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Assembling Digital Economies: Geographic Information Markets and Intellectual Property Regimes in the United States and the European Union

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Geographic Information Markets and Intellectual Property Regimes
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by

Luis Felipe Alvarez León

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ABSTRACT OF THE DISSERTATION

Assembling Digital Economies:

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Luis Felipe Alvarez León

Doctor of Philosophy in Geography

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Professor Allen J. Scott, Co-Chair

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This dissertation explores how Intellectual Property regimes and information markets shape each other to produce geographically differentiated digital economies. The geographic variations and underlying conditions of this process are investigated through a multi-scalar comparison of various jurisdictions, geographic spaces defined by legal frameworks. The United States and the European Union (with a focus on the UK, Spain and Germany) are taken as leading examples of these spaces and studied through the lens of their respective Intellectual Property regimes to understand the dynamics in the construction of their information markets. The study is centered on the commodification and marketization of a particular good: geographic information stored and distributed through the Internet, also known as the geoweb. Geographic information

(publicly financed, private and personal) is chosen as the object of study because it embodies defining features of contemporary capitalism including a) the expansion in size and value of the informational economy, b) new forms of production, distribution and consumption due to digitization and networking c) dramatic rearticulation of activities formerly dominated by the state, such as surveying and cartography. These three trends are synthesized to produce a geographic theory of the spatial and multiscalar construction of geographically variegated digital economies, which centers on the integrating vector of Intellectual Property regimes as a way to bound information within particular territories.

The dissertation of Luis Felipe Alvarez León is approved.

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Para Luis Alvarez Colín (1944-2013), *amigo de los amigos, amigo amigo*.

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Introduction

1 Problem Statement

The category of geographic information is rapidly becoming ubiquitous in the era of "Big Data" through the assimilation of geolocation and IP mapping services by massive Internet services and developments such as volunteered geographic information, geotagging of social media and other types of online content, and widespread utilization of GPS technologies in mobile devices. Due to its integration of location and context, geographic information has a distinctive legal and regulatory status with significant implications for privacy, policy, and commerce, which lead to its governance under provisions that do not necessarily apply to other types of information.

In economic terms the ability to pinpoint features and events in space, link and deploy layers of data about them has endowed geographic information with increased monetary, social and political value. Whether it is for military-strategic purposes, commercial, public or private interests, geographic information is rapidly becoming contested and sought-after. As a growing segment of the digital economy, particular attention must be paid to the context and framework that structure and regulate property rights over this information and govern its potential uses and profit.

To understand the process of commodification of geographic information, it is necessary to examine the establishment of property relations and protections through the law. While these protections are recorded in statute, they have technological, geographical, political and economic dimensions that both precede and exceed it. The geographic perspective is useful to shed light on the ways in which the law operates, since it can help bring to the surface many of the implicit

spatial assumptions that underwrite it. For example, under the widespread doctrine of territorial jurisdiction, the authority of courts is spatially bound (Berman 2002; Raustiala 2005; 2009). Although this is currently under transformative pressures from factors such as global linkages and technological change, many jurisdictions still tend to operate on a territorial basis, which means that they constitute the geographical extent of the judicial power's authority (Raustiala 2005). This produces specific and relatively stable environments where certain codes regulate social and economic interactions.

However, as critical race theorists, socio-legal scholars, and other social scientists have repeatedly pointed out, the law is not a neutral entity in the power relations that in pretends to regulate, nor does it does produce ossified, impermeable spatial structures. Instead, the law itself represents the outcome of social and political struggles at different scales while in turn producing new ones (Delaney, Blomley, and Ford 2001).

Since these struggles cannot be separated from the relations constitutive of an economy, we must acknowledge that the law does much more than 'regulate' economic activity. In this dissertation one of my goals is to disentangle these multiple sets of relations between the law, its geographical expressions, and the political economy they avowedly regulate. The concrete purpose of this is to better understand the commodification process of geographic information from a place-sensitive political economic perspective. In short: to produce a political economic geography of information markets underpinned by a legal geography of Intellectual Property.

The objects of study are the following: a specific commodity to be regulated (geographic information data), a body of law (Intellectual Property) and a set of jurisdictions (the United States, the European Union, as a supranational jurisdiction, and three of its member states: the United Kingdom, Germany, and Spain). These elements are addressed by systematically building a theoretical framework through the following strategies: Firstly, I identify and outline

the relationship between digital information and space in the context of the legal regulation of economic activity. Second, I develop an understanding of geographic information as a resource and its transformation into a market commodity through the lens of the property regimes that emerge in this process. Third, I conduct an analysis of the legal regimes that govern this information, their characteristics and implications for the formation of jurisdiction-specific informational markets. Fourth, I mobilize this by focusing on the impact of a specific body of law, Intellectual Property, its ramifications, and its economic expressions in the process of market formation in the jurisdictions mentioned above. Finally, these strategies are integrated into a coherent theoretical framework that connects the construction of information markets, their regulation and co-constitution through Intellectual Property, and the dynamics of variegated global capitalism, with its local forms and multiple place-specific outcomes. This represents a theoretical innovation towards explaining the connections between the digital environment, the social world, and place-specific political economic dynamics.

2 Objectives

The overarching goal of this dissertation is to produce a systematic theory accounting for the spatial constitution of information markets, and which links the broad level dynamics of variegated global capitalism with the finely grained understanding of the commodification of information goods. The connecting axis of this theory is the integrating role of Intellectual Property law and its spatializing qualities, institutional configurations, and regulatory actions in defining the structure and operations of information markets.

The development of this theory entails two further specific objectives. The first of these objectives is to advance understanding of the mutually constitutive relations between legal frameworks and the geographic information markets they define and regulate in the following jurisdictions: the United States, the European Union (specifically through three of its member states: the United Kingdom, Germany, and Spain). The second objective is to uncover how value is produced and exchanged in information markets structured by different legal architectures through the examination of one commodity (geographic information) using the combined lenses of economic and legal geographies, and critical data studies.

These objectives are significant because they provide avenues to reveal the specific mechanisms through which digital economies of information become geographically differentiated and embedded within legal regimes, political and economic processes in the context of contemporary capitalism. These economies are exponentially growing in their size and importance, but little is known about how they are structured and articulated through (and with) geographical, political and economic processes.

This project integrates several research agendas that motivate my academic contribution. As a political economic geographer I am interested in understanding the spatial configuration of economic production and its relation to social and political structures. While much research in economic and political geography has uncovered the patterns and dynamics of previous rounds of industrialization and de-industrialization, attention to economies of information –and digital goods in particular– is relatively recent. In light of the enormous impact of the Internet and its ongoing monetization, it is paramount to develop sophisticated, nuanced and grounded research that utilizes geography's versatile conceptual and methodological toolkit.

The cognitive-cultural, informational, and symbolic dimensions of the economy are becoming increasingly prominent, driving drastic changes in sectors that range from media (i.e.

publishing, television and film) to logistics, consulting and healthcare. Crucial questions such as the specific mechanisms of information commodification, the property regimes emerging out of this process, the resulting distribution of value, and the regulatory landscape of the digital economy should be at the forefront of contemporary geographical research.

This dissertation makes a contribution in this direction, laying the groundwork for future research that advances our understanding of this economic frontier. The present project integrates, adapts and develops insights from different geographical perspectives to shed light on a leading edge of capitalism: the digital information economy, with a specific focus on the production, distribution, marketization and regulation of geographic information. This informational category presents a vantage point to advance knowledge about the geographical dimensions of the digital information economy and their interaction with legal and regulatory regimes in the process of variegation of contemporary global capitalism.

3 Relation to present state of knowledge

3.1 Geographies of digital economies

The arguments of this dissertation are premised on the fact that the digital economy as well as the relations and transformations that comprise it do not develop in a geographical or political vacuum. In fact, they are embedded, not contained, in specific locations and at multiple scales, with which they engage in processes of co-constitution. This dissertation breaks new ground in understanding the digital economy as an integral part of a highly differentiated and adaptable capitalist economic system that is, simultaneously, a coherent project. The emerging literature on variegated capitalism provides a framework that both examines the deep connections in

capitalism and acknowledges its complex interdependencies with local place-specific factors, in order to account for deeply uneven results at all scales (Brenner, Peck, & Theodore, 2010; Dixon, 2011; Jessop, 2011; Macartney, 2010; Peck & Theodore, 2007; Peck, Theodore, & Brenner, 2009). Building on this foundation, I examine the geographically differentiated expressions of digital economies through their co-constitution with regulatory regimes in different jurisdictions.

In the past quarter century the extent of the industrial and societal transformations exerted by digital technologies has become readily apparent, if not adequately understood. Geographical research has worked towards more complete explanations of these changes through detailed accounts of the Internet, its industries and the different ramifications of this communications network in a variety of productive sectors (Zook, 2000; 2006; 2008; Zook, Dodge, Aoyama, & Townsend, 2004). Others have documented a growing diversity of monetary and non-monetary economies existing within digital networks and their geographical expressions (Currah, 2007; Leyshon, 2009). Given increased demographic, economic and technological agglomerations, much research has focused on disentangling the imbrications of digital technologies in urban environments. Kitchin and Dodge have examined the myriad intricate ways in which the work of software code reshapes the construction, experience and functions of space (Kitchin & Dodge, 2011). Graham, on the other hand, has highlighted the wiring of cities through digital networks and its enhancement of surveillance, control and militarization processes (S. Graham, 2005; 2011b).

