We ran the common PLS algorithm with the path weighting scheme as recommended in SmartPLS 3.2.3. To test for the significance of relationships between the latent constructs, we calculated the t-values of the path coefficients. We used bootstrap validation with 5,000 bootstrap samples to test the loadings, weights, and paths (Hair et al., 2011). As recommended in SmartPLS 3.2.3, we enabled the "no sign changes" option, which is the most conservative estimation method. This method generates relatively large standard errors; consequently, the t-values calculated by this method are lower than the t-values calculated by alternative estimation methods. All the hypotheses in the model were supported.

The data support Hypothesis 1a—as there is a strong and significant relationship between "openness of data" and the extent of "shared digital content".

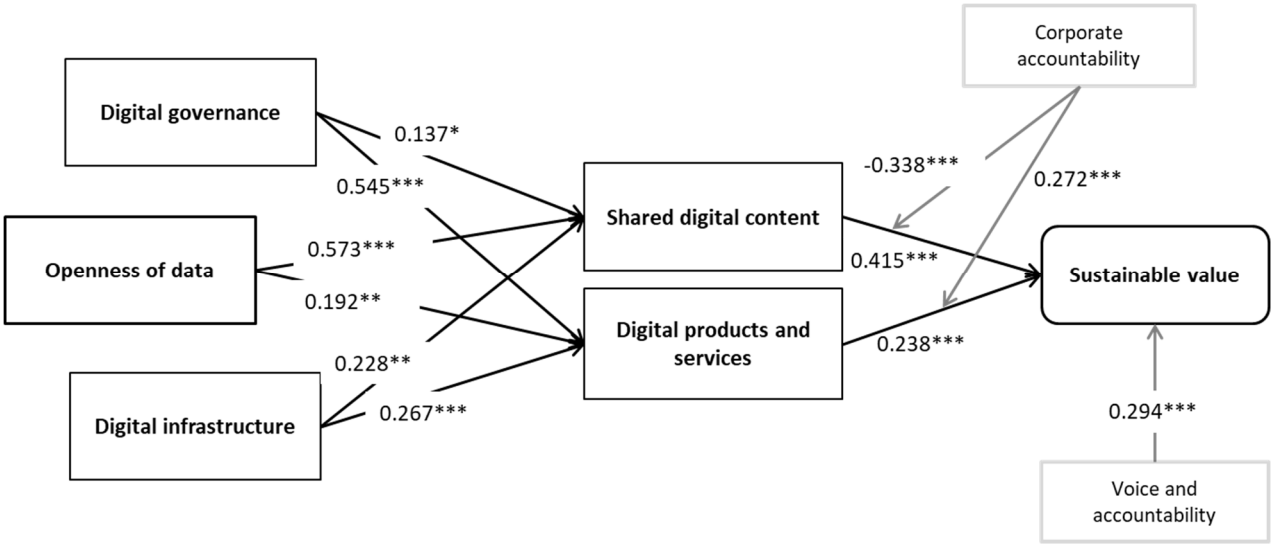
Moreover, the data also support Hypothesis 4, as there is a strong and significant relationship between the extent of "shared digital content" and "sustainable value". Therefore, we can conclude that the data support our hypothesis that there is a positive and significant relationship between "openness of data" and "sustainable value", which is mediated through "shared digital content" with a strong overall impact size of 0.238. While a cross-sectional model cannot be used directly to draw conclusions with regard to causality, our theoretical proposition maintains that

this path reflects an underlying causal relationship, which we have conceptualized as the *information sharing mechanism*. We hypothesized that increased openness of data would positively influence the availability of shared digital content, which in turn would enhance sustainable value through improved decision-making of informed citizens. Thus, the increased openness of data positively influences sustainable value through shared digital content that improves decision-making and contributes to positive behavioral change. The data analysis confirms that countries that provide more openness of data also have more availability of informative online content (as defined and measured by the Web Index—http://thewebindex.org/) and tend to enjoy significantly higher levels of sustainable value.

The data also support Hypothesis 1b, as we find a significant relationship between "openness of data" and "digital products and services". However, this relationship is weaker than the previously discussed relationship (path parameter 0.192 versus 0.573). The lessened effect is corroborated by other empirical sources such as the Open Data Barometer, which suggest that while open data have some impact on commercial product and service development, this effect is only secondary. A qualitative estimate of this impact is rated, on average, at 0.144 out of 10 over the 76 countries in the 2013 sample (Davies, 2013). The data also support Hypothesis 5, which holds that there is a positive relationship between "digital products and services" and "sustainable value". It is surprising, however, that this effect is considerably weaker (path parameter 0.238) than the similar relationship between "shared digital content" and "sustainable value" (path parameter 0.415). Thus, the overall impact of open data mediated through products and services is 0.046. Based on the data, the total effect of open data on sustainable value is **0.284**.

The data support the *market mechanism* with positive and significant paths through "digital products and services". The market mechanism provides private companies with signals that indicate profit opportunities and facilitate income generation through sales in commercial markets. However, the data indicate that in 2013 the path mediated through "digital products and services" explained only a small part of the indirect effect of "openness of data" on "sustainable value". While the total indirect effect of "openness of data" on "sustainable value" is strong and significant (0.284), only around 16% of this impact is explained by the market mechanism. We might argue that it takes longer to achieve penetration in society by using open data to develop and market commercial products than by using these data for digital content generation and publishing. However, the data may suggest that the impact of information sharing on sustainable value is more pronounced and essential than most observers have recognized. We consequently suggest that societies should pay increased attention to the effects of information sharing and transparency and should make an effort to measure its societal impact.

The effect of "openness of data" on "sustainable value" is fully mediated via "shared digital content" and "digital products and services". A direct path from "openness of data" to "sustainable value" was insignificant and did not affect the significance of the two existing paths or other relationships in the model. The Sobel test statistic was 3.54 for the mediation effect of "shared digital content" (significant at $p < 0.01$) and slightly weaker (1.77) for "digital products and services" (significant at $p < 0.1$).



