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The political economy of spatial data infrastructures

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ABSTRACT

This article explores the political economy of spatial data infrastructures (SDIs) by focusing on three key elements: (1) legal framework, (2) politics, and (3) their potential for economic impact. Empirically, the article draws specifically from the experiences of Infrastructure for Spatial Information in the European Community, in the European Union and the National Spatial Data Infrastructure, in the United States, which are representative of projects in advanced stages of implementation that nonetheless have evolved within very different legal regimes and political-administrative contexts. The article argues that SDIs are both technical and political projects that simultaneously respond to interscalar political dynamics characteristic to particular administrative arrangements. These dynamics are reflected in their respective legal frameworks governing SDIs in each jurisdiction, which are in flux due to the technological changes in geographic information and its role in society. The combination of these factors influences the role played in politics, government, and society by each SDI, while shaping its potential for economic impact.

RÉSUMÉ

Ce papier explore l'économie politique des infrastructures de données spatiales sous trois angles de vue: 1/ le cadre légal, 2/ le cadre politique et 3/ leurs possibles impacts économiques. Ce papier suit une démarche empirique, construite de façon spécifique à partir d'expériences d'une part de l'infrastructure de données spatiales INSPIRE au niveau de l'Union Européenne, et d'autre part de l'infrastructure nationale de données spatiales NSDI des Etats Unis. Ces deux infrastructures sont représentatives de projets ayant un stade avancé d'implémentation qui, pourtant, se sont développées dans des cadres législatifs et des contextes administratifs très différents. Dans ce papier nous défendons l'idée que les infrastructures de données spatiales sont des projets à la fois techniques et politiques qui répondent, de façon simultanée, à des dynamiques politiques inter-échelles, qui sont caractéristiques d'organisations administratives spécifiques. Ces dynamiques se reflètent dans la gouvernance des SDI de chaque juridiction. Elles sont en constante évolution en raison des changements technologiques associés à l'information géographique et son rôle dans la société. La combinaison de ces facteurs influence le rôle joué par chaque SDI au niveau politique, de la gouvernance et au niveau sociétal tout en déterminant son potentiel d'impact économique.

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1. Introduction

The state has long been at the center of the geographic information economy and thus the infrastructures and policies created to produce and distribute it. The scale and scope of this undertaking, the security implications of geographic information, and the essential nature of geographic information for statecraft reinforced this status quo. However, shifts in the relations between the state and the market – as those experienced under processes of neoliberalization – have important repercussions in the production, distribution, and consumption of geographic information (Leszczynski, 2012).

In addition to broader political-economic factors, technological changes have similarly affected the constitution of the geographic information economy. The adoption of computing and the digitization of geographic information have led to the construction of systems to produce, manage, and distribute this informational resource. These systems, often called spatial data infrastructures (SDIs), are accompanied by ‘a cocktail of laws, policies, conventions and precedents which determine the availability and price of spatial data’ (Rhind cited in (Meyer, 2016)).

While the term ‘strategy’ has been used to refer to this broader set of technical, political, and legal mechanisms (Masser, 2003, p. 4), the present article defines an SDI as one that encompasses all of these elements. The term SDI has the added benefit of legibility, since it is commonly used in academic, policy, and technical settings. Thus, we can understand an SDI as the integration of technical, political, legal mechanisms for the production, management, distribution, and use of spatial data, which increasingly take place in digital environments. Often, these infrastructures have an explicit governmental logic, and they are geared for the use of spatial data by the various components of the state. However, SDIs are increasingly sites of convergence for the interests of government, firms, user communities, and other groups.

The combination of factors mentioned above has led to the development of comprehensive National Spatial Data Infrastructures (NSDIs) around the world in the past two decades: the US, Japan, Korea, UK, Australia, the Netherlands, to name a few. In parallel, supranational initiatives have emerged that play a coordinating and integrating role across national boundaries. Two prominent examples of this are Infrastructure for Spatial Information in the European Community (INSPIRE), at the European Union level, and United Nations Initiative on Global Geospatial Information Management, which is UN-led initiative to develop a common set of geographic information standards worldwide. Aided by the increased availability of sophisticated computing resources and their low cost, many subnational administrations have also developed their own spatial data repositories and online data portals. While their scale is smaller than full-fledged national infrastructures, many of them are sophisticated products that use cutting edge online mapping resources. Some advanced examples are the Flanders region in Belgium, and several of the German länder, such as Bavaria and Baden Württemberg.

Today, there is a great diversity of SDIs at several scales, many of which are linked with each other in regional, national, and supranational initiatives. While SDIs are generally developed and maintained by governments to facilitate the distribution of geographic information, they are also symptomatic of a more profound change. The very availability of geographic information enabled by SDIs, combined with widespread use of digital mapping technologies, has enabled private firms and the general public to engage with

this product in new and different ways, which is transforming the geographic information ecosystem.

Across sectors and industries, high-profile examples of this are becoming increasingly visible. For example, recently, Facebook announced that it is producing the most comprehensive population map ever created, and produced with the aid of new artificial intelligence technologies (Meyer, 2016). This builds on a dynamic mapping economy where products such as Google Maps and Google Street View have enormous coverage all over the world and enjoy millions of users every day. In addition to this, spatial data have become ubiquitous with the general public using and producing navigation applications through the widespread mobile phones with GPS.