Beyond the spatial reconstitutions of the urban fabric associated with digital technologies, geographical research has also explored the patterns and determinants of diffusion and distribution of digital communications networks (Perkins & Neumayer, 2011). Several scholars have shown that digital networks and related technological innovation patterns do not build on a blank slate, but upon previous rounds of infrastructural and economic development –exhibiting

high levels of urban and developmental biases (Castells, 2001; Kogler, Rigby, & Tucker, 2013; Malecki, 2003; Malecki & Moriset, 2007; 2009). These technologies have also intensified to the global division of labor and the development of new production processes, products and services, which has enabled the seemingly paradoxical rise of both agglomeration and spatial disaggregation of a widening range economic activities (Leamer & Storper, 2001; Malecki & Moriset, 2009).

Others focus on the content as well as the directions and ramifications of information flows through digital networks. Some have explored the role of knowledge generation and exchange (Grabher & Ibert, 2013; Powell & Snellman, 2004) in the organization of the economy and its geographical clustering as a defining feature of this new era in capitalism (Bathelt, Malmberg, & Maskell, 2004; Lorenzen & Mudambi, 2013; Porter, 2000). Those probing the qualitative shifts of global capitalism focus on cultural, creative and symbolic goods and services (Lash & Lury, 2007; Lash & Urry, 1994) along with the industries that produce them (Gibson & Kong, 2005; Power & Scott, 2004; Scott, 2005).

These research agendas have generated insights about the cognitive-cultural economy (Scott, 2007) and its socio-spatial configuration (Scott, 2000) economic potential and contestations (Scott, 2004), industrial restructuring (Currah, 2006; Pratt, 1997), as well as industry studies ranging from film production (Currah, 2003; Scott, 2002) to fashion (Currid, 2007) to comic book production (Norcliffe & Rendace, 2003), animation (Yoon & Malecki, 2010), video games (Izushi & Aoyama, 2006) and the performing arts (Leslie & Rantisi, 2011). These industries specialized in the production and distribution of products and services with high semiotic and creative content, usually protected by copyright, all face dramatic pressure to reorganize and adapt to the digital revolution.

The range of transformations brought by digitization and networking is broadening and sweeping ever more industries and sectors, but further research is needed to contextualize the digital economy within the global and local expressions of contemporary capitalism, attending to how legal regimes mobilize to regulate its development. This dissertation advances such an integrated by showing how regulatory regimes co-constitute the specific forms of variegated capitalism and how this relationship is expressed as digital information economies. This requires integrating an economic geographical perspective with *critical data studies of the geoweb* and *legal geographies*, two literatures synthesized below.

3.2 Critical data studies of the geoweb

The geoweb, or geospatial web, refers to the aggregation of digital platforms that integrates different kinds of geographic information, mapping applications, new locational media and practices with digital information communication technologies (ICTs). The synergistic quality of the geoweb to productively consolidate this diversity of elements has been central to its definition as a distinct and innovative informational environment (Scharl & Tochtermann, 2007).

Through the intersection of information management tools and vast data repositories, the geoweb has enabled the continuous creation of geographic information, storing and delivering spatial data while enriching them with a growing semantic context –much of it user-generated. These features made the geoweb a key component in the mid 2000's shift from a largely static web to a more dynamic, interactive, mobile and social Web 2.0 (O'Reilly, 2007). The geoweb contributed to this transformation through the growth of geospatial data communities, new forms of navigation and the proliferation of geographic information applications –from location-based advertising to environmental risk assessment (Scharl & Tochtermann, 2007).

A growing literature seeks to examine the broader social, political, and economic dimensions of this informational environment. Research on *volunteered geographic information*, or VGI, has advanced this examination by highlighting the participatory nature of much of the information created and uploaded to the geoweb by non-professional user communities. VGI is rich in scientific and societal value due to three key qualities: timeliness, low cost and extensive coverage (Goodchild, 2007). This type of crowdsourced information has received extensive attention (Sui, Elwood, & Goodchild, 2012). This research shows how crowdsourced geographic information can produce new geographic knowledge (Goetz & Zipf, 2013), leverage public participation for scientific (M. Haklay, 2013a) and government projects (P. A. Johnson & Sieber, 2013), as well as address increasingly complex societal challenges, such as severe weather events (Palmer & Kraushaar, 2013) and public health developments (Goranson, Thihalolipavan, & di Tada, 2013). While there are many challenges in its production and implementation, such as privacy concerns and data quality, VGI signals a change in relationships behind information production, outlining the many avenues for participatory engagement in the geoweb.

The exploration of the new possibilities presented by crowdsourcing and the geoweb has produced a sense of optimism about its innovative and disruptive potential. Some argue that it represents the democratization of information, upending traditional hierarchies of expertise and established epistemologies of geographic knowledge (Warf & Sui, 2010). The term *neogeography* has emerged to describe the transformations in the production and practice of geographic knowledge brought by the expansion of participation enabled by the geoweb (A. Turner, 2006). The ongoing debate on the geoweb and shifts in the production of geographic knowledge situates neogeography in a broader context and explore its possibilities, implications and limitations (Wilson, 2013; Wilson & Graham, 2013).

In order to comprehensively address transformations catalyzed by the geoweb, we should be attentive to the multiplicity of relationships it creates and reinforces, the myriad types of information that comprise it (each with its own particular possibilities and constraints) and how these relate to broader social forces. On the one hand, the distribution of mapping tools does not imply their successful use or adoption (Das, van Elzakker, & Kraak, 2012). Similarly, a central caution should be to avoid conflating the broader distribution of technical tools with processes of political democratization (M. M. Haklay, 2013b). While the two are not necessarily antithetical, we must show why they are not mutually implicated. There are new privacy concerns related to geographic information (Elwood & Leszczynski, 2011), persistent social inequalities in information access (M. Graham, 2011a), and the massive use of geographic information for surveillance (Crampton, 2014).

The development of the geoweb is closely intertwined with the recent and highly publicized explosion of 'big data'. Although large datasets are not new, the recent surge in their volume, velocity, variety and application motivates their reconceptualization (Kitchin, 2014). These datasets, including volunteered, extracted and automatically generated information are increasingly drawn by central to governments, private corporations, researchers and citizens. Since most of them contain geographic identifiers, they are increasingly studied within the umbrella of the geoweb. Recent conversations provide signposts for future research directions with respect to the formidable task of making sense of the geoweb in the context of big data (Dalton & Thatcher, 2014), situating big data in time and space through a critical engagement with the work of data assemblages in the world and their relationship with social forces (Kitchin & Lauriault, 2014a).

The examination of such new informational environments from a critical geographical perspective continues the path opened by the GIS and society debates from the 1990s (Pickles,

1995). By extending this conversation and engaging with dialogues in other disciplines (boyd & Crawford, 2012; Elwood, 2008), the prospective research agenda of critical data studies is developing a rich and varied theorization of big data and the geoweb drawing on a diversity of theoretical contributions, conceptual tools and approaches (Crampton et al., 2013; M. Graham & Shelton, 2013; Leszczynski & Wilson, 2013).

The "opening up" of geographic information and GIS through the geoweb and neogeography have spurred innovation in mapping technologies, allowed the expansion and broader circulation of geographic information, and catalyzed new forms and practices of geographic knowledge. These development make it increasingly clear that geoweb cannot be studied in a vacuum: it is part of a much broader network of technologies, social practices, political economic processes and legal frameworks (Elwood & Leszczynski, 2012; Leszczynski, 2012; Smith, 2014). By integrating critical data studies of the geoweb with political economic and legal geographic perspective, the present research contributes to develop a much needed understanding of the geoweb and big data as key components of digital economies and their growing role in the variegated geographies of contemporary capitalism.

3.3 Legal geographies

To show how modes of regulation integrate into forms of variegated global capitalism it is necessary to understand how legal frameworks operate through and within different geographies. A key objective of this dissertation is to show how the law works to commodify, marketize, and regulate of flows of information within geographically bounded jurisdictions. In so doing, this project enriches both the understanding of the digital economy and the development of legal geographies by exploring how digital information is incorporated into geographically variegated

forms of capitalism through processes of commodification mediated by jurisdiction-specific Intellectual Property regimes.

Legal geographies have grown out of the increasing interest in the spatial dimensions of the law. Their main premises are, first that the law is inherently (although often only implicitly) spatial; and second, that vast majority of the space of the world is inscribed with the law (Braverman, Blomley, Delaney, & Kedar, 2013). Wigmore's "Map of the World's Law" (Wigmore, 1929) was an early effort to show the distribution and interaction of the different legal traditions in space. Going beyond the scale of national legal systems, Clark (1985) later showed how the legal rulings of courts and judges are imbricated within a urban contexts. Several legal scholars have written extensively about problems that relate explicitly to spatial structures, such as immigration and territorial borders (Neuman, 1996; 2005), racialized legal spaces (Calmore, 1994; Ford, 1994), the formation of administrative scales (Frug, 1980), and of their modes governance (Briffault, 1990; 2013). However, in spite of these periodic and productive contributions, the exchange and engagement between law and geography has not been a sustained project.