Note: *p < 0.1, **p < 0.05, ***p < 0.01

Figure 2. Research Model Results

Both Hypotheses 6a and 6b are supported by the data. Hypothesis 6a maintains a negative moderation effect of "corporate accountability" on the relationship between "shared digital content" and "sustainable value". In other words, the effect of "shared digital content" on "sustainable value" is more pronounced in countries where private companies are less accountable (red line in Figure 3a). We suggest that this indicates a new type of information-based social control that can counter the ill conduct of companies that act against the economic, social, and environmental well-being of their constituencies. Information-based social control is more effective when companies do not willingly adhere to rules and regulations that would hold them accountable, as shown by the difference in slope between the red line (less accountable) and the green line (more accountable). Hypothesis 6b states that the influence of "digital products and services" on "sustainable value" is greater in countries exhibiting higher levels of private sector accountability. This indicates that if companies are held accountable, they are more likely to produce products and services that contribute to sustainable value generation. Figure 3b shows that in countries with low corporate accountability, there is a weak and even slightly negative relationship between "digital products and services" and "sustainable value" (red line). However, in countries with high corporate accountability, there is a strong positive relationship between "digital products and services" and "sustainable value" (green line).

We checked the effect sizes of each of the paths that lead directly to sustainable value by comparing the R^2 of the sustainable value construct both with and without the variable in question, using Cohen's f^2 measure, as shown in Table 8. [1] Subsequently, we conclude that both mediating variables can explain the variance of the sustainable value construct. However, the direct effect of "shared digital content" is much stronger than the direct effect of "digital products and services". Both interaction terms exhibit moderate to high effect sizes.

Looking more closely at Hypothesis 2a, we observe a positive but only marginally significant relationship between "digital governance" and "shared digital content". Although somewhat surprising, the relatively weak effect here may indicate that digital governance of free exchanges of content over networks operates in a different manner than do markets. In contrast to transactions of digital products and services, shared digital content is usually exchanged with no contracts and free of charge. Subsequently, there may be a need for a different type of digital governance to stimulate exchanges of shared digital content. Moreover, if the composite variable "digital governance" (DG) is broken down into its first-order components, we see that the path from "regulatory data and privacy protection frameworks" (DP) to "shared digital content" is significant, but the path from "digital leadership of government" (DL) to "shared digital content" is not. While this finding requires more in-depth analysis than is possible within the scope of this paper, we suggest that governments with extensive ICT focus do not necessarily encourage free dissemination of information (or, for that matter, freedom of speech). This finding indicates that the public sector should not only focus on increasing the use of technology but also seek to stimulate and encourage the private sector to contribute to a better society through the sharing of informative digital content. Drawing on our previous discussion, such information offers the potential to influence decision-making and spurs action towards more socially cohesive and sustainable choices and activities.

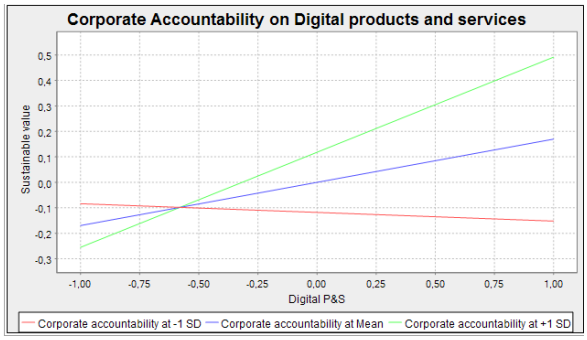


Figure 3a: Moderating Effects of Shared DC

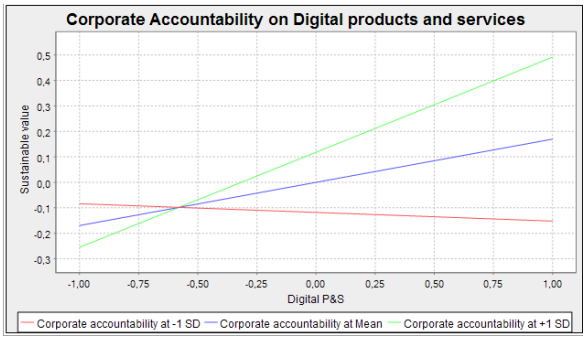


Figure 3b: Moderating Effects of Digital P&S

[1] The conventional values for effect size (f^2) proposed by Cohen (1988) are 0.02 (weak), 0.15 (medium), and 0.35 (high).

Table 8. Direct Effect Sizes: f^2

Shared digital content f^2	Digital products and services f^2	Interaction: Accountability * Content f^2	Interaction: Accountability * Products f^2
0.254 (moderate/high)	0.094 (weak/moderate)	0.243 (moderate/high)	0.183 (moderate)

The data support Hypothesis 2b with a strong positive effect between "digital governance" and "digital products and services". Thus, the effect of "digital governance" on "sustainable value" is mediated mostly through the "digital products and services" variable (which embodies the market mechanism), with a strong impact size of 0.130, and marginally through "shared digital content" (which embodies the information sharing mechanism), with an impact size of 0.057. The total effect of digital governance on "sustainable value" is **0.187**.

The data also support Hypothesis 3a and 3b, with positive and significant paths from "digital infrastructure" to both mediating variables. Specifically, "digital infrastructure" has an indirect effect on "sustainable value" of 0.095 through "shared digital content", and of 0.064 through "digital products and services". The total effect of "digital infrastructure" on "sustainable value" is **0.159**.

7 Discussion

This paper builds on the growing discourse that portrays open data as a potent strategic resource (Lindman & Kuk, 2015; Zeleti et al., 2016; Zuiderwijk & Janssen, 2016; Welle Donker & van Loenen, 2017). Specifically, the paper contributes to a key theme in this discourse that explores how private and public organizations can use open data to create economic and social value, and what is needed to facilitate this process over value networks where stakeholders collaborate on creating and sharing free informative content and related services (Benkler, 2006; Bowman, 2015; Grover & Kohli, 2012).