The term volunteered geographic information (VGI) captures an important part of the fundamental change in the geospatial economy: the participation of the general public in the production and dissemination of this informational resource. With the rise of 'Web 2.0' services in the first decade of the 2000s, the Internet became increasingly transformed by the emergence of social networks and interactive content, which in the geospatial economy has led to global-scale participatory projects such as OpenStreetMap. Some have argued that social media and the widespread participation of the public in the geographic information ecosystem have 'democratized' this informational resource, and given rise to a 'neogeography' of the 'geoweb' (Hudson-Smith, Crooks, Gibin, Milton, & Batty, 2009; Turner, 2006). Given that technological and political changes are not necessarily linked in the same direction, the widespread distribution of GI may not lead to an increase in democratic practices (Haklay, 2013), or even the redefinition of our understanding of 'geography' (Leszczynski, 2013). However, these developments are significant in their own right, as they express and enable new relationships in the production, distribution, and consumption of geographic information between government, private firms, and the general public.

In this context, SDIs have undergone a process of continuous adaptation (Harvey, Iwaniak, & Coetzee, 2012) that responds to changes in government, policy, and technology, as well as widespread popular uptake of geographic information. This implies a redefinition of the relations between traditional producers and other actors that constitute the increasingly diverse geographic information ecosystem. Simultaneously, this points to the formation of a new political economy around geographic information, since new economic opportunities, expanded use, and new actors, also carry with them the emergence of alternative configurations.

In the present article, I trace this new political economy of SDIs through the examination of three key aspects: legal frameworks, politics, and economic impact associated with creating and maintaining SDIs at multiple scales. The interactions between these aspects provide an explanatory framework of the broader context in which SDIs operate. I argue that paying close attention to this context will allow us to better understand an expanding digital economy, where SDIs and other infrastructures for digital information will continue to acquire a growing role in coordinating the flow of important strategic and economic resources – both within and beyond the sphere of government. Furthermore, while our understanding of SDIs and geographic information is robust, this understanding is centered on its technical and administrative dimensions. In order to properly assess their role in society, we need tools to grasp the political dynamics that characterize them, and the role they have in shaping a digital information

economy that includes countries, cities, and regions, but also firms, user communities, and society at large.

2. The political economy of SDIs

2.1. Legal framework

In order to explore the political economy of SDIs, it is useful to consider the laws and regulations enacted to coordinate them, as well as the priorities, designs, and values embedded within them. A legal framework is an essential requirement to building an SDI. As Onsrud (2004) has pointed out, there are three broad types of legal issues that intersect with geographic information, and directly shape the construction and impact of SDIs: intellectual property, freedom of information, and individual privacy.

These legal issues bring together geographic information in and of itself, the relationships between participating actors, and the overall social impact of both of the above. A coherent legal framework can also reduce duplication, streamline operations, and increase interoperability (Harvey et al., 2012, p. 27). It is also a necessary component for SDIs to produce policy results. While a legal framework alone is insufficient to produce results, these are difficult to achieve in its absence – as has been convincingly documented in the initial stages of the Polish national SDI (Harvey et al., 2012, p. 26).

An expanding informational ecosystem necessitates a robust and versatile set of rules, standards, and policies that are able to handle existing issues and adapt to new ones. For example, with the increased participation of private firms and user communities, issues of attribution, privacy, and liability become central points of concern (Rak, Coleman, & Nichols, 2012).

Overall, SDIs require a legal framework that governs the production, governance, and use of geographic information. The spatialization of information and its infrastructure introduce new dimensions to existing legal and social issues. As Elwood and Leszczynski (2011) have shown, privacy has become redefined with the use of spatial media, and particularly exacerbated with their dissemination through networked environments.

The technical transformations affecting geographic information have produced other kinds of changes, such as the property regimes that govern the commercialization and ownership of geospatial products and services. One example of this is how the transition from maps to spatial databases has transformed the Intellectual Property protections for these objects. In the United States, for example, pictorial maps have long been considered original creative expressions and protected by Copyright. On the other hand, the spatial databases at the heart of Geographic Information Systems are not automatically protected, since they are considered compilations of facts (Karjala, 1995). This directly affects how these geographic information goods are produced, regulated, and how they can circulate in the market. SDIs must grapple with changes in the geographic information ecosystem, while simultaneously enforcing common standards within a given legal framework. This process necessarily implies negotiations between a multitude of actors, all of which have inescapably political dimensions.

2.2. The politics of SDIs

A key goal of SDIs is the development of interoperability standards for geographic information. As shown by examples from the European Union (European Commission, 2016) to

South Africa (Harvey et al., 2012, p. 28), this is a collective effort involving participation from the government, private sector, researchers, and the public (Harvey et al., 2012, p. 29). In fact, the very idea of standards implies a coordination mechanism between various actors to enable efficient communication and action. This necessitates political negotiations over how geographic information can be produced, transmitted, and stored. In economic terms, these negotiations can have direct implications over the potential benefits of an SDI and the distribution and use of information.