In this state of relative detachment, de Sousa Santos broke new ground by advancing a postmodern conception of the law that used maps as analogy for a different, uneven, unstable and overlapping conception of legal space, which he labeled "interlegality" (de Sousa Santos, 1987). More recently the work of Raustiala has addressed many of the underlying geographical assumptions that inform legal doctrines through insights from political geography, which show the complexities and tensions underlying legal notions of jurisdiction, territory, and sovereignty (Raustiala, 2006; 2009). Over the past decade the increased exchanges between both disciplines have nurtured legal geographies. The volume *Law, Space and the Geographies of Power* (Blomley, 1994) synthesizes the central concerns of the legal geographical perspective by bringing to the

surface many of the spatial assumptions in the of legal theory and practice. Building on this, legal geographies have explored the intersections of law and geography in different contexts, from the constructions of nature informing the development of legal traditions (Delaney, 2003) to the mutually constituted spheres of race, place and the law (Delaney, 1998).

The *Legal Geographies Reader* (Delaney, Blomley, & Ford, 2001) further establishes an interdisciplinary research program of legal geographies. Building on this, the edited volume *The Place of Law* (Sarat, Douglas, & Umphrey, 2006), examines the co-constitutive relationships between law, space, place and other geographical concepts through the complementary perspectives of legal scholars, geographers, sociologists, literary theorists and legal anthropologists, among others. For the purposes of the present research, the essays by Lessig (*The Place of Cyberlaw)* and Ford (*Against Cyberspace*) are of note with regards to the different ways in which the specific interpretations and uses of the law help understand –or reject– spatialized constructions of cyberspace (D. R. Johnson & Post, 1996).

Within and around geography, the problems of land use (Platt, 2004), boundaries (Murphy, 1994), political redistricting (Johnston, 1983; Morrill, 1981), the construction of scales (Delaney & Leitner, 1997) and other issues of territorial division (Delaney, 2005) and control have motivated research that endeavors to understand the legal discourses used to justify power, representation and ownership over space and their resulting geographical expressions (Forest, 2005). The growing issue of environmental externalities and the allocation of responsibility and jurisdiction have become central to legal geographies (Osofsky, 2005; 2008). At the intersection of environmental issues and property rights, Aoki probed emerging issues of biopiracy and the commodification of life (Aoki, 2008). Furthermore, his incisive exploration of the development of Intellectual Property regimes from a critical geographical perspective is particularly illuminating in the development of the present research (Aoki, 1992; 1996; 1998; 2000).

The present research project contributes to the legal geographies literature by producing new insights on the co-constitution of digital geographic information markets and Intellectual Property regimes, an area of law that has been relatively underdeveloped from this perspective, and whose spatial assumptions and implications remain mostly unexplored. Building on this insights generated by recent research integrating an economic geographic analysis with perspectives on the role of the law in the dynamics of capitalism (Barkan, 2011; Christophers, 2013, 2014, 2015), this dissertation seeks provide a systematic theory accounting for the spatial constitution of information markets and the development of geographically differentiated digital economies. This represents both an expansion of the research project of legal geographies and a substantial innovation in the understanding of the economic geographic expressions and mechanisms of Intellectual Property regimes in the context of the digital economy.

4 Research questions and methods

This dissertation is guided by three main research questions, which together constitute the foundations of a geographical theory of the spatial constitution of information markets in the context of geographically variegated capitalism, which accounts for the role of Intellectual Property regimes in the commodification and marketization of geographic information. These questions are the following:

Research Question 1: How are Intellectual Property regimes created and implemented across different jurisdictions to regulate the development of digital geographic information economies?

Research Question 2: How are markets for digital geographic information configured in relation to Intellectual Property regimes in the United States and European Union?

Research Question 3: What are the political economic dynamics among actors shaping the commodification, marketization and regulation of digital geographic information in the United States and the European Union?

To answer these questions the research design of this project entails four analytical stages.

(1) The conceptualization and description of the relationship between geographically variegated forms of capitalism, Intellectual Property regimes, and the place-specific manifestations of the digital economy. This extends the propositions of variegated capitalism (Peck & Theodore, 2007) towards the geographically differentiated configurations of the digital economy and its relationship with Intellectual Property regimes.

(2) The identification of the political, economic and technological dynamics driving the production, commodification and marketization of digitized geographic information. The conceptual schema of property regimes developed by Schlager and Ostrom (1992) is extended and deployed to elucidate the variety of complex arrangements between actors producing relations of ownership and use rights that enable the commodification of geographic information. This is explored through jurisdiction-specific Intellectual Property regimes and the constraints and possibilities they present for actors such as firms, states and user communities.

(3) The conceptual model of geographic information markets assembled in the previous stage is deployed to analyze two actually existing geographic information markets, circumscribed by the jurisdictions of the United States and the European Union. The focus of analysis at this stage is how geographic information markets are constructed through their interactions with Intellectual Property regimes. This entails the thorough understanding of the objectives and ramifications jurisdiction-specific Intellectual Property regimes through laws, directives and key

court cases. On the other hand, it is also necessary to study the patterns, operations, trends and decisions that are directly regulated by these Intellectual Property regimes. This is accomplished through the combined analysis of interview data collected from geographic information firms operating in the United States and the European Union as well as employees form government agencies involved in the production of geographic information and policy.

(4) The United States and the European Union case studies are interrogated in relation to each other to examine the similarities, differences, and tensions between these competing paradigms. Having established the co-constitutive dynamics between information markets and individual Intellectual Property regimes within each jurisdiction, the comparison analyzes them, not as closed political economic systems, but in continuous and reciprocal interaction.

The framework built by the three chapters in Part I of the dissertation (Chapters 1-3) is designed to examine the co-constitution of geographically variegated forms of capitalism, Intellectual Property regimes and geographic information markets, addressing the first two analytical stages described above: (1) the digital economy in variegated capitalism; (2) the commodification and marketization of digitized geographic information.

Part II of the dissertation consists of Chapters 4 and 5. It is centered on the empirical study of geographic information markets and copyright regimes informed by the theoretical framework presented in Part I. Part II addresses the latter two stages of analysis in this research project: (3) the study of two geographically differentiated markets and their relation to their respective Intellectual Property regimes –the US and the EU; and (4) the comparative analysis of these two cases.

This research strategy is enacted through the integration of two principal research methods: (1) document analysis with a particular focus on legal documents such as statutes, policy documents, case histories and rulings, and terms of services agreements. (2) interviews with key

figures in the agencies and organizations involved in the production, regulation, and commercialization of geographic information. These methods are summarized below:

Method: Document analysis using IRAC (Issue, Ruling, Analysis, Conclusion) legal method studies (Bittner, 1990; Gopen, 2011; T. Turner, 2012). Document analysis of key legal texts (i.e. EU Data Protection Directive), relevant court cases (e.g. the Supreme Court of the United States 1991 ruling on the case *Feist v. Rural*, etc.) and *amicus curiae* briefs will reveal the logic, tensions and legal architecture of the Intellectual Property regimes of the US and the EU. This analysis is placed in context to understand the competition, cooperation and negotiations that constitute the US and EU geographic information Intellectual Property regimes. Throughout the dissertation there is a comparative thrust between these two Intellectual Property regime, which is structured around four axes: (1) government copyright of geographic information, (2) conditions for commercialization, (3) possible property regimes and (4) privacy protections.

Method: Semi-structured and unstructured interviews. Fifteen semi-structured interviews were conducted with firm representatives, activists and public officials. These interviews provide data on sources, pricing, licensing, distribution and ownership of geographic information by key actors in geographic information markets. Most interviewees are public officials from agencies that (1) oversee geospatial policy (i.e. the Copyright Office in the US and the European Commission in the EU and national mapping agencies in EU member countries) and (2) produce, collect and distribute geographic information (i.e. Federal Geospatial Data Committee in the US and national mapping agencies in European countries). In addition to these interviews, I attended INTERGEO, the largest geospatial industry trade fair in the world, which was held in Stuttgart, Germany, from September 15-17, 2015. In this trade fair I compiled research materials, took notes, and conducted unstructured interviews with exhibitors and

participants from private firms, government geographic agencies, and non-governmental organizations.

Interviews focused on the perceived goals and effects of geographic information policy, pricing of government information, (public and private) collection practices, supply chains and market operations. Interviews were semi-structured using the same format for all groups, which includes a set of ten fixed questions. This allows cross-comparison of results as well as flexibility for new data generation. Interviews were conducted between August and September 2015: in the European Union (the United Kingdom, Spain, Germany, and the European Commission offices in Brussels, Belgium) and March 2016 in the United States.

5 Statement of Intellectual Merit

This dissertation generates substantial interdisciplinary insights on the development of digital information economies, which constitute leading edges of contemporary capitalism. These insights demonstrate on the mechanisms by which the geographic information economy is embedded with legal structures and the geographically variegated forms of capitalism that these regulate and co-constitute. The contributions of this research are summarized below:

(1) It advances the *economic geographic* analysis of the digital and informational sectors of the economy and their relation to territorialized legal-political structures and regulations by presenting an innovative examination of digital economies and their embeddedness with geographically variegated forms of capitalism.

(2) This work enriches *legal geographies* by showing the complex interactions between the legal regimes and economic processes to spatially constitute information markets. In an original

examination of Intellectual Property regimes as mechanisms of spatialization for digital information flows it provides new evidence informing the multiple processes by which the law contributes to the construction of the space-economy.

(3) Within *critical data studies*, this research contributes to integrate a growing literature which explores the political, technical, and legal dimensions of data (Kitchin & Lauriault, 2014a) with research on the geoweb by showing how geographic information on the Internet is integrated into digital economies through the geographically differentiated construction of geographic information markets.

(4) By incorporating a range of literatures that lack sustained channels of mutual exchange this study furthers the interdisciplinary analysis of digital information economies and the development of new research agendas that understand them as co-constituted through spatialized legal, technical, political, and economic processes.