In particular, this paper contributes to the discussion on the "new economy" (Castells, 1996) where information and technology enable value creation in entirely new ways. While society developed markets to facilitate the buying and selling of goods and services through the exchange of currency, we have not yet cultivated a comprehensive method to quantify the value that is generated through open sharing of information products. For example, new information may have a significant effect on a person's health, their ability to choose a suitable education, the way they interact with their natural environment and with other people. Whereas such effects have inevitable personal and social value, they are unlikely to be reflected in any performance indicator that is designed to measure the contribution of the public sector to economic value or public value. Subsequently, we aimed to address this gap by unveiling the relationship between open data and value.

We offer a framework that explains how open data resources generate value by looking for both tangible and intangible value that is created when public and private organizations have access to data that they did not generate themselves. In other words, we argue that value generation through open data stems from creating an opportunity for anyone to reuse data beyond the organizational boundaries of the data custodian and the technical boundaries of the originating device or system. However, this opportunity can be realized only if potential users are willing and able to exploit the data for value-generation purposes.

The case of Zillow illustrates how an agile private company is better equipped than the public sector to leverage the "new economy" and deliver sustainable value. Zillow was founded in the USA in 2006 by former Microsoft executives who anticipated the commercial potential of the emerging open data repositories that were inspired by the promise of open innovation (Chesbrough, 2003). Soon thereafter, the open data movement inspired the American OPEN Government Act of 2007 and the Open Government Initiative of 2009 that explicitly encourage companies to make good use of the open data supplied by public sources. Equipped with free access to newly opened data sources and the technology that provides the ability to transform the data to value, Zillow had the incentives and was well positioned to develop a company that turns open data into valuable services.

The fragmented real estate market in the USA and the prevailing information asymmetry that allowed real estate brokers to take advantage of buyers and sellers alike provided an excellent opportunity for a company that can offer a reliable online real estate database with national coverage. While different branches of the public sector collected much data on the real estate market, none of them were able to aggregate the data across functional and jurisdictional boundaries, let alone able to extract and communicate the relevant information to the public. This was the golden opportunity of Zillow. However, while free data are a priceless resource, it does not pay for the salaries and the IT infrastructure needed to build a company. Thus, Zillow had to adopt a two-sided platform business model in order to generate income. Zillow uses free content to generate website traffic of real estate buyers and sellers and subsequently uses website traffic to sell advertising to vendors of real estate-related services.

In addition to creating a thriving company that contributes to economic growth, Zillow also generates a mix of both tangible and intangible value for individuals who take part in the real estate market, as well as for society at large that benefits from more efficient and stable real estate markets.

7.1 Research Implications

This study is an illustration of how secondary data or, more specifically, open data can be used in various ways that may be quite different from the original purpose initially motivating the data collection. In this study, we exclusively used publicly available data to test the research model and the research design underscores the value of secondary data for research efforts in general. Secondary data render considerable benefits to enriching research projects as well as to nurturing a data-rich discipline (Avital et al., 2007.) First, one of the prime benefits is the provision of data that cannot be obtained directly by the researchers due to various constraints, such as time, money, and access limitations (Sabherwal & Sabherwal, 2005). Secondary data, therefore, extend the universe of research opportunities and allow researchers to study phenomena that may otherwise be beyond reach. Second, secondary data are inherently sustainable because they turn data into a reusable resource with nominal or no additional costs to the data custodian. Therefore, the researcher's cost of acquiring secondary data is likely to be significantly lower than the cost of obtaining similar primary data. Third, secondary data are more likely to be more robust than primary data and therefore more suited for confirmatory research with strong, generalizable results (Lyytinen, 2009). Moreover, secondary data are more likely to foster longitudinal studies and to provide researchers with a pragmatic way to go beyond cross-sectional data (i.e., single snapshot sampling) research design (Avital, 2000).

The study aimed to uncover the overarching mechanisms that facilitate the generation of value from open data and to determine whether openness of data stimulates generation of sustainable value across countries. We used secondary data collected from multiple resources and relied on firsthand experience in various open data initiatives. The study builds on the current body of knowledge and, in particular, draws on research on the generation of value in complex multi-stakeholder relationships (Benkler, 2006; Bowman, 2015; Grover & Kohli, 2012). However, dealing with the research question required a resourceful approach, given that the value-generating mechanisms are unobservable and that research on the underlying topic of interest is still in a nascent state (Zuiderwijk & Janssen, 2014b; Safarov, Meijer, & Grimmelikhuijsen, 2017). Overall, the study extends the state-of-the-art body of knowledge on open data within the discourse of information systems research.

We maintain that data serve as raw material or a resource for the creation of informative content or new products and services. The research model highlights that open data drive value generation through complex and interrelated networks of relationships. Thus, we argue that the availability of data alone is not sufficient for value generation; rather, the whole ecosystem should be supportive of value generation through open data (Zuiderwijk, Janssen, van de Kaa, & Poulis, 2016, Welle Donker & van Loenen, 2017). Moreover, while market transactions still play a prominent role in enabling the generation and appropriation of value, technological advances are slowly shifting from one-to-one transactions towards many-to-many network exchanges, where the relationships between value generation and value appropriation are blurred (Benkler, 2006). Consequently, evaluating the extent of the value created through open data becomes a challenge, because this value is generated only partly through traceable market transactions. Although there is a growing body of literature on the nature of network effects and intangible value creation over digital (multisided) platforms, there is still much to uncover (de Reuver, Sørensen, & Basole, 2018). We predict that in the future, more research will focus on the role of such intermediaries in an attempt to reconcile economic profits with the valuable network externalities that arise from information sharing.