Standards are crucial for the assembly of SDIs since they have an impact on transaction costs by shaping the information-sharing pathways. Simultaneously, they embody technical capacities, resources, and decisions of actors and organizations involved in the creation and maintenance of an SDI. These decisions, in turn, can have economic impact, since often the adoption of a standard can rely on a particular service or product – as is especially the case with proprietary standards. On the one hand, if no standard is chosen, communication between organizations and administrative scales can be hampered. On the other hand, the selection of and reliance on a particular standard may lead to path dependency in a region or organization, which can result in technological lock-in. Open standards are a way to avoid this, but they require additional cooperation coordination than proprietary ones, since the economic incentives are dispersed and rest on the possibility of long-term benefits that cannot be captured by any single actor.

In the process of developing interoperability and standardization for geographic information, SDIs engage in continuous inter-organizational coordination. SDIs are deeply embedded within the mechanisms of administrative scales ranging from metropolitan to national, and even transnational. This enrolls the efforts of various kinds of government agencies, private firms, and the public. While standards are an important coordination channel in an SDI, they are mostly centered on streamlining the distribution and use of geographic information. Politics around SDIs, however, encompass a variety of mechanisms beyond standards, such as negotiations, consultations, and even competition between agencies and other actors. Overall, for an SDI to be successful, collaboration must overcome any individual gains, to build a balance between different incentives and objectives. This is why examining inter-organizational coordination can elucidate the political dimensions of an SDI, as well as bring to the surface its embeddedness into broader political structures.

The most developed example of a functioning transnational SDI is currently INSPIRE, an initiative coordinated by the European Commission and implemented by EU member states. As an initiative that has been supported and enacted by European and national governments and geographic agencies, INSPIRE is the result of formal mechanisms that govern and coordinate development of SDIs. The production and sharing of geographic information, while usually housed within governments, include today an ever-expanding ecosystem of private firms and user communities. This makes it increasingly necessary to have standards that facilitate the communication and transactions between various actors. However, while necessary, they are not sufficient to achieve full interoperability of an SDI. They must be integrated into broader level political initiatives at various administrative scales that take on the task of aligning the legal systems, technical specifications, and coordinating the operations of agencies in each locale.

Ultimately, SDIs must deliver benefits to the governments that implement them and the societies they administer. While the notion of an SDI may be intuitive and the

projected benefits compelling, it is often difficult to track them with precision and leverage them toward a broader impacts. An area where this is becoming increasingly important is the digital economy, since geographic information has proven to be highly valuable in a growing number of economic activities (Henttu, Izaret, & Potere, 2012; Oxera, 2013). Part of the challenge of SDIs is to integrate the benefits they generate in the sphere of government into the emerging digital economy without losing the public nature of their mission.

2.3. SDIs and the digital economy

In recent years, the economic potential of SDIs has become clearer in light of the continued expansion of the knowledge and information economy. A significant indicator of this is how the European Commission's plan for the digital single market (DSM) is considering INSPIRE, the European Spatial Data Infrastructure, as a model for its development (Euro-geographics, 2015). Given the strategic and economic value of standardized geographic information, it is no coincidence that INSPIRE is playing an important role in the design of a unified digital market for Europe.

A key reason is that, within the knowledge and information economy broadly conceived, SDIs stand to have a direct impact in the digital economy in particular due to their ability to structure and streamline the circulation of digital goods and services. While this ability stems from their function as systems for information administration, there is much potential for integration into broader economic transactions beyond the sphere of government. Yet, the mechanisms by which SDIs can be integrated within the (digital and non-digital) economy, and the actors and decisions that would intervene in this process have not been extensively explored. In light of this, the present article aims to explore SDIs' potential for economic activity alongside the politics that accompany their design, assembly, and deployment.

Geographic information has long been a key strategic asset for the state. Governments around the world have built SDIs to standardize and streamline the production and distribution of geographic information. This process has become essential to administrative functions from security to tax collection, service provision, and policy-making. Beyond its role in government, geographic information has increased in value for an expanding range of industries and sectors, from logistics to agriculture to emergency management (Oxera, 2013). In this context, SDIs provide platforms for the circulation of an informational resource that is becoming marketized in various forms.

Like other types of infrastructure, the construction, coordination, and governance of SDIs reflect the operational and governance capacities of official organizations. However, since geographic information is becoming more ubiquitous, SDIs increasingly show greater levels of participation from the private sector, volunteer user communities, and the public in general. Thus, SDIs are constantly changing, evolving entities that adapt to the changes in both geographic information and its social and institutional landscape (Harvey et al., 2012). On an economic dimension, the increased diversity around the creation and maintenance of SDIs translates into a more heterogeneous set of economic incentives and preferences. While this poses challenges for SDIs centered on governmental structures and focused on the provision of public sector information, it also provides an opportunity for them to become platforms for digital markets, as is the goal with the DSM in the EU (Annoni, 2011).

Table 1. Requirements for SDIs to develop socioeconomic benefits. With information from Craglia and Johnston (2004, p. 19).