6 Outline

Chapter 1: The Digital Economy and Variegated Capitalism – This chapter explains a range of key legal, political and technological factors that contribute to geographic differentiation of the digital economy while remaining compatible with (and integral to) the dynamics of global capitalism.

A version of:

- Alvarez León, L.F. (2015). The Digital Economy and Variegated Capitalism. *Canadian Journal of Communication*. 40(4).

⋆ Winner of the 2015 UCLA Geography Department Graduate Student Publication Award.

Chapter 2: Property Regimes and Commodification of Geographic Information – This chapter explores the process of commodification in the geoweb through the interaction between legal frameworks and technologies that enable their application in the construction of property regimes specific to new digital commodities. This is illustrated through the example of Google Street View and the property regimes associated with this product.

A version of:

- Alvarez León, L.F. (2016). Property Regimes and the Commodification of Geographic Information: an Examination of Google Street View. In Leszczynski, A. & Crampton, J. (Eds.). Spatial Big Data and Everyday Life [Special issue]. *Big Data & Society*. Forthcoming

Chapter 3: Intellectual Property Regimes and the Spatial Constitution of Geographic Information Markets – This chapter presents alternative framings of geographic information markets as a way to understand the possible interactions between their key actors, such as state agencies, private intermediaries and user communities. It argues, furthermore, that these markets are constituted in space to an important degree as a result of the spatializing functions of jurisdiction-specific Intellectual Property Regimes.

A version under review (Revise and Resubmit) as:

- Alvarez León, L.F. (2016). Intellectual Property Regimes and the Spatial Constitution of Digital Geographic Information Markets. In Alvarez León, L.F., Christophers, B., and Yu, L. (Eds.), The Spatial Constitution of Markets [Special Issue]. *Economic Geography*.

Chapter 4: The European Union – Interoperability and the Digital Single Market – This chapter makes use of interview and documentary evidence to examine the European initiative to develop a Digital Single Market. This examination is centered on a specific good, geographic information, and the construction of an infrastructure to standardize its production and distribution across the European Union: INSPIRE, the European Spatial Data Infrastructure initiative of the European Commission. The analysis focuses on the key requirements of legal and technical interoperability between different administrative scales and jurisdictions and follows its implementation at the EU level and three member states: UK, Germany and Spain.

Chapter 5: The United States – Commercialization, Privatization, and Public Information – This chapter discusses the construction of the geographic information market in the United States in the context of the production of public information by the US government. Through documentary and interview data it explores this through a series of legal and administrative decisions that have oscillated between the drive to incentivize commercialization of information and the risk of privatization of public information assets. The focus of the chapter centers on the roles of the Intellectual Property regime, and the development of legal and technical interoperability in shaping the structure of the market for geographic information in the United States

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Part I

Chapter 1. The Digital Economy and Variegated Capitalism

Abstract

This paper sets out to conceptualize the ways in which the development of the digital economy (Malecki & Moriset, 2007) can be understood within the framework of variegated capitalism (Peck & Theodore, 2007). In doing so, it explores the question of how communication technologies interact with place-specific institutional, political and economic configurations to shape the geographically differentiated construction of an economy centered on the production, distribution and consumption of digital information. These interactions are examined through the development of geolocation technologies and their impact on a variety of approaches to jurisdiction over the Internet.

Keywords: variegated capitalism, digital economy, geolocation technologies, Internet governance

1 Introduction

While early notions of the aspatial nature of the Internet and the unambiguous space-time compression of digital communications (Cairncross, 1997) have largely been dispelled (Malecki & Moriset, 2009; Zook, 2006), this paper further problematizes the range of geographical dimensions present in these sociotechnical systems. Particular attention is paid to the drive towards configuring geographically bounded economies through the combined use of technical means (such as geolocation technologies that determine the spatial location of Internet transactions) and legal regimes (such as the establishment of jurisdiction over flows of information).

I propose an approach that contributes to understanding how the digital economy is assembled throughout geographical scales and places. I argue that, as part of the global capitalist system, the digital economy is at once deeply intertwined with its development while continuously branching into localized manifestations that reflect specific technical, economic and political arrangements. This argument is developed through the use of variegated capitalism, or variegation, as a theoretical framework, and its extension towards the issues presented by digital technologies. This theoretical approach has done much to advance the understanding of a unified capitalist system, while accounting for the systematic production of heterogeneity in its manifestations at varying geographical scales (Brenner, Peck & Theodore, 2010).

Through the contributions to policy mobilities, this literature has also shown the specific mechanisms by which the neoliberalization project has been established in different locales (Peck, 2011; Peck & Theodore, 2012). Variegation is thus a useful lens to characterize and understand the relentless spread, as well as the increasingly differentiated manifestations, of global capitalism. In this context, the aims of this paper are firstly, to shed new light on the digital economy

through the variegated perspective, and secondly, in doing so, to extend this theory by applying it to the study of the digital economy—an area that, though increasingly salient, remains unexplored through this optic.

The digital economy is a growing part of the capitalist system, and as such it requires theorization that avoids isolating it as a self-contained phenomenon. Here, I argue that it must be studied as constitutive of the transformations of capitalism at large while simultaneously examining the localized configurations of digital information throughout different scales of governance. This argument is developed in three parts. First, I offer a brief outline of the main conceptual propositions of the variegated capitalism literature and stress the need to extend this project towards the digital economy. Second, I characterize the digital economy by highlighting its embeddedness in the socio-spatial formations of capitalism across locations and scales. Third, I explore increasingly visible geographic dimensions of the digital economy. I do this by examining cases illustrating the development of geolocation technologies and their growing relevance for the regulation of the digital economy at different scales. These examples show but a sample of the mechanisms by which difference is produced geographically within the digital economy. The variegated research program proposed here can serve to catalogue the growing array of differentiation engines in the digital economy, as well as how its myriad localized manifestations play an active role in shaping other social formations.

2 Variegated capitalism

Variegated capitalism is a theoretical approach developed through contributions in economic, political and urban geography. It situates itself in opposition to mainstream economic theory that considers economic outcomes as reflections of economic laws, it privileges the salience of market

forces, and it stresses the tendency towards equilibria. Variegation is also sharply critical of the neoliberal program promoted by international organizations, rich states and global capital. It takes issue with the wholesale prescription of across-the-board polices aimed at getting developing countries "up to speed" with a model of society centred on free market capitalism.

Simultaneously, variegation also branches out from many influential approaches in the heterodox, institutional, and radical schools of international political economy. Specifically, it takes as its point of departure the proposition made by the Varieties of Capitalism school (Albert, 1993; Boyer, 2005; Hall & Soskice, 2001) that there are distinctly identifiable *capitalisms* that depend on the cultural traits and institutional arrangement found in different countries. Albert (1993) states that the two main models of capitalism are the "Anglo-American" model based in the US and the UK, and the "Rhinish" model, based in continental Europe. Although this division breaks with mainstream economics by acknowledging the influence of local contexts in the formation of capitalism, it does so by establishing rigid categories informed by a primarily Anglo-Eurocentric paradigm.

The variegation literature is critical of a division of capitalism in forms that correspond to discretely bounded nation states, cultures or even regions. Seeing it as rigid and scale insensitive, variegation instead proposes that capitalism is a single economic system that, while joined at the root, adapts and manifests in diverse ways simultaneously throughout scales and in particular locales. This opens the door for possibilities of understanding "the economy" beyond the methodological nationalism that often impairs the explanation of the astounding variety of outcomes that populate the geo-economic landscape. While acknowledging that there are fundamental commonalities at the core of the global economic system, variegation pays particular attention to the institutional, political and social arrangements that arise at different

scales and specific places and considers those arrangements as instrumental factors that, through the "messiness" of implementation, shape the myriad local mutations of capitalism.

Brenner, Peck and Theodore (2010) define variegation as "systemically produced geoinstitutional differentiation, at the heart of a reformulated conception of neoliberalization" (p. 207). The differentiation they point out is not merely the result of geographical diversity, but the outcome of a deliberate project to adapt to a range of institutional settings, while reshaping them through market-compatible and market-centred solutions. The implementation of a set of neoliberal priorities—commodification, state restructuring, openness of capital flows, etc.—through local and conjunctural conditions produces a variegated landscape of neoliberalization that emanates from a singular project. In fact, a core premise of the argument is that it is precisely this capacity to adapt and mutate that has made the neoliberal project so resilient (Mirowski, 2013; Peck, 2010).

The use of the term variegation is an effort to acknowledge both the coherence and the immense variability of this project in a growing diversity of geographical settings. Peck and Theodore (2007) introduced variegation as a response from within economic geography to a set of approaches to globalization that define capitalism either in terms of fixed national models—as the above cited Varieties of Capitalism—or as a collection of independent context-specific manifestations—as in the Governmentality perspectives (Ong, 2006; 2007). Thus variegation is proposed as a framework that understands capitalism in general, and neoliberalism in particular, as engines of differentiation that, while following a singular logic, thrive precisely due to their ability to produce systematic variation as they are implemented in different locations. This necessarily carries the consequence of contributing to the uneven socio-spatial development:

> Crucially, however, across all contexts in which they have been mobilized, neoliberalization processes have facilitated marketization and commodification while

> simultaneously intensifying the uneven development of regulatory forms across places, territories and scales. (Brenner et al., 2010, p. 184).