Overall, the results indicate that both information sharing and market mechanisms facilitate the generation of sustainable value through open data. However, to our surprise, the empirically estimated path through the information sharing mechanism turned out to be much stronger than the path through the market mechanism. This outcome indicates a significant but previously unquantified relationship between open data and value. The case of climate data illustrates how the information sharing mechanism works. Government-released open climate data are currently stimulating unique partnerships that cross boundaries among businesses, governments, and academia to fuel an entirely new level of discoveries within the field of environmental sustainability. For instance, IBM offers free supercomputing hours on its World Community Grid for researchers who utilize mass quantities of open data to study climate change. One of the projects that use the grid, Harvard University's Clean Energy Project, is investigating new materials that could potentially double the efficiency of current carbon-based solar cells. Their open database contains 400TB of data on 2.3 million molecular structures in 22 million geometries. The findings of the Harvard Clean Energy Project Database are open (in digital form) to others who are interested in further research and discovery of new materials. Although measuring the value of such initiatives is not straightforward when using traditional market-based methods, it is evident that these synergistic networks

of relationships generate sustainable value through freely available information that contributes to the environment, health, and education.

Although this paper is not aimed at providing prescriptive recommendations, we feel compelled to suggest that policymakers should pay attention to their ability to evaluate the societal impact of open data programs and initiatives. We already discussed how the information sharing mechanism drives complex many-to-many relationships and exchanges that generate social value. However, it is also evident that a great deal of the value generated from sharing information over networks is not reflected in the corporate or national-level financial reports. Given that improved utilization of data and information is becoming an increasingly important competitiveness factor for organizations and societies, policymakers should consider new measures for estimating the value of data. This paper can serve as a contribution to further clarifying the concept of sustainable value at a societal level and its underlying value-generation mechanisms. We also suggest that nurturing companies' self-reporting on their respective contributions to society might go a long way toward helping to measure sustainable value generation at the organizational level. Initiatives such as globalreporting.org are already creating standards and measures to help companies along this path.

This study contributes to the conceptualization of openness of data as a measurable construct. Building on the seven inherent attributes of open data (Jetzek, 2016), we conceptualize open data as a holistic construct that unifies the strategic, economic, legal, and technical dimensions of openness that are commonly discussed in the open data literature. The proposed construct provides a basis for a more nuanced and round measure that can be used to evaluate data sets of various types, quality, size, and openness. This extended conceptualization implies that data do not constitute a homogenous resource and that openness itself is not a binary measure. Furthermore, while we could not find usable measures of all the seven attributes, we managed to measure the openness of data over five of them by using available (open) secondary data across 76 countries. Given that the concept of open data has suffered from ambiguity (Yu & Robinson, 2012), our definition of openness of data and the accompanying measures make a theoretical contribution that can stimulate further discussion on the state and impact of open data.

The study also contributes to the conceptualization of the information sharing mechanism. This new mechanism builds on the following assumptions: (1) the information sharing mechanism provides signals that indicate the demand for available shared content, which in turn encourages the dissemination of useful information and stimulates engagement with open digital content; (2) open digital content spawns social control; (3) open digital content helps individuals and companies to make informed decisions; and (4) individuals, in general, *want* to make decisions that lead to sustainable value. Estimating the relevance of shared information and its subsequent value to users poses a challenge because it is hard to monetize free content found online in the absence of prices and contractual transactions. Therefore, we need to resort to an alternative measure of value. The market mechanisms indicate demand and supply with price variation. Similarly, the information sharing mechanisms indicate value information with use variation. In other words, we assume that the extent of engagement with shared content indicates the degree to which that content is valuable to individual users and, subsequently, to society at large.

Finally, the study contributes further to the operationalization of the different constructs in the research model. We conceptualized and measured not only openness of data and sustainable value but also the societal-level factors that play an essential role in enabling the generation of sustainable value in the digital economy. The set of constructs and their operationalization are described in detail throughout the paper. It is noteworthy that the measure of sustainable value consists of four different dimensions, which must be balanced at a country level to reflect a fine-tuned expression of sustainable value. Using the PLS method, we were able to identify the specific weights of each of the selected indicators based on their antecedents. We suggest that this method represents an alternative to the common practice of creating an index from arbitrary weights.[2] Thus, we offer a newly developed quantified estimation of the latent construct of sustainable value. Whereas there is, in general, a strong correlation between the monetary measure of GDP and the other indicators of health, education, and sustainable environment, our operationalization of the sustainable value construct ranks countries rather differently than the GDP

[2] For example, the UN's Human Development Index (HDI) is a composite indicator comprising individual indicators that are compiled into a single index to reflect and measure a multidimensional construct. The aggregation procedure by which the individual indicators are combined is usually according to arbitrary judgment regarding the relative weight of each component. The partial least squares method has been suggested as a way of identifying an empirical basis for the relative weight of each component in composite indicators. For extended discussion, see Hall (2005); Trewin & Hall (2010); and Guagnano & Sebastiani (2018).

measure. For instance, Qatar ranks third out of 76 countries when GDP is measured in dollars per capita, but it ranks 29th using the sustainable value measure. Alternatively, Norway ranks first in GDP dollars per capita and second in sustainable value, which we suggest is due to Norway's more balanced approach to open information sharing and market-driven innovation.

The results of the study have practical implications for policymakers in the public sector. In particular, the study highlights the importance of developing policies that promote the right social context for stimulating the generation of sustainable value through open data. While having access to open data as a resource provides an opportunity to undertake digital content development and engage in the creation of data-driven products and services, the actual value-generating actions also depend on digital governance and digital infrastructure. Further research into the antecedents of sustainable value would provide policymakers with better insight into how to nurture regulatory and normative environments that stimulate and bolster further generations of sustainable value.

7.2 Limitations and Future Research Direction

The first limitation stems from the exploratory nature of the study, which is pertinent given the embryonic state of research on the societal level impact of open data. Accordingly, we aimed to generate new theory, rather than to confirm or extend an existing theory. Consequently, we had to introduce several new constructs and relationships that do not yet have a strong foundation in the literature. The complexity of the constructs discussed and the lack of consensus on how to measure most of them, at least at the societal level, underscores the need to explore and validate them further in future research.