Operations	SDIs operate at all levels: local, regional, national, European, global
Connections	SDIs are well connected with other related infrastructures such as those of e-government, and public administration in general, research, and the private sector.
Maintenance	SDIs are regularly maintained.
Responsibility	There are clear lines of responsibility for SDIs' development, operation, maintenance, and regulation.

This is not without important political-economic implications, since the objective of infrastructures for public services does not necessarily overlap with the competitive and profit-driven logic that characterizes markets. However, the changes in the role of SDIs transcend the market/state binary. The core policies of SDIs still tend to be primarily defined by governments, operate within territorial jurisdictions, and address the production of geographic information by official agencies. In fact, in some jurisdictions, such as is the norm in European countries, those policies establish the implementation of solutions through the use of SDIs in public administrations, with an explicitly economic logic designed to generate revenue for governments. However, these policies are increasingly influenced by new spatial media practices of users and citizens, who are producing increasingly reliable VGI (Sui & Goodchild, 2011).

This process has many technical and political challenges, and reflects social and technological trends as well as the devolution in the provision of government services in the wake of neoliberalization (Johnson & Sieber, 2013). However, while the integration of VGI in government may be incomplete, SDIs at all scales (such as cities, regions, and countries) must now engage with new actors in an increasingly diverse geographic information ecosystem populated by internet companies, user communities, and NGOs, among others. In this changing context, it is useful to recall the requirements identified by Craglia and Johnston (2004) that an SDI needs in order to develop socioeconomic benefits. These requirements are organized in Table 1.

In a digital economy characterized by the expansion of social networks and the exponential production of big data (much of it geographical), SDIs can play a key role in organizing the flows of information and making this resource available to organizations and users. While some SDIs – particularly those in developed countries – have made advances in coordinating the production, reporting, and circulation of geographic information, they continue to face important challenges in translating them into economic impact. In the following sections, I show how two of the largest and most developed SDIs, the NSDI in the US and INSPIRE in the EU, are positioned in relation to their economic impact in their respective jurisdictions and beyond.

3. NSDI (US)

3.1. Legal framework

Executive Order 12906, signed by President Clinton in 1994, established the Plan for the NSDI. It aimed to outline a framework that consolidated and standardized the production of geographic information by the US Federal Government at a time when digital technologies were beginning to cause great impact: among others, GIS systems were accelerating

the production of maps and GPS positioning systems were increasing the accuracy and precision of navigation and location. In light of these technological advancements, it was necessary to provide a set of guidelines and policies that would coordinate the efforts at federal agencies in a way that would ensure the quality, timeliness, and standardized production of a key strategic informational asset for the country.

Parallel to this push for coordination were the provisions that identified market potential for a range of government-produced geographic products. One important example of this is remote sensing satellite data, which have undergone an incremental commercialization through the passage of acts in 1984, 1992, and 2003 (Gabrynowicz, 2005). Particularly, the 1984 and 2003 acts were designed to increase the commercial incentives for the use and distribution of satellite data.

The diversity of digital technologies to extract location and integrate it into an increasingly detailed context is entangling geographic information with a range of privacy issues. The privacy aspects of geographic information have long been part of the public discourse in some places with a high degree of sensitivity to state use of personal information, such as Germany, where the census was boycotted in the 1980s (Hannah, 2009). However, new debates are emerging, as technological change has produced a qualitative leap in terms of the threats to privacy posed by ubiquitous GPS tracking systems in mobile devices and geolocation of information flows through digital networks. These patterns of activity have brought the production of geographic information into privacy battles in the US, Europe, and other parts of the world. The outcomes of these struggles largely depend on the specific conditions under which geographic information is produced, circulated, commercialized, and (crucially) the legal regimes regulating these processes.

Privacy is often in tension with the property regimes of geographic information, which determine who owns it, who can use it, and who can derive economic benefit from it. In today's technological and socioeconomic context, the increasing value of geographic information often leads to its commodification into new market products. The Intellectual Property protections that apply to geographic information are in flux due in large part to technological transformations. For example, while pictorial maps have been protected by copyright in the US under Title 17 of the US Code, electronic maps and other forms of digitized geographic information have different types of protection. This is because digital databases are considered compilations of facts, which do not meet the minimum standard of originality required for their copyright protection (Karjala, 1995).

For the purposes of commercialization, this places geographic information in an ambiguous area. Often, this turns to a more restrictive means of protection than copyright, which is the use of contracts. In the United States, these issues affect more directly information produced by parties other than the Federal Government. While in Europe government-produced information is often copyrighted, in the United States, it is in the public domain and can be reused as inputs for commercial (and non-commercial) products (US Copyright Office, n.d.). This is unique in the world and can be credited with catalyzing the growth of the information economy in general and the geographic information economy in particular, since it allows the recombination of information and creation of new products. At subnational levels, however, the public domain provision of government-produced information does not always apply. Therefore, states and cities can copyright the data they produce, thus restricting use of data and their role in creating secondary works. These legal differences within and between countries

are both the result of interscalar politics and an important factor in governance processes across different agencies and administrations. In the next subsection, I turn to a broader examination of some of the political dynamics related to geographic information and SDI in the US.