In light of this unevenness, the variegation approach seeks to capture both the global forces of capitalism that are remaking social relations in the shape of the market, and simultaneously elucidate how they consolidate into specific configurations throughout places and scales. One of the objectives is to demystify the idea of globalization as a singular end state and, by pointing to the diversity and contingency of particular processes, identify possibilities of resistance (Macartney, 2009).

My argument is premised on the fact that the digital economy, as well as the relations and transformations that comprise it, do not develop in a geographical or political vacuum. In fact, they take shape throughout specific locations and at multiple scales, where they are not so much contained but rather actively contribute to their production. Although I will group them in three levels, the following elements are continuously remaking each other to configure the different iterations of a continuously mutating digital economy.

First, at the most basic level are the infrastructural requirements, which enable the existence of digital communications networks and other necessary components. Second, the digital economy is embedded within a broader social and geographical context through location-specific sets of rules, laws, policies, practices and regulations. In ways that mirror institutional configurations at different scales, these norms and practices can structure and define the operational principles and protocols of the digital economy. A third level is constituted by set of social practices associated with digital information in specific settings. While these are certainly influenced by the availability or characteristics of technological means, the digital practices and cultures of specific places are not merely extensions of technical capabilities or local regulations.

As the literature on the social construction of technology (Pinch & Bijker, 1984) and the debates it generated (Winner, 1993) have shown, technologies themselves are in large part shaped by social relations and cultural practices. In light of this, the three levels presented here should be seen not in isolation but in continuous and reciprocal transformation.

While the national and subnational scales exhibit a great degree of variation in the elements that configure the digital economy in each place, there are recognizable forces at the supranational scale that strongly influence this process. Powerful countries, transnational corporations and international institutions, such as the IMF, WTO, ICANN and WIPO, have strong incentives to homogenize the commodification of digital information along regimes that maximize structured flows of monetized information; however, as noted above, the digital economy is always constituted through particular infrastructural, geo-institutional and social configurations. As Brenner has pointed out, these configurations are continuously re-scaled between the urban, the regional and the supranational, among other scales (Brenner, 2004).

Variegation is particularly attentive to this process of rescaling that enables the re-articulation of power, agency and governance across a range of administrative scales. The lens of variegated capitalism provides an optic to integrate the multiplicity of actors, technologies and scales that assemble the digital economy throughout the geo-economic landscape. In the following section, I will outline some of the characteristics of the digital economy that lay the groundwork for a variegated study of its constitution and operations.

3 The digital economy

With the rise of the digital economy, there has been a reorientation of the legal systems of different jurisdictions towards certain core tenets aimed at reshaping information exchange into a

market, such as establishing intellectual property rights and bespoke forms of commodification specifically tailored towards digital information. This should not be surprising in light of the dramatic increase in the monetary value of digital information with the diffusion of the Internet and the integration of computers in most aspects of work and life. It should be noted, however, that the Internet has been for much of its historical development an ecosystem where explicit monetary exchange has not been the norm (Abbate, 2000; McChesney, 2013). This means that currently we are witnessing the substantive transformation of this network from a means of information exchange to a platform of economic activity. It is at this juncture that I characterize the consolidation of a digital economy increasingly built on the logic of capitalism.

I use the term "digital" to describe a particular kind of economy in terms of its primary technological means of production, distribution and consumption, as well as the particular qualities of its commodities. Other labels, which themselves have long conceptual lineages, do not quite capture this specific set of activities, technologies, relations and commodities. For example, the "information" economy runs the risk of being too broad, since information is and always has been essential for economic transactions—and information can be transmitted in a number of ways, many of which lack a digital component. "Network society" and even more so "information age" are in turn even broader concepts that describe more general societal transformations that transcend the economic sphere (Castells, 2010). "Knowledge" economy (Drucker, 1992), while useful in its own regard, tends to refer to the skills necessary to thrive in the leading professions, as well as the increasing sophistication of certain tasks and the know-how required to perform them. On the other hand, in this analysis, I avoid terms such as "post-fordism" (Lipietz, 1997), "post-industrialism" (Bell, 1973) and "late capitalism" (Jameson, 2003). While these concepts, each with its own theoretical yield, signal major recent transformations in

the historical configuration and overall character of capitalism, my aim here is to focus on a more circumscribed set of activities.

For these activities, the use of digital technologies structures the production, distribution and consumption of commodities and fundamentally determines the qualities of the commodities themselves. Conceived in this way, the digital economy is centred on the firms, industries, organizations and consumers that are explicitly in the business of creating, selling and consuming digital products, as well as the relations articulated by these economic transactions. While the market is an important part of the digital economy, there are many non-market elements that are essential to its constitution. Thus, the digital economy also includes the patterns of use and consumption of digital commodities, non-monetary transactions, such as file-sharing networks, and the regulatory frameworks specifically deployed towards the digital environment.

While my definition of the digital economy rests firmly on the use of a particular set of technologies, it should be noted that these are conceived in way that emphasizes their embeddedness within the social world. As Webster (2007) points out, technology-centred definitions of our era most often implicitly understand technology as something external that produces an impact on society. The variegated study of the digital economy that I advance in this article considers technology integral to the dynamics of capitalism in their global scope as well as in their multiscalar manifestations.

The integration of computers in production initially led to the so-called "productivity paradox" famously identified by Robert Solow: "you can see the computer age everywhere but in the productivity statistics" (Solow, 1987). While the Internet has continued to increase the production of data and derived information, a new paradox has arisen. The explosion in the wealth of information and the noise it generates may obfuscate the impacts of the digital economy at particular geographical scales, as well as the ways in which this information

contributes to the production of those very scales. This paradox has persistently been one of the key difficulties in understanding the digital economy and its broader impacts.

Even today, it is still very difficult to identify the effects of the Internet on a particular location, its industries, government or labour force. It is even more difficult, it seems, to understand the precise mechanics behind them. Some efforts have been made towards measuring increases in productivity (Czernich, Falck, Kretschmer & Woessmann, 2009; Greenstein & McDevitt, 2011; Koutroumpis, 2009), others towards the increased gains in democratic exchange and speech—and the reactions against them (Howard, Agarwal & Hussain, 2011)—while others yet point to the intelligence and security agencies as the main beneficiaries of the data generated in the digital economy (Soghoian, 2010; 2011). Nearly two decades after the National Science Foundation (2003) opened the Internet for massive consumption, we are still grappling with how to understand and measure the integration of this technological platform into the economies and societies of countries, cities and regions, as well as the transformations, gains and losses it produces.

Negroponte (1995) famously used the differences between bits and atoms to characterize the contrasts between the digital and physical parts of the economy. Weightlessness and speed of transmission are key elements of this distinction. By focusing on the differences between digital and physical communication technologies, Negroponte compellingly isolated the fundamental innovation of the "new" economy: beyond networks or information, the digitization of goods and services is a transformative factor of the dynamics of capitalism (Malecki & Moriset, 2009).

However, the bits and atoms metaphor quickly runs out when translated into the real world. While bits may not "weigh" anything, or individually "take space," they certainly have an observable and measurable physical existence (Blanchette, 2011; Kirschenbaum, 2008). Furthermore, storing bits requires major infrastructural investments such as land, cable digs,

buildings to house the servers, ideal cooling conditions, and even friendly energy tax-regimes that keep down power costs (Mosco, 2014; Moss & Townsend, 2000). And while the Internet is not a "truck," as the late senator Ted Stevens eloquently put it, his famous characterization of it as a "series of tubes" vividly depicts the physical requirements that underlie the world of digital information that we have come to identify with the Internet (Moss & Townsend, 2000). Thus, directly and indirectly, these bits do have a physical existence that is reflected on their physical traces, the requirements for storage, and the network of underground and undersea cables connecting specific geographical locations, such as countries, cities and individual data centres. To exist in these locations, bits also necessitate social, political and institutional arrangements that make them "appear" in particular configurations on our screens—or disappear from them.

Any "tweet," Facebook message, or video stream is possible due to several layers of requirements, and those that relate to hardware form only the most immediate. Beyond the digital requirements (such as software compatibility), and infrastructural underpinnings (such as the cables and data centres), there is a series of decisions, contentions, negotiations, investments, litigations and contracts that lead to a place being "wired" a certain way or an Internet user being able (or allowed) to perform certain activities online. These social, political and economic arrangements that come together in different ways to construct the Internet and the digital economy across geographic locations are crucial to its embeddedness into the capitalist economic system. They are precisely the ways in which states, markets and institutions come together to shape, regulate, surveil and control the flows of digital information exchanged through the "series of tubes."

The digital economy is articulated through the diversified commodification of information flows. This process transforms the nature and purpose of the information itself as well as the social and economic relations around it. Yet, what are the specific mechanisms by

which digital information is transformed into a commodity to be bought, sold and turned into revenue and profit? A cursory look at the main strategies pursued by firms in this business will suggest that there is no single or clear answer (McCallum & Gleason, 2013). Many large Internet companies, such as Google and Facebook, monetize information based on an advertising model where services are offered free of charge in exchange for mined personal information that is then sold to advertisers. Another monetization strategy is consolidating through the vigorous app market, which has increased dramatically in recent years and is deployed on proprietary hubs such as the iTunes App Store or Google Play.

In spite of the swelling of the digital economy, many industries continue to struggle with coherent strategies to monetize their online content, particularly traditional media industries transitioning to the digital medium. Business uncertainty in the digital economy is compounded by risks, such as piracy, identity theft and hacking—all of which are ultimately policed to different degrees by territorial jurisdictions. Although the digital economy is not necessarily any more or less unpredictable than any of its non-digital counterparts, its novelty and rapid development make it difficult to assess the degree to which its dynamics are unique.