The second limitation relates to the extent of the sample size. There is limited availability of data that are consistent across multiple countries and are fit for the purpose of reflecting the core concepts of the study, such as the openness of government data, the extent of information sharing, and sustainable value. The data were essentially limited by the number of observations in the Open Data Barometer. However, we have reasonable evidence to suggest that the model contains enough explanatory power to draw preliminary conclusions from the results of the analysis.

The third limitation concerns the use of secondary data. While secondary data may have many benefits for researchers as described in the previous section, they also have some limitations. First, one of the key concerns with secondary data is the extent of their representativeness of the population under investigation. Unlike primary data that are collected from a population of interest, secondary data are collected independently and often used for another purpose than originally intended. Second, another concern with secondary data is the risk of confirmation bias—that is, the risk that a researcher selectively embraces data that confirm his or her a priori view while ignoring or rejecting data that contradict it. Unlike primary data that are cohesively collected for a specific study with precautionary control data, secondary data often comprise loosely coupled data sets that provide a broad spectrum of data. Given that secondary data often include much more data than are needed for a particular study, a researcher must select a subset thereof. This selection runs the risk of confirmation bias. Third, an additional concern—one that is especially relevant when a data set contains time series—is data inconsistencies stemming from changes in the data collection method. Due to technological advances, regulatory revisions, and other extenuating circumstances, the method by which data are collected may change over time. For example, the Open Data Barometer that was used in the study keeps evolving and improving. Therefore, future research building on newer versions of the Open Data Barometer data set would have to take this into account. However, all the other data sets that we used in this study are well established, and we assessed and verified their data quality.

With this study, we aim to highlight the two alternative paths from open data to sustainable value. The first path or mechanism explains how value is generated when multiple stakeholders start to share valuable information over networks, which results in reducing information asymmetry, creating awareness, and influencing decision-making and prompting behavior. The second path or mechanism explains how value is generated through the development, marketing, and use of new products, services, and processes. However, in practice, these two mechanisms are not easily untangled. Most of the companies we have reviewed as successful users of open data utilize both information sharing mechanisms and market mechanisms. In fact, they exploit the synergies between these two mechanisms and use the business models of multisided platforms. However, the macrolevel model in this study cannot reflect these organizational-level interactions. As a potential direction for future research, we recommend studying the interplay between these different types of value-generating mechanisms over multisided digital platforms.

To study the complex relationships that can eventually explain how value is created through open data over multisided platforms, we suggest that critical realism may serve as a promising research approach. Critical realism is increasingly being recognized as an alternative philosophical tradition that can help to overcome the objectivism-relativism chasm (Henfridsson & Bygstad, 2013). To this end, critical realism clearly distinguishes between the domains of

the real, actual, and empirical (Bhaskar, 1979; 2008). The real domain consists of generative mechanisms that function as the underlying but invisible cogs and wheels that drive the events taking place in the actual domain. As a subset of the actual domain, the empirical domain consists of only those events that are directly or indirectly observed and recorded (Miller & Tsang, 2011). Critical realism posits that researchers can uncover generative mechanisms by searching for events in the actual domain that act as manifestations of the underlying mechanisms (e.g., symptoms function as manifestations of an underlying disease). Critical realism-based research would involve proposing and testing alternative generative mechanisms to the two we propose and test here. Moreover, critical realism-based research would add a qualitative dimension to this research, using methods such as retroduction to help to identify the best candidate mechanism or mechanisms, as well as the conditions that triggered these mechanisms (Wynn & Williams, 2012).

8 Conclusion

This study sheds light on how open government data contribute to sustainable value generation. Overall, the data suggest that openness of public data creates an opportunity for all stakeholders, including individuals, private companies, and public organizations, to generate sustainable value for society at large. Specifically, building on the research model, we reach the following conclusions. First, opening access to government data enables public authorities to create a widespread opportunity for sustainable value generation, which is driven by two inherently different mechanisms: the information sharing mechanism and the market mechanism. Second, the application of open data for creating new digital content, products, and services is contingent on the context in which these mechanisms operate. Ultimately, the prevailing institutional factors (that influence motivation) and the digital infrastructures (that influence ability) encourage or inhibit the use of available open data by the respective actors, which together determine through collective action how much value is generated from open data in a country.

The findings highlight the increasing effect of networks where loosely coupled cohorts of stakeholders collectively contribute to value without any formal transactions taking place. Given that data, information, and networks are likely to play a vital role in future societies, new models that explain further the nature of network-based value generation through digital resources are of utmost importance. In conclusion, if the insights in this paper help nurture a more prevalent open data culture and the conditions that support turning open data into sustainable value, then this study will represent one step forward on the path towards a more sustainable, humanistic, and prosperous future.