3.2. Politics

In order to coordinate and enact the Plan for the NSDI, the Federal Geographic Data Committee brings together various federal agencies involved in this collective effort. The goal of this organization is to ‘provide executive, managerial, and advisory direction and oversight for geospatial decisions and initiatives across the Federal government’ (Federal Geographic Data Committee, 2015). This means organizing the collaboration of agencies at the federal level (such as the Departments of Commerce, Agriculture and Defense, and the Census Bureau) and at various subnational levels (such as the National League of Cities, the National Association of Counties, and the Western Association of Governors).

The high degree of institutional diversity combined with the decentralized governance structure in the US has created conditions for a great number of SDIs at different scales (Harvey et al., 2012, p. 29). While the NSDI aims to play a central and overarching role, it coexists with SDIs at the state and metropolitan levels. Due to this diversity, SDIs at various scales must seek a balance between centralization and decentralization in the provision of data, as well as the policies governing them. A central point in this process is the fact that SDIs are reflections of the political and economic relations between different administrative scales in the US. This means that there are several important differences and tensions between the federal, state, and metropolitan administrations that become manifest in the ways data are produced, governed, and distributed.

The institutional diversity of the United States – and its particular interscalar politics – shapes the construction and operations of its NSDI, as well as myriad state and local SDIs. This has important implications for the political relations enabling the building and maintenance of SDIs in this country. For example, the power dynamics between agencies at different levels, as well as the negotiation and governance mechanisms between them, are expressed in the type of participation they have in an SDI. As Harvey has succinctly identified, ‘building an SDI is fundamentally an interagency act, and thus a matter of trust’ (Harvey, 2003, p. 29). This is an important point because without attending to the actual incentives, capabilities, and limitations of different agencies to engage in an SDI, we run the risk of conflating the ideal scenario devised in the policy with the everyday institutional reality of participating in an SDI.

In the United States, the NSDI has been characterized by this disjuncture between administrative levels: federal agencies play the main roles in coordinating the SDI, while the participation of local agencies is much lower. This is in large part due to local perceptions of the top-down nature of the NSDI. These perceptions simultaneously reflect both the federal bias in the NSDI’s design and a more generalized skepticism of federal projects entrenched in US political processes. In this context, local agencies have more incentives to focus their data production efforts at the local level instead of contributing in a sustained manner to a project about which they have little knowledge, and which they perceive as removed from their immediate context (Harvey, 2003). In the following subsection, I will explore how efforts at different scales of

governance translate to the economic dimension of the NSDI, and the ways in which this is mobilized.

3.3. Economic impact

SDIs are complex, long-term projects that require the cooperation of many agencies across levels of government. While they have the potential to generate efficiency gains and essential information for government, industry, and society, SDIs often have difficulty accounting for expenses, avoiding duplication, and justifying increased investment (Government Accountability Office, 2015). This is an issue particularly at lower levels of government, where budgetary constraints are felt more immediately and there is a lack of adequate technology and sufficient integration into large-scale initiatives such as the NSDI. This highlights the need for the NSDI to engage more thoroughly with the regional and (especially) local levels and strengthen mechanisms to enlarge their financial capacity and a robust bottom-up approach (Nedović-Budić, Knaap, Budhathoki, & Cavrić, 2009).

The cost constraints at the lower levels of government highlight a paradox in the economic dimension of SDIs: geographic information is most valuable at the more accurate and granular it is, which tends to be at the local level; yet, the NSDI functions (and is funded) primarily at the federal level. While a focus on federal agencies is important for the coverage and coordination of a national SDI, it downplays state and local actors that are key sources of granular data. These data are not only essential for informed decision-making, but are also increasingly valuable in monetary terms.

As the value of geographic information and geospatial services is growing worldwide, the United States holds a significant competitive advantage in this regard. The Federal Geographic Data Committee's latest strategic plan (2014–2016) reports the following valuation:

A 2012 study by the Boston Consulting Group (BCG) estimated that the U.S. geospatial industry generated approximately \$73 billion in revenues in 2011 and comprises at least 500,000 high-wage jobs. In addition, BCG found that geospatial services deliver efficiency gains in the rest of the economy that are valued at many times the size of the sector itself—with geospatial services driving \$1.6 trillion in revenue and \$1.4 trillion in cost savings. These benefits, representing 15 to 20 times the size of the geospatial services sector itself, create an important competitive advantage for the U.S. economy. In addition, the U.S. Department of Labor recently identified the geospatial technology sector as one of the three technology areas that would create the greatest number of new jobs over the next decade. (Federal Geographic Data Committee, 2015, p. 10)

These economic estimates illuminate the key role of the NSDI in the development of the geospatial industry. While the FGDC plan recognizes that many of the initial developments in this industry (from GPS to geospatial standards and remote sensors) have their roots in government, this landscape has changed significantly since the NSDI began development in 1994. Today, the NSDI must expand coordination and cooperation beyond the sphere of government (at all levels) and engage more directly with actors in the private sector (such as Internet firms, geospatial industry firms, data intermediaries, utilities companies, etc.) as well as NGOs, user communities, and the public in general.