In this respect, one of the pressing questions about the digital economy is how it can or should be regulated, in particular when it comes to transnational flows of information and conflicts over regulation and jurisdiction. Following the localized embeddedness of the Internet, the answer to this question currently depends to a great degree on *where* it is asked. This is precisely where the lens of variegated capitalism can offer insights into how states, firms, international organizations, civil society and other actors interact to produce the different instances of the digital economy across places and scales.

Much like capitalism, the digital economy has expanded globally, with the Internet serving as its central platform. Early in its development, the Internet was considered the final nail

in the coffin of space, distance and geography itself (Cairncross, 1997). While initially seductive, the retrenchment of the promised virtual utopia has now given way to a more explicitly spatialized, and increasingly territorialized, version of the global digital information ecosystem.

This shift is analogous to the state of capitalism as viewed through the lens of variegation: while retaining connections at a root level, the digital economy takes different forms that are at once place and scale sensitive. Like capitalism, the digital economy is "always embedded" in broader contexts of institutions, politics, multiscalar relations, resources, infrastructures and so on. It also happens that many of those contexts have relatively stable geographic expressions, such as states, sub-national regions and metropolitan areas.

As a theoretical framework that seeks to understand the place- and scale-specific nuances of the capitalist system, variegation can help us understand how the digital economy is integrated into the economic geography of the contemporary world. Similarly, by explicitly making the digital economy into an object of study for variegation, this theoretical approach can greatly benefit from grappling with an increasingly relevant—yet still understudied—dimension of the capitalist economy, and specifically of the neoliberalization project.

I argue that a fruitful area for this research is to study the creation of legal regimes that structure the marketization of digital information and how those regimes operate across different geographies. In the following sections, I will address two specific aspects of the digital economy from the perspective described above. First I will show how geolocation technologies enable the construction of location-specific digital economies. Secondly, I will explain how, through the use of these technologies, legal frameworks from different jurisdictions are able to enact specific regimes and regulations that structure the digital economy in manifestly distinct ways that both reflect and construct geographically specific conditions.

4 Geolocation and jurisdiction

4.1 Geolocation

When someone types the word “restaurants” in a search engine in the year 2014, the list of results is mostly populated by offerings conveniently located in close proximity to the location of the search itself. Online shopping produces a similar outcome: the prices are often marked in the relevant national currency and the choices tend to reflect local availability and even popular brands and styles. Advertisements are tailored by language, city, and, sometimes neighbourhood. Behind this sorting of information is a combination of the power of increasingly sophisticated search engines and the insights produced by geolocation technologies. These elements are but two interlocking pieces of an increasingly complex and localized digital economy.

These technologies perform the task of matching a point of access to the Internet with its physical location. Moreover, companies like Quova, Akamai and Digital Envoy routinely pair the location of access to census data in order to create demographic profiles of users (Associated Press, 2004) and thus provide increasingly comprehensive geographic information about them. This has dramatically changed the way users experience the Internet. It has also brought to light a geographical dimension of this experience that had remained relatively obscure until the 2000s. For most of its early life, the Internet had been a place of anonymity and seemingly devoid of geography. With the spread of geolocation technologies, the former is near extinct, while the latter is increasingly visible.

For the purposes of identification and location addressing, each computer or device that connects to the Internet is assigned an Internet Protocol address, or IP address. This is a binary number whose label in turn consists of four numbers in the case of type IPv4 or six for IPv6. Given the enormous expansion of the Internet in recent years and the increasing need for new IP

addresses, IPv6 was designed to replace IPv4, active since 1984. The new protocol and was deployed beginning in 1999 and first massively used at the Beijing Summer Olympics of 2008.

Far from being a purely technical issue, IP addresses are embedded in a network of private and public institutional arrangements that owe their structure to the historical and geographical development of the Internet as a by-product of governmental research in the United States. IP addresses are assigned by the Internet Assigned Numbers Authority (IANA), located in Marina del Rey, California. This entity is in turn a department of the Internet Corporation for Assigned Names and Numbers, or ICANN. The United States Department of Commerce oversees both of these corporations, as stated in a contract signed with ICANN in 2000 where the latter is granted the authority to administer IANA (U.S. Department of Commerce, 2000; National Science Foundation, 2003).

This institutional framework governs the assignment of IP addresses following a geographic hierarchy, where the world is divided into five regions, each covered by a Regional Internet Registry (RIR). Within these regional registries, there are National Internet Registries (NIR) and Local Internet Registries (LIR). Cable companies, such as Time Warner or Comcast, in their role as Internet Service Providers (ISPs), obtain IP addresses from the pools allocated by IANA to these registries and assign them to end users (U.S. Department of Commerce, 2000).

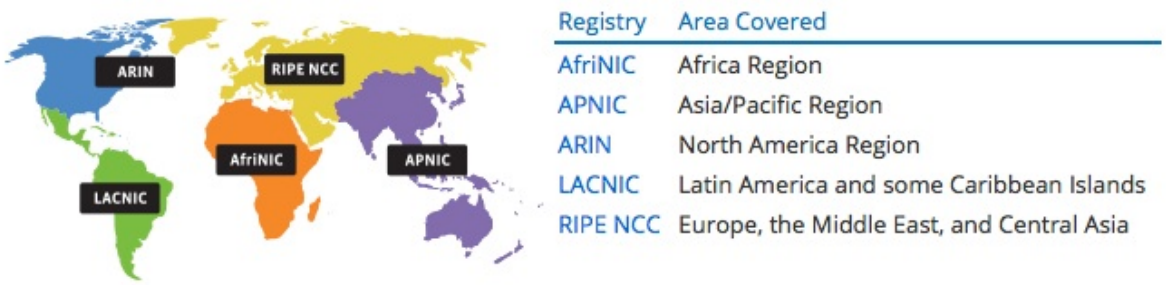

Figure 1. The IANA world map of Regional Internet Registries. Source: https://www.iana.org/numbers (N.D. Accessed January 27, 2015)

While IP addresses refer to a hierarchy of networks that loosely mirrors the political divisions of the world, the correspondence is far from exact. In order to extract location information, IP addresses are translated by geolocation technologies that perform a match with databases containing real-world addresses. One of the main sources of location error in this process is the fact that Internet Service Providers' servers, which assign the IP address, may not be in the same location as their users. However, in recent years geolocation companies have been able overcome this obstacle by following the data packets in order to narrow down the approximate location of the user with a higher degree of confidence. Today it is common in the U.S. to find accuracy at the ZIP code level identification and, most recently, even street level identification, with a median error distance of 690 meters (Wang, Burgener, Flores, Kuzmanovic & Huang, 2011).

The fact that information on the Internet can increasingly be located in space means that it can be more explicitly integrated into place-based social, legal, political and economic processes. This trend can be observed in the growing range of commercial applications of

geolocation technologies. According to Quova, a leading geolocation firm, the main areas of application for these technologies are local legislation, licensing requirements, technical standards, court orders, taxation and criminal liability (Quova, 2010). Geolocation is also routinely used to improve network administration and cloud computing performance.

Location, however, is never devoid of context, and thus implies other types of spatial relations that are now part of the Internet in different ways. In the commercial applications mentioned earlier, the location of the actors involved can translate into specific and quite tangible consequences. For example, whether Internet users are located inside or outside the boundaries of a jurisdiction may determine their rights, their responsibilities, the services they can enjoy or the punishments they risk for certain types of infringement.

Locational information in the Internet has become so pervasive that it is often difficult to imagine how it ever functioned without it. Looking back at the early attempts of online film distribution, the problem of geography emerged as a major concern for copyright holders. Interviewed in 2004, the CEO of the now defunct online video pioneer Movielink commented on this issue:

> The laws for copyright and licensing and the business rules are different in every country, so it's important the content providers be given a facilitating technology...We're beginning to prove that we can do that. (Associated Press, 2004, paragraph 30)

These were inklings of the shift in operations of the Internet at large. In the process of creation of a viable digital economy, the localization (and territorialization) of the Internet has played a key role. This process has allowed the flows of information to be subsumed within the multiscalar forces of global capitalism. While the specific mechanisms exhibit a great deal of

variation, the thrust of turning information into capital has been enhanced by the development of a more explicitly localized—and territorialized—Internet.

The defining features of the Internet's first decades and the interactions they enabled were captured in the popular adage from New Yorker cartoonist Peter Steiner: "on the Internet...nobody knows you're a dog" (Steiner, 1993, p. 61. However, today this has changed to the degree that younger users are likely to find the lack of anonymity as natural as the location-based dimension of their online experience. This is enhanced by the widespread use of GPS-enabled smartphones. It would be tempting to suggest that this "placing" of information catalyzed by geolocation technologies has added a new dimension to the Internet. However, from its conception this network was significantly influenced by a territorial logic of defense and infrastructural concerns. Yet, until recently, this dimension of the Internet had remained relatively invisible to most users due to the lack of perceptible manifestations in their everyday experience.

The perceptions of aspatiality, placelessness and deterritorialization shaped a cultural understanding of the Internet that deeply influenced expectations about its governance, operations and future possibilities. This understanding gave birth to the enduring idea of cyberspace, or the Internet, as a realm apart from the physical world. Today, in spite of the now evident and intensified geographical dimensions of the Internet, the notion of cyberspace is still deeply rooted and equally influential. Its influence is impossible to ignore when we consider how to "place," manage, and regulate the flows of digital information and capital that constitute the digital economy.