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Appendix

Table A1: Operationalizing of Variables

Construct	Definition	Measures	Source
OD Openness of data	Liquid open data are available online without technical restrictions to access, link, and stream across systems, provided for free and under an open access license	Is the data set available free of charge? (aggregated from 15 data categories) [1-10]	Open Data Barometer http://www.opendataresearch.org/barometer
		Is the data set openly licensed? (aggregated from 15 data categories) [1-10]	
		Is the data set provided in machine-readable formats? (aggregated from 15 data categories) [1-10]	
		Was it easy to find information about this data set? (aggregated from 15 data categories) [1-10]	
		Is the data set downloadable for bulk download? (aggregated from 15 data categories) [1-10]	
DL Government IT leadership	Reflects the extent to which government is promoting ICT use	In your country, how successful is the government in promoting the use of information and communication technologies (ICTs)? [1 = not successful at all; 7 = extremely successful]	World Economic Forum's Global Information Technology Report http://www.weforum.org/reports/global-information-technology-report-2013/
		To what extent does the government have a clear implementation plan for utilizing ICTs to improve your country's overall competitiveness? [1 = no plan; 7 = clear plan]	
		In your country, to what extent do government purchasing decisions foster innovation? [1 = not at all; 7 = to a great extent]	
DP Regulatory data and privacy protection	The robustness of existing regulatory frameworks that promote privacy and data protection	To what extent is there a robust legal or regulatory framework for protection of personal data in your country? [1-10]	Web Index http://thewebindex.org/
		To what extent does the government enforce the laws in place to protect people from crimes committed using the Internet?	
		To what extent does the law protect people from crimes committed using the Internet?	
AN Cost of high-speed networks	Reflects how expensive it is to get high-speed network access for most of the population	Affordability of bandwidth per MB	ITU—International Telecommunication Union http://www.itu.int
		Affordability of fixed broadband	
AS A skilled workforce	A construct measuring the availability of skilled workers in a country	The general approach of companies in your country to human resources is (1 = to invest little in training and employee development; 7 = to invest heavily to attract, train, and retain employees)	WEF—World Economic Forum: Global Competitiveness Report http://www.weforum.org/reports/global-competitiveness-report-2013-2014
		Does your country retain talented people? [1 = the best and brightest leave to pursue opportunities in other countries; 7 = the best and brightest stay and pursue opportunities in the country]	

Table A1: Operationalizing of Variables

Construct	Definition	Measures	Source
		Does your country attract talented people from abroad? [1 = not at all; 7 = attracts the best and brightest from around the world]	
SC Shared digital content	Reflects the level of informative digital content that is freely shared online by various stakeholders	Educational content creation on the web, average of the following questions: – To what extent do CSOs use the Web to educate and inform citizens about government decision-making and public policy issues? – To what extent do trade unions use the Web to educate and inform citizens about government decision-making and public policy issues? – To what extent do local organizations use the Web to disseminate environmental information and facilitate education about climate and environmental concerns?	Web Index http://thewebindex.org/
		Governmental content creation on the web, average of the following questions: – To what extent is information about government-funded local health care services made available on the Web? – To what extent is the Web being used by the government to inform women of their legal rights in areas such as right to equal opportunities, right to inheritance, and rights to seek legal redress against violence? [1-10] – To what extent is the Web being used by the government to provide information about support that is available for victims of gender-based violence? – To what extent does the government publish school-level information about education performance online?	
PS Digital products and services	Reflects the extent to which ICT influences the creation of innovative business models, products, services, and processes	To what extent are ICTs creating new business models, services, and products in your country? [1 = not at all; 7 = to a significant extent]	WEF—World Economic Forum: Global Information Technology Report http://www.weforum.org/reports/global-information-technology-report-2013/
		To what extent do ICTs enable new organizational models (e.g., virtual teams, remote working, or telecommuting) within businesses? [1 = not at all; 7 = to a great extent]	
VAL Sustainable value	Sustainable value is a contribution that simultaneously delivers both short and long-term economic, social, and environmental benefits. The measure thus reflects the degree of economic, social, and environmental	Natural logarithm of gross domestic product per capita	World Bank http://data.worldbank.org/
		Number of years a newborn infant could expect to live if prevailing patterns of age-specific mortality rates at the time of birth stayed the same throughout the infant's life (UN)	United Nations: Human Development Index http://hdr.undp.org/en/content/human-development-index-hdi
		Number of years of schooling that a child of school entrance age can expect (UN)	United Nations: Human Development Index

Table A1: Operationalizing of Variables

Construct	Definition	Measures	Source
	value in society (triple bottom line).		http://hdr.undp.org/en/content/human-development-index-hdi
		Measures environmental sustainability based on 67 empirical measurements	Yale Center for Environmental Law & Policy and the Center for International Earth Science Information Network at Columbia University http://epi.yale.edu/
CA Corporate accountability	Reflects the extent to which private business follow private and public rules and regulations that are conducive to accountability and good practices	How strong are financial auditing and reporting standards? [1 = extremely weak; 7 = extremely strong]	WEF—World Economic Forum: Global Competitiveness Report http://www.weforum.org/reports/global-competitiveness-report-2013-2014
		How would you characterize corporate governance by investors and boards of directors? [1 = management has little accountability to investors and boards; [7 = management is highly accountable to investors and boards]	
		To what extent are the interests of minority shareholders protected by the legal system? [1 = not protected at all; 7 = fully protected]	
		Strength of Investor Protection Index on a 0-10 (best) scale	
VA Voice and accountability	Control variable	Voice and Accountability is an index developed by the World Bank to reflect perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media	World Bank: World Governance Indicators http://info.worldbank.org/governance/wgi/

Table A2. Descriptive Statistics

	Mean	Median	St. Dev.	Kurtosis	Skewness	Minimum	Maximum
OD1	3.69	3.93	2.62	-0.74	0.22	0.00	10.00
OD2	1.,17	0.00	2.40	3.15	2.07	0.00	10.00
OD3	3.89	4.29	2.81	-0.94	0.21	0.00	10.00
OD4	3.82	3.75	2.94	-0.76	0.38	0.00	10.00
OD5	1.51	0.71	1.99	6.58	2.27	0.00	10.00
DL1	4.58	4.55	0.72	0.04	-0.05	2.92	6.20
DL2	415	4.15	0.73	0.33	0.04	2.25	5.89
DL3	3.58	3.57	0.66	1.00	0.17	1.87	5.57
DP1	6.47	7.00	3.21	-0.71	-0.46	0.00	10.00
DP2	5.45	5.00	3.16	-0.87	0.08	0.00	10.00
DP3	6.95	7.00	3.20	-0.58	-0.63	0.00	10.00
AN1	109.00	20.00	511.00	68.00	8.12	0.54	4392.00
AN2	0.18	0.02	0.39	15.52	3.63	0.00	2.32
AS1	4.16	4.07	0.68	-0.79	0.13	2.94	5.64
AS2	3.78	3.61	0.96	-0.40	0.44	1.81	5.97
AS3	3.73	3.69	1.01	-0.08	0.40	1.48	6.08
SC1	6.63	6.50	2.58	-1.15	-0.14	1.20	10.00
SC2	5.12	4.50	2.61	-0.97	0.09	0.00	10.00
PS1	4.68	4.75	0.68	-0.14	-0.40	2.55	5.89
PS2	4.40	4.43	0.67	-0.71	-0.17	2.68	5.57
VAL1	9.00	9.31	1.71	-0.26	-0.64	3.73	11.52
VAL2	72.76	75.04	8.80	-0.76	-0.70	52.51	83.58
VAL3	13.84	14.10	2.96	-0.59	-0.32	7.50	19.90
VAL4	57.21	55.41	17.05	-1.11	-0.13	18.43	87.67
CA1	4.73	4.76	0.57	-0.34	0.09	3.50	6.02
CA2	4.44	4.44	0.73	-0.06	0.34	3.08	6.22
CA3	5.68	5.30	1.56	-0.05	0.43	2.30	9.70
VA	0.24	0.30	0.98	-1.08	-0.18	-1.80	1.75