This is a necessary step to translate the benefits of efficiency and standardization, which NSDI has developed within government, to a growing sector of the economy. In this way,

the multiplier effect of the geospatial industry can be expanded, and the information exchanges within government and with other sectors can be streamlined. All of this has the potential to produce savings through efficiencies and allow the widespread use of geographic information for decision-making as well as economic activity. However, extending a model developed for the sharing of public sector information into an increasingly heterogeneous informational environment is a challenge not without risks.

There are indications that the NSDI has struggled to deal with institutional diversity even within the sphere of government. As was suggested earlier, agencies at the state and local government have not been thoroughly integrated into an infrastructure that remains dominated by the federal level. Currently, there are renewed attempts to remedy this structural imbalance: the Geospatial Data Act of 2015 (S. 740), under consideration in the US Senate, aims 'to improve the coordination and use of geospatial data' (Hatch, 2015, p. 1). This has several implications for the economic impact of the NSDI.

Firstly, the NSDI has underperformed over the course of two decades in its role of coordinating the production and sharing of geospatial data within government. According to the Council of Geospatial Organizations, the NSDI is not yet a fully integrated system and it should undergo important changes in order to be viable for future use (Council of Geospatial Organizations, 2015, p. 4). In light of this, it is unlikely that its adoption as a central infrastructure for the broader geospatial economy might yield substantially better results.

Secondly, the geospatial economy is increasingly characterized by widely used services developed by private producers, such as ESRI (ArcGIS Online), Google (with Maps, Street View, Earth, and Waze applications), Microsoft (Bing Maps), Apple (Apple Maps), among major competitors. This means that there are other emerging standards outside of the direct coordination of the NSDI, which limit the direct impact of this infrastructure outside of government. A more thorough integration with other sectors of the geospatial economy would require the NSDI to engage with these new standards.

It is, however, a risk for any public information infrastructure to rely too heavily on privately developed standards or products since they cannot ensure long-term sustainability or openness. On the other hand, a lack of compatibility with those standards could mean a barrier for the commercial potential of the NSDI, because an increasing number of users outside the government are now familiar with them through ubiquitous use of mobile and online navigation applications. Yet, since much commercially produced data cannot be brought into the NSDI due to licensing restrictions (Council of Geospatial Organizations, 2015, p. 3), new strategies must be devised to leverage the economic potential of government-produced geospatial data without compromising the public nature of the infrastructure. While many of the changes in the geospatial industry are global in nature, the way they affect specific SDIs and their potential economic impact is highly differentiated. In the following section, I explore the political economy of INSPIRE, the SDI of the EU.

4. INSPIRE (EU)

4.1. Legal framework

In an attempt to establish clear property rights over informational goods, the European Commission enacted the Database Protection Directive in 1996. This provides intellectual property protection of databases, by allowing their consideration as original creative

works. While the goal of intellectual property in general is to stimulate the production of original work by rewarding creators with a temporary monopoly over the use and distribution of their work, the specific protections enacted can have a number of unintended consequences. The EC's protection of databases has been criticized as creating conditions that may restrict the free flow of information and stifle the development of the digital economy (and as a consequence, the geospatial economy) (Janssen & Dumortier, 2006; Rosler, 1995).

As Maurer, Hugenholtz, and Onsrud have suggested, by protecting the creation of databases, the European Commission distorted incentives in a way that allowed the fencing in of vast informational resources. This provision is designed to protect 'collections of independent data ... arranged in a systematic ... and individually accessible way', and which require a substantial investment. However, these two conditions establish a threshold so low that, 'almost any jumble of data, including pages in a Web site and classified ads in a newspaper, will suffice', which means that '[e]ven trivial databases, such as a collection of 251 hyperlinks, are routinely protected' (Maurer, Hugenholtz, & Onsrud, 2001, p. 789).

This database protection has affected the development of information industries in the EU, such as geospatial industry, because they rely on the recombination of government-produced and privately collected information to create new products and services. When it comes to information produced by the government, this is already granted a high degree of protection in most European countries under government or crown copyright, which can allow for various types of licensing – including limited commercial uses. However, unlike in the United States (which is an exceptional case in this regard), the government-produced information in the EU is not considered part of the public domain. This has been changing in the last decade due to open data initiatives that have sought, with some success, to place an increasing amount of government-produced information in the public domain, or at least lower the restrictions on different kinds of use (Huijboom & Van den Broek, 2011). This, however, may cause conflicts due to the types of data that can be considered open (Kulk & Van Loenen, 2012), since these may include personal information, which has been increasingly protected in Europe under regulations such as the Right to Be Forgotten (Rosen, 2012).

In this context, INSPIRE, established in 2007 by the European Commission and set to be completed in 2021, has made progress in streamlining the production, reporting, and sharing of government-produced geographic information across the European Union at all levels of government. This SDI is currently the most ambitious initiative in terms of cross-border interoperability toward the standardization of geographic information. While there is much work to be done, INSPIRE has established robust mechanisms for the negotiation and implementation of specific goals. This includes a clear roadmap with successive stages for reporting and harmonizing various kinds (European Commission, n.d.).