These two seemingly contradictory understandings of the Internet, one anchored in physical spatiality and the other avowedly virtual, coexist to this day. The hybrid nature of the Internet's relationship with geography is both a mirror and a catalyst of many re-articulations in

society that explicitly address its myriad effects. The law is a realm where these re-articulations are becoming increasingly salient. While capitalism exhibits a high degree of malleability in adapting to different places, scales and even modes of spatiality, however, the law is notoriously less supple. Yet, in line with the broader processes of globalization and the transformations brought by the Internet (and those internal to the network itself), there is a change underway at the core of the idea and practice of jurisdiction.

The Westphalian political order, premised on the hard spatiality of territorial jurisdiction coterminous with the boundaries of the state, is under increased scrutiny and contestation. Raustiala (2004) refers to this shift as the "uneven evolution of legal spatiality" (p. 155) and detects a thrust towards a more contextual and functional approach to jurisdiction. This erosion of a fixed notion of territoriality appears to be in consonance with the challenges posed by the emerging spatialities of information flows. The integration of the digital economy into variegated capitalism is one of the problems at the core of these jurisdictional transformations.

The notions of spatiality adopted in the wake of this legal shift will have fundamental consequences for the ways in which monetized information flows circulate within and between places. In light of this, it is important to examine the evolution of the Internet in relation to ideas of location, territoriality and the virtual nature of cyberspace. This evolution is becoming a central concern in the construction and enforcement of legal frameworks that attempt to regulate a digital economy that is at once increasingly localized and intensely global. In the following section, I will consider some of the key developments that have brought geolocation and the law into closer contact and, in doing so, impacted the Internet's role as a platform of economic activity.

4.1.1 Geolocation and the law: The Yahoo! case of 2000

One of the most emblematic court cases in the history of the Internet is directly related to the development of geolocation. This case brought to the fore the possibility of states enforcing their jurisdiction over the flows of information on the Internet. However, it also showed the multiple obstacles for consensus about jurisdiction over the Internet.

At the height of its power in the Internet industry, the search engine giant Yahoo! found itself in the midst of a legal battle that would prove to be lasting in significance. Two French groups, The League Against Racism and Anti-Semitism (LICRA) and the Union of French Jewish Students (UEJF) sued the American firm and its French affiliate, Yahoo France. The lawsuit was filed in May 2000 in the Tribunal de Grande Instance de Paris (the County Court of Paris). It states that, at the time, Yahoo! operated an auction portal where thousands of items of Nazi memorabilia were accessible to users located in France. The court initially ruled that the display and sale of Nazi objects through the portal constituted a violation of article R645-1 of the French Criminal Code, which prohibits the public display of Nazi uniforms, insignias and emblems (Akdeniz, 2001).

Later that month, the court ordered Yahoo! to prevent these transactions from involving any French residents. It also ordered Yahoo France to issue warnings to French users before they viewed the merchandise in the auction site. Yahoo!'s defense had noted that since their servers were located in the U.S. and their services targeted primarily U.S. users, these transactions were protected under the free speech guarantees of the First Amendment to the United States Constitution (Akdeniz, 2001). Additionally, Yahoo! argued that it was infeasible to comply with the court's order due to lack of technical means. Even if the means to comply with the order in fact did exist, they argued that its implementation

> would entail unduly high costs for the company, and might even place the company in jeopardy and would to a degree compromise the existence of the Internet as a space of liberty and scarcely receptive to attempts to control and restrict access. (Akdeniz, 2001, p. 2)

There were two major issues underlying the case itself and the decision of the court. Both of them are geographical issues at heart and have serious repercussions for how the Internet is regulated, who has the right to rule over it and consequently how the digital economy can be configured. The first issue is that of imposing national jurisdictions on a transnational communications network and the information contained and produced therein. The second issue is identifying the physical location of users in order to comply with those national jurisdictions. Although both of these matters have become central to the operations of the Internet, they are still not fully or uniformly resolved. In fact, recent debates about privacy, security and surveillance ensure their continued salience in the Internet's present and future.

Much of how we currently experience the Internet in relation to the offline world is due to the invention and widespread implementation of geolocation technologies: from geo-targeted local advertising to content licensing by country or region to widespread surveillance, censorship and commercial use of personal data. During the frontier phase of the Internet, until the early 2000s, it was unclear at a fundamental level what could or could not be done with and through it. The digital economy had not yet coalesced around this platform in part because the possibilities for controlled distribution and regulation were still remote and unclear.

A breakthrough moment for the Yahoo! case and the development of the Internet came when Cyril Houri, a French software engineer demonstrated that he could feasibly filter users by location with 90% accuracy through Geo-ID, a product he developed and that pioneered

geolocation technologies (Goldsmith & Wu, 2006). It is worth noting that the judge argued that Yahoo! was already familiar with geolocation technologies and thus able to implement the decision of the court because it already displayed advertisements in French for users inside France. In response to this, the judge convened a panel of experts to suggest how Yahoo! could comply with the order of restricting French users from breaking the local law. The three person panel, made up of Ben Laurie, Francois Wallon and Vinton Cerf, supported the claims made by Cyril Houri, which meant that Yahoo! would be compelled to make a "best effort" to geolocate its users and block access to those located in France (Goldsmith & Wu, 2006, p. 7).

The central debate in this case was not the availability of Nazi merchandise in Yahoo!'s auction site, which was not contested, but the jurisdiction under which this fell. In its defense Yahoo! claimed that it was operating under the jurisdiction of the United States, an argument the company later raised in a related trial to the Ninth Circuit Court of Appeals in San Jose, California. The fundamental question was whether a French court had jurisdiction over an American company whose portal allowed transactions *that may take place* in France, but which (according to Yahoo!) was impossible to determine?

In the end, the case would open more questions than it would answer. Before the American Ninth Circuit Court of Appeals declared the incompetence of the French court, the case had been seemingly resolved when Yahoo! opted to remove the Nazi paraphernalia from its auction site. The larger significance of this case lies in how it paved the way for an explicitly geographical treatment of the Internet as a matter of regulation. In fact Yahoo!'s subsequent intensification of geographically targeted advertising suggests a dramatic shift away from the placeless conception of the Internet it had previously upheld (Goldsmith & Wu, 2006).

As the Internet matured into a full-scale commercial nexus, it has undergone a spatialization that is neither fully territorial nor entirely virtual. The flows of information-capital

that run through the network must negotiate technical and regulatory checkpoints across jurisdictions if they are to realize their promise of connecting a global marketplace. It is this technical and regulatory landscape that provides the scaffolding for the logic of variegated global capitalism to become instantiated through digital transactions while adapting across a staggering range of conditions. More than a feature, variegation in the digital economy is a condition for its survival. In spite of the significant changes since the Yahoo! case, a uniform approach to regulation of the Internet, or even an underlying spatial logic, have yet to be agreed upon. The next section explores a series of key questions surrounding this problem.

4.1.2 One Internet, many jurisdictions?

Establishing jurisdiction on the Internet brings about the dilemma of dividing it through the use of borders. Border creation, even in the physical world, is a messy process full of pitfalls and unforeseen consequences (Ford, 2012). Given the complex relationship between information, location and jurisdiction, we can expect this process to be no less problematic on the Internet. Svantesson (2006) suggests two ways in which the jurisdictional difficulties associated with the Internet can be addressed:

1. Placing borders *on* the Internet, or territorializing it, which amounts to partitioning it according to discrete territories, or

2. Placing a border *around* the Internet, or considering it a separate territory in its own right—with its own laws, regulation and governance dynamics.

These two alternatives imply different kinds of territorialization processes. The first one would be an extension of physical/legal territories governed by states—analogous to airspace, for example. Thus, we would have the Chinese Internet, the Iranian Internet, the Australian

Internet and so on. The second one would be an attempt to separate the direct ties between territorial structures in the physical world and treat the virtual world of cyberspace as its own supranational realm. In the best-case scenario, it would be a multilaterally regulated space where no actor—state or private—would dominate over others. In the worst case, the most extreme power differentials would be reproduced and amplified, allowing certain actors to exert control over others far beyond "their borders."

The current state of the Internet is a combination of both of these scenarios. In certain sections of cyberspace, there is a closer correspondence between the informational network and the political borders through the hard territorialization imposed by some authoritarian states, such as China, Iran and Syria, among others. On the other hand, in the rest of the Internet there is constant tension where the United States exerts hegemony in many respects (such as the governance of names and numbers mentioned earlier), but there is active competition between other states and private companies for influence, surveillance and control over information flows. Undisputedly, the United States is currently the state actor with the most capabilities to pursue its interests beyond its jurisdiction over the Internet. Partly this reflects the ambiguity over *where* its (or anyone's) jurisdiction ends; however, it also mirrors the technical and geopolitical capacity of enforcement beyond its borders.

The recent case of Kim Dotcom illustrates how the physical location of digital information, the economic interests of certain copyright holders, and different states' claims to jurisdiction interact in specific ways to reinforce a particular regulatory approach to the digital economy. In particular this case reflects a vision of the digital economy strongly influenced by the interests of copyrights holders and enacted by the United States beyond its borders through political and judicial power. German millionaire Kim Dotcom is the founder and owner of the Hong-Kong-incorporated file-sharing site Megaupload. He has been accused by the U.S.