Table A3. Cross Loadings

	OD	DL	DP	AN	AS	SC	PS	VAL	CA	SC*CA	PS*CA	VA
OD1	**0.9701**	0.2452	0.6339	0.3443	0.5457	0.7769	0.6102	0.7705	0.4810	0.1203	0.0274	0.7470
OD2	**0.7935**	0.1834	0.4087	0.1610	0.4393	0.5441	0.4683	0.4548	0.4160	0.3611	0.2242	0.5202
OD3	**0.9681**	0.2653	0.6539	0.3485	0.5358	0.7945	0.6345	0.7832	0.4488	0.0807	-0.0044	0.7534
OD4	**0.9281**	0.2929	0.6112	0.3061	0.5345	0.7286	0.6305	0.7015	0.4293	0.0893	0.0287	0.6893
OD5	**0.8360**	0.2033	0.4217	0.1550	0.4407	0.6068	0.5110	0.5125	0.3502	0.2041	0.0725	0.5548
DL1	0.2436	**0.9568**	0.2387	-0.0044	0.6661	0.2104	0.6950	0.2314	0.5616	-0.0398	-0.0733	0.0525
DL2	0.2070	**0.9289**	0.2909	-0.0349	0.7069	0.1877	0.6763	0.2688	0.5582	-0.0751	-0.0854	0.0574
DL3	0.3057	**0.9694**	0.3020	0.0539	0.6891	0.2767	0.7531	0.3332	0.5942	-0.0376	-0.1041	0.1104
DP1	0.4887	0.2634	**0.8465**	0.3848	0.3507	0.5439	0.4684	0.5616	0.3506	-0.1107	-0.1951	0.4197
DP2	0.5417	0.3730	**0.8361**	0.3463	0.5315	0.6241	0.5442	0.6929	0.5278	-0.0071	0.0283	0.5666
DP3	0.4877	0.0621	**0.7876**	0.2465	0.2016	0.6008	0.3815	0.5423	0.3698	-0.0157	-0.1039	0.5785
AN1	0.1661	0.0379	0.2764	**0.8483**	0.0782	0.2997	0.1947	0.2669	0.0424	0.0175	0.0534	0.1279
AN2	0.3395	-0.0116	0.4128	**0.9508**	0.2623	0.5141	0.3302	0.5895	0.2472	-0.0619	0.0648	0.3659
AS1	0.4450	0.6317	0.3947	0.1386	**0.9049**	0.3945	0.6868	0.4605	0.6472	0.0310	0.0121	0.3815
AS2	0.6093	0.5988	0.5074	0.3170	**0.9203**	0.6235	0.7981	0.6998	0.8156	0.1260	0.0550	0.5679
AS3	0.4329	0.7576	0.2929	0.0881	**0.9006**	0.3140	0.7040	0.4157	0.6918	-0.0147	-0.0571	0.2279
SC1	0.7295	0.3062	0.6864	0.4398	0.5026	**0.9711**	0.6652	0.7640	0.5195	0.0491	0.0372	0.6918
SC2	0.7748	0.1618	0.7087	0.4858	0.4830	**0.9744**	0.6004	0.8081	0.4711	0.1038	-0.0061	0.7512
PS1	0.6350	0.7374	0.5298	0.3253	0.8189	0.6259	**0.9878**	0.6671	0.7283	0.0353	-0.0704	0.5201
PS2	0.6253	0.7348	0.5946	0.2805	0.7781	0.6573	**0.9874**	0.6563	0.7104	-0.0016	-0.1627	0.5787
VAL1	0.6459	0.2202	0.6306	0.5449	0.5777	0.7149	0.5884	**0.9138**	0.5269	-0.0297	0.0475	0.6539
VAL3	0.7102	0.2744	0.6951	0.3879	0.5278	0.7762	0.6385	**0.9400**	0.5310	-0.0767	-0.0334	0.6822
VAL4	0.6894	0.3112	0.7315	0.4308	0.5774	0.7523	0.6394	**0.9364**	0.5988	-0.0053	0.0377	0.6865
VAL2	0.6632	0.2841	0.6639	0.5610	0.5310	0.7628	0.6241	**0.9284**	0.4458	-0.1115	0.0422	0.6035
CA1	0.4786	0.5398	0.5279	0.2468	0.7439	0.5286	0.7129	0.6195	**0.9641**	0.0468	-0.0706	0.5060
CA2	0.4918	0.5717	0.5581	0.1535	0.7791	0.5286	0.6995	0.5184	**0.9377**	0.1883	0.0351	0.5069
CA3	0.3811	0.6081	0.3786	0.1378	0.7635	0.3980	0.6727	0.4823	**0.9604**	0.1557	0.0541	0.4006
SC*CA	0.1740	-0.0526	-0.0519	-0.0357	0.0602	0.0794	0.0172	-0.0599	0.1365	**1.0000**	0.6094	0.1559
PS*CA	0.0660	-0.0926	-0.1024	0.0664	0.0092	0.0153	-0.1176	0.0246	0.0065	0.6094	**1.0000**	-0.0479
VA	0.7327	0.0786	0.6353	0.3045	0.4496	0.7426	0.5561	0.7066	0.4938	0.1559	-0.0479	**1.0000**