A key provision in INSPIRE is that, while national governments carry out its implementation and negotiation with subnational administrations, the European Commission exercises oversight of the project through the Directorates of the Environment, Eurostat, and the Joint Research Center (Masser, 2007). Furthermore, it has authority to impose fines to individual countries for the delays in implementation. These provisions have allowed INSPIRE to make progress toward full implementation. This progress notwithstanding, the creation of this transnational SDI is also characterized by political relations that

reflect the interscalar dynamics of the European Union and its member states while creating new challenges in the decision-making over informational resources.

4.2. Politics

INSPIRE is a project that emerged out of the European Commission's goal to harmonize governmental spatial data production, reporting, and distribution across the European Union. However, as any SDI, it is an interagency – and in this case, an international – endeavor. This means that there are several layers of collaboration that include agencies at the European level, national governments and geographic agencies, and subnational administrations.

The scale of INSPIRE implies a degree of complexity that is in a sense greater than most SDIs because it involves politics internal to EU member states, the relations among those countries, and relations between member states and EU as a supranational governance structure. This political arrangement is reflected in the various mechanisms by which the EC seeks the implementation of INSPIRE. Tréguer has identified three main mechanisms for the development of pan-European interoperability projects. These are: (1) Binding regulations and directives issued by the European Commission. In the case of the latter, it is the national governments that are in charge of 'transposing' them into specific policies, (2) Cooperation between enforcement agencies across EU countries, and (3) Alignment of decisions in European and national courts (Tréguer, 2012, pp. 5–6). In the case of INSPIRE, it is the first two mechanisms that play a central role in its implementation and the development of cross-border interoperability in geographic information.

This means that there is a heterogeneous mix of legal, regulatory, and political mechanisms that coexist at any given time in the implementation of a project as complex as INSPIRE. On a European level, this means attempting to strike a balance between the authority of the EC and the sovereignty of each country, which is expressed in the latitude to find the best ways to 'transpose' EC regulation into specific, tangible outcomes. In this way, geographic agencies from all over Europe implement the provisions of INSPIRE while following the guidelines established by the EC.

While this system aims to balance different scales of governance, it does not preclude tensions from arising within countries, as well as between countries and the EU. In some cases, the requirements of INSPIRE exceed the existing capacities of some countries, and, despite continued efforts, are often unsuccessful in expanding them (Masser, 2007, p. 87). Within countries, meeting the INSPIRE guidelines can imply a greater degree of negotiation and coordination between subnational administrations which, like in the US, are burdened by more immediate fiscal and budgetary constraints. This means that in order to increase the participation of local data producers, the national geographic agencies must continuously manage the relations between national government and subnational administrations, as well as between them in order to ensure the standardization and the timely production of data to meet European standards.

The goal of these efforts in coordinating interscalar political dynamics is to achieve interoperability in the production, reporting, distribution, and use of government-produced geographic information over Europe. This is a process that works on several levels, which include the technical as well as the political and legal arrangements necessary to coordinate and standardize the operations of any information infrastructure.

From its inception, INSPIRE was designed to be a collaborative and participatory project in which the rules were designed by a community of interested parties, rather than an exclusively top-down fashion (Craglia & Annoni, 2006). In this case, it included over 185 organizations all across Europe that involved government and non-governmental actors, and which offered input to draft the INSPIRE Proposal for a Directive in July of 2004. This was further enriched when the process was opened for stakeholder involvement by communities of users and other parties who were interested in developing an infrastructure for geographic information (European Commission, 2016). This collaboration between the European Commission, national governments, Legally Mandated Organizations, NGOs, private industry, and the general public resulted in the Implementation Rules for INSPIRE and which informed the Directive of 2007.

Thus, while INSPIRE is still undergoing a process of implementation, and every stage entails various degrees of success for different countries, its significant advances toward integrating and coordinating transnational production of geographic information have made it a potential model for further developments in the European digital economy, such as the DSM and the ENERGIC – Open Data framework.

4.3. Economic impact

The initial focus of INSPIRE has been to increase the availability of environmental and other scientific spatial data for improved decision-making across Europe. In addition to its impact in overall governance, this initiative has a very clear economic logic, which, like the NSDI, relies on the promise of avoiding duplication, ensuring timely production of information, and translating these actions into savings for the government and taxpayers. While such a complex transnational endeavor represents important costs (on the order of €200 to €300 million annually for 10 years), its projected savings are much larger (in the range of €1.2 to €1.8 billion per year) (Masser, 2007, p. 70).

From early on, INSPIRE has made continued progress on several important grounds: efficiency by avoiding the duplication of efforts, increasing the availability and awareness of data, and improving data for environmental policy and other kinds of decision-making (Crompvoets, Wachowicz, De Bree, & Bregt, 2004). While these are significant gains for governance, policy, and administration across Europe, it has been argued that INSPIRE should expand its aims beyond the sphere of the government and toward a broader range end-users in society at large (Salvemini, 2009, pp. 8–10).

In light of this potential, which remains to be fully realized, INSPIRE is taking another form of economic impact by influencing the architecture of the DSM in Europe. The DSM is a priority initiative of the European Commission that seeks to break down the national barriers in the provision of digital products and services, and advance the creation of a pan-European digital market analogous to the European Single Market. The combination of regulatory and technological variations, linguistic differences, and cultural traits has kept the digital market in Europe much more divided along national borders than that of non-digital products and services.