Table A4. Correlations Between Indicators

	OD1	OD2	OD3	OD4	OD5	DL1	DL2	DL3	DP1	DP2	DP3	AN1	AN2	AS1	AS2	AS3	SC1	SC2	PS1	PS2	VAL1	VAL2	VAL3	VAL4	ACC 1	ACC 2	ACC 3	ACC 4	VOICE
OD1	1.000																												
OD2	0.698	1.000																											
OD3	0.979	0.656	1.000																										
OD4	0.910	0.617	0.940	1.000																									
OD5	0.740	0.707	0.731	0.650	1.000																								
DL1	0.219	0.166	0.244	0.277	0.179	1.000																							
DL2	0.277	0.237	0.300	0.320	0.236	0.914	1.000																						
DL3	0.200	0.112	0.208	0.234	0.160	0.817	0.846	1.000																					
DP1	0.480	0.348	0.514	0.511	0.310	0.026	0.076	0.073	1.000																				
DP2	0.571	0.338	0.580	0.518	0.391	0.328	0.381	0.354	0.445	1.000																			
DP3	0.509	0.324	0.517	0.481	0.335	0.213	0.267	0.272	0.539	0.572	1.000																		
AN1	0.184	0.090	0.186	0.165	0.102	0.042	0.072	-0.011	0.166	0.234	0.282	1.000																	
AN2	0.390	0.180	0.395	0.346	0.165	-0.031	0.036	-0.044	0.260	0.364	0.392	0.643	1.000																
AS1	0.627	0.424	0.616	0.599	0.445	0.550	0.585	0.576	0.259	0.578	0.391	0.118	0.390	1.000															
AS2	0.414	0.373	0.415	0.425	0.382	0.577	0.585	0.646	0.179	0.479	0.292	0.072	0.159	0.733	1.000														
AS3	0.409	0.396	0.393	0.401	0.362	0.711	0.726	0.729	0.088	0.364	0.252	0.009	0.123	0.730	0.758	1.000													
SC2	0.726	0.529	0.744	0.678	0.583	0.267	0.343	0.259	0.579	0.604	0.508	0.290	0.467	0.595	0.401	0.334	1.000												
SC1	0.784	0.530	0.800	0.738	0.597	0.146	0.199	0.111	0.589	0.610	0.549	0.293	0.532	0.618	0.368	0.278	0.893	1.000											
PS1	0.596	0.444	0.626	0.628	0.499	0.679	0.748	0.666	0.437	0.546	0.478	0.191	0.294	0.768	0.661	0.677	0.603	0.678	1.000										
PS2	0.609	0.480	0.627	0.617	0.511	0.694	0.739	0.669	0.318	0.529	0.447	0.194	0.357	0.808	0.695	0.713	0.583	0.636	0.951	1.000									
VAL1	0.672	0.435	0.683	0.608	0.469	0.159	0.253	0.213	0.474	0.646	0.419	0.327	0.597	0.657	0.506	0.373	0.732	0.657	0.570	0.592	1.000								
VAL2	0.716	0.379	0.724	0.648	0.453	0.232	0.316	0.259	0.462	0.622	0.545	0.315	0.628	0.617	0.420	0.372	0.746	0.738	0.606	0.626	0.794	1.000							
VAL3	0.749	0.438	0.774	0.687	0.489	0.221	0.322	0.233	0.520	0.642	0.545	0.171	0.461	0.642	0.385	0.365	0.763	0.746	0.624	0.637	0.820	0.823	1.000						
VAL4	0.726	0.439	0.730	0.664	0.494	0.247	0.345	0.292	0.557	0.666	0.574	0.188	0.513	0.686	0.407	0.435	0.763	0.699	0.638	0.625	0.792	0.838	0.848	1.000					
ACC 1	0.500	0.377	0.475	0.444	0.344	0.504	0.548	0.487	0.391	0.525	0.375	0.056	0.324	0.782	0.579	0.638	0.526	0.503	0.699	0.709	0.574	0.514	0.561	0.654	1.000				
ACC 2	0.489	0.457	0.457	0.440	0.380	0.537	0.560	0.535	0.414	0.555	0.396	0.052	0.191	0.785	0.646	0.672	0.535	0.495	0.687	0.694	0.486	0.379	0.500	0.559	0.847	1.000			
ACC 3	0.388	0.357	0.352	0.345	0.278	0.567	0.593	0.576	0.253	0.432	0.232	0.013	0.192	0.767	0.627	0.669	0.427	0.350	0.648	0.681	0.449	0.383	0.459	0.501	0.912	0.837	1.000		
ACC 4	0.410	0.302	0.398	0.387	0.310	0.290	0.347	0.243	0.144	0.201	0.139	0.048	0.220	0.395	0.265	0.386	0.426	0.414	0.360	0.397	0.383	0.309	0.409	0.271	0.445	0.435	0.457	1.000	
VOICE	0.747	0.520	0.753	0.689	0.555	0.053	0.110	0.057	0.579	0.567	0.420	0.128	0.366	0.568	0.381	0.228	0.692	0.751	0.579	0.520	0.654	0.603	0.682	0.686	0.506	0.507	0.401	0.280	1.000

About the Authors

Thorhildur Jetzek holds a M.Sc. in economics from the University of Iceland and a PhD in IT Management from Copenhagen Business School (CBS). Thorhildur worked for two years as a postdoctoral researcher at CBS researching big data platforms and is currently the director of R&D in the data platform company Activity Stream. Thorhildur's dissertation focused on how to conceptualize and estimate the value of open data. Throughout her career, Thorhildur has strived to understand, explain, and improve how public and private stakeholders use information and information technologies to generate value for society.

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