In this context, the EC's Initiative for a DSM represents a comprehensive 'relaunch' of the European Single Market (Monti, 2010) to standardize and homogenize regulation, technologies, taxation, and the provision of digital goods ranging from electronic media retail to utilities. The projected benefits of such transformation are consumer welfare,

economic growth, and increased competitiveness of European information industries, which have lagged behind their American counterparts (European Policy Centre, n.d., p. 1). INSPIRE is currently the most advanced example in the development of interoperability for the production, sharing, and distribution of governmental information in Europe. Thus, while there is no explicit 'business model' or market logic driving the implementation of INSPIRE, this SDI has been positioned as a model informational infrastructure that can be expanded into other domains and exert positive economic impact that transcends the sphere of government information.

Such potential has been identified by the European Commission, as the experience of INSPIRE is directly informing the development of the Single Digital Market initiative, a cornerstone of the Digital Agenda for Europe: 'By aligning some actions of the DAE Action Plan and the INSPIRE roadmap it will be possible to extend the INSPIRE infrastructure to be beneficial for other domains and deploy operational solutions in a quicker and more efficient way' (Annoni, 2011, p. 16). This shows that the adaptive potential of SDIs allows the strategies developed within them to be expanded toward areas well beyond the sphere of geographic information. Simultaneously, it shows that the work done to standardize geographic information can have important multiplier effects in the rest of the economy not only by serving as blueprints for interoperability, but also by allowing the use of geographic information in a widening range of areas and activities. While the development of the SDM in Europe is still in its infancy, the experiences of INSPIRE can provide a robust roadmap to navigate the technical challenges, interagency relations, and interscalar politics that characterize pan-European digital initiatives.

Another aspect in which INSPIRE is being leveraged toward greater economic impact is through the ENERGIC-OD project. This initiative, which stands for 'European Network for Redistributing Geospatial Information to User Communities', is currently under development as part of the Competitiveness and Innovation Framework Programme by the European Community. The goal is to establish a brokering model through a set of Virtual Hubs in five European Countries (Italy, Spain, France, Germany, and Poland) that facilitate the integration of a diverse array of geographic information (from public authorities, private firms, user communities – including INSPIRE data), and provide a single point of access in open format (Czarnota, 2016). One of the key features of ENERGIC-OD is to increase interoperability beyond the framework provided by INSPIRE to include a growing diversity of data sources (Bruno, Previtali, Barazzetti, Brumana, & Roncella, 2016). This project has the dual aim of increasing the circulation and economic impact of geographic information in Europe, while addressing issues of access to open data in an increasingly heterogeneous geospatial environment.

5. Conclusion

The landscape of geographic information is rapidly changing, and becoming increasingly integrated into the digital economy. This change is characterized by developments such as the expanded production of VGI, new technologies of location, mapping, and navigation, as well as the entry of Internet and information companies into this industry. This is taking place in political-administrative context where governmental functions on collection and distribution of geographic information have been rearranged, and often outsourced. In this diversifying landscape, SDIs play a crucial role in structuring and standardizing the

production, sharing, and distribution of geographic information in the sphere of the government. However, through the incorporation of linked data, as well as increased prominence of private firms and user communities, SDIs are rapidly expanding their functions beyond the government, and in some cases acting as models for the construction of digital markets – such as is the case with the DSM in the EU.

In order to understand SDIs' changing role and future potential, it is important to conduct an examination of their political economy. In this article, I have analyzed two of the most advanced examples of SDIs (the NSDI in the US and INSPIRE in the EU) by focusing on their legal frameworks, their politics, and their economic impact. This tripartite analysis allows the integration of these (and other) SDIs into their broader political, economic, technological, and societal contexts, and explores avenues for their continued improvement and fulfillment of their potential for impact both within and beyond the sphere of the government.

The different configurations of legal regimes, interscalar politics, and economic relations have a direct impact in the role played by SDIs in each particular location. In the case of the NSDI and INSPIRE, while both of these play similar roles in terms of their administrative import in government, their economic impact is quite different. While the NSDI is shaped by interscalar tensions between federal, state, and local governments, the economic impact of geographic information in the US is intensified in large part due to the latitude given for marketization of federal data.

While in the EU interscalar politics between local, national, and supranational level have characterized the negotiation and implementation of INSPIRE, these have been competently managed within an administrative context and coordination between agencies. However, when it comes to the economic impact of this SDI, country-specific property regimes are dominated by government ownership, and have limited the economic potential of INSPIRE to the efficiencies resulting from its administrative function. This may be changing with the adoption of INSPIRE as a model for the European DSM and the implementation of the ENERGIc – Open Data brokering framework. In the context of a geographic information ecosystem that is rapidly evolving with the entry of new actors and the emergence of new data linkages across domains, it has become more necessary than ever to understand the role of SDIs in the integration of geographic information into the political and economic processes that shape and are shaped by the digital economy – one of the key features of twenty-first century capitalism.

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