Government of criminal conspiracy, copyright infringement, and racketeering, among other charges. These charges are due to the activities on his website, which allegedly cost copyright holders in excess of USD $500 million. Megaupload served as a digital locker where users could store, access and share all kinds of files and media—much of it under copyright. The site was at one point was the 13th most popular on the Internet and received as much as 4% of all traffic worldwide (USA v. Dotcom et al., 2012).

The antiterrorism-style raid on his mansion near Auckland, New Zealand, involved 76 officers, two helicopters and attack dogs. It was revealed afterwards the U.S. government had pressured and provided material assistance through the FBI, which set off a political scandal for New Zealand's Prime Minister (Graeber, 2012; ONE News, 2012). One of the main reasons the US can claim to have jurisdiction over Kim Dotcom and the "Mega Conspiracy" is the physical location of the information stored on the website. Megaupload reportedly hired the services of Carpathia hosting, a "hosting company headquartered in the Eastern District of Virginia," where "thirty-nine infringing copies of copyrighted motion pictures were present on their leased servers" (USA v. Dotcom et al., 2012, p. 11). As the U.S. continues to seek Kim Dotcom's extradition from New Zealand, the case is gaining widespread notoriety regarding the claims of jurisdiction over the Internet, privacy protection issues, sovereignty disputes, and the regulation of the digital economy.

In the case of Kim Dotcom, the United States exerted power beyond its territorial borders on the basis of two elements: economic damages to U.S. copyright holders and the physical location of the servers where those damages "took place." The territorial jurisdiction over the Internet can be combined with extra-territorial reach to produce a multiplicity of outcomes—and to advance radically different conceptions of the digital economy. Using a similar argument based on the location of digital information as well as the identity of the user and the location of

access, the European Commission is enacting its territorial jurisdiction to promote a different regulatory approach. Through the proposed creation of the "Right to be Forgotten," the Commission is trying to regulate the actions not only of EU-based companies, but of extra-territorial actors that handle personal information of EU citizens (European Commission, 2012).

This regulation would force Internet companies and other services to take down any personal information consumers consider damaging to their privacy or public image. It would severely limit the powers of search engines and other data miners, while constraining the dominant Internet business model that encourages the monetization of users' personal information. While the European Commission argues that consumer data protection should take precedence, Internet companies have argued that it stifles free speech, the right to public information and forces them to become adjudicators, thereby hampering innovation. Echoing the general sentiment across the Atlantic, American legal scholar Jeffrey Rosen (2012) has called the Right to be Forgotten "the biggest threat to free speech on the Internet in the coming decade" (p. 88).

A key point here is once again the location of jurisdiction over digital information on the Internet. This is fundamental for the digital economy, since the Internet represents its central infrastructural platform, and the flows of digital information are potential flows of capital. The creation of markets for digital information is at once premised on the circulation of that information and on the enforcement of rules that standardize and protect its monetization.

These market dynamics thus bring with them the problem of enforcement, since it is unclear who has the right to exercise jurisdiction over transactions of digital information over the Internet. While some courts in the U.S. have placed jurisdiction on the location of the Internet server (as in USA v. Kim Dotcom et al., 2012), others—for example, in France—have done so over the location of user access (as in LICRA v. Yahoo!, 2000). Currently there are widely

diverging interpretations on the matter, which correspond to the type of activity, the legal precedents available, and the jurisprudential tradition of a particular jurisdiction, among other factors.

The resulting maze of directives provides a glimpse of the variegated landscape on which the digital economy is embedded. In spite of its accelerated growth and global reach, it will continue to depend more, not less, on the location of users, firms, transactions and states, their positionality in multiscalar networks of social and geo-economic relations, as well as the complex interdependencies established between them.

5 Conclusions

The cases discussed above bring to light the uneven territorialization of the Internet and the variegated forms adopted by the digital economy in its expansion. I have stressed throughout this article that the digital economy should be understood in its embeddedness in a variety of socio-spatial formations. While these formations may be states, as shown above, the digital economy can also simultaneously take shape at (and actively re/produce) other scales, such as urban, regional and supranational. The focus on geolocation technologies and their role in enabling different kinds of jurisdictions served to illustrate some constitutive aspects of the specific geographical contexts in which the digital economy develops.

As the digital economy continues to grow, it is crucial to study its relation to capitalism at large and its myriad manifestations throughout scales and places. The optic of variegated capitalism represents a productive theoretical avenue that enables the geographically differentiated integration of social, political, technological and economic elements that come together to create the digital economy. It is only through the synergy of place-specific contexts

and the systemic study of capitalism that we can understand how the digital economy is contributing to restructuring places, countries and regions, and in turn evaluate the scale, scope and quality of those transformations.

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Chapter 2. Property regimes and the commodification of geographic information: an examination of Google Street View

Abstract

The body of information on the Internet is becoming increasingly geographical. This is both due to expansion of established categories of geographic information (e.g. digital maps and geospatial databases) and to the simultaneous enrichment of other types information through geographic identifiers (e.g. geotags, check-ins, and GPS coordinates). As this repository of geographic information expands, it is also a key site for multiple processes of commodification transforming informational resources into market goods. Understanding the dynamics driving the integration of geographic information into the digital economy requires a comprehensive political economic analysis (Leszczynski, 2012). A key component of this analysis is to explain the logics of creation and allocation of economic value from geographic information on the Internet. Addressing this need, in the present article I deploy and expand Schlager and Ostrom's (1992) conceptual schema of property regimes to elucidate the differentiated commodification processes of geographic information on the Internet. Property regimes are arrangements that define rules, distribute rights, and delineate roles with respect to particular goods. These arrangements are enabled by elements such as legal frameworks, jurisdictions, type of information, and

technologies of access. In this article I explore how the legal frameworks regulating traditional categories of geographic information (such as maps) have been destabilized in the process of technological innovation, leading to the creation of new informational goods along with their respective property regimes, and rearticulating legal, economic, and sociotechnical relations. To illustrate this I analyze the case of Google Street View images through their property regimes in various jurisdictions.

Keywords

geographic information, geoweb, property regimes, commodification, digital economy, Google Street View

1 Introduction

The overarching goal of this article is to analyze and explain the commodification of geographic information on the Internet by examining the property regimes that emerge in this process. Property regimes are ways of organizing diverse bundles of rights with respect to a specific resource. These rights are the product of rules, which define how they can be allocated to particular actors, which in turn creates roles with specific functions within the property regime.

A well-defined conceptual schema of property regimes can help sharpen the analysis and management of resources and their economic exploitation. In this article I mobilize the schema developed by Schlager and Ostrom (1992) and extend it to analyze the commodification of digital geographic information. The goal is to produce a more finely grained understanding of how geographic information is integrated into the digital economy. This analysis begins by exploring how the digitization of geographic information has destabilized and reconfigured property regimes from established informational categories such as maps and databases.

Through the lens of property regimes I explore the interactions and configurations between actors, technologies, and institutional frameworks that both enable and result from the creation of market goods through digitized geographic information. Furthermore, by showing the diverse dynamics of commodification this article contributes to the necessary task of building a richer political economy of geographic information on the Internet (Elwood and Leszczynski, 2012; Leszczynski, 2012) that "goes beyond the geotag", or transcends the locative aspects of geographic information and analyzes its contextual elements in greater depth (Crampton et al., 2013).

By organizing the allocation of rights over resources, property regimes also articulate social relations among actors. This process is mediated by technologies tailored to specific types

of resources and individual goods. Such technologies are used to grant access to and monitor the use of the resource, as well as to define, allocate, and regulate the rights specific to each particular role. Technology thus plays a key role in the allocation of rights to a resource and therefore its management, exploitation, and commodification. For example, a fishery will require management technologies quite different from digital systems controlling access to copyrighted digital content. New kinds of property rights management technologies have proliferated in digital information environments. Some examples of these include anti-piracy digital rights management software (DRM), password protection, region encoding, and subscription charges, among many others. Following the widespread imperative to extract profit from information, the digital economy is increasingly characterized by the use of rights management technologies in the context of monetary exchanges.

However, in digital environments, the technologies used to access, manage, and commercialize information often go unnoticed or appear 'natural' to many users. In his discussion of the 'disburdenment' of human intelligence from the context of experience, Borgmann (2000) cautions that the increasing complexity of mediating technologies often obscures the nature of the social relations they articulate. Building on this insight, the property regimes analysis advanced in this article contributes to a political economy of digital information that tackles the power dynamics, socioeconomic relations, and technological configurations behind an economy of digital information —which, despite its physical expressions (Blanchette, 2011) and infrastructural requirements (Blum, 2012), is often abstracted into an immaterial 'cloud' (Mosco, 2014) and characterized as 'bits' rather than 'atoms' (Negroponte, 1995).

A crucial instance of this mediation is the technological composition of information, or how specific technologies and formats shape its structural features. Since technology and information are inseparable from the rest of the social world, the technological composition of

information is influenced by socio economic relations (Pinch and Bijker, 1984) and simultaneously impacts them (Winner, 1993). This mutually constitutive relationship has important implications for the construction of property regimes of digital geographic information. An illustrative case in point is the contrast between digital and print information technologies. In the last four decades, increased digitization has entailed a sweeping disruption of long-established information practices and categories. The emergence of new media to store and display information has transformed significantly how goods are categorized in law and practice, affecting the rules regulating their economic exploitation. These reconfigurations of rules, technologies, and practices have created new property regimes for the management and economic exploitation of informational goods.

The growing repository of geographic information on the Internet (often referred to as the 'geoweb') is the result of cumulative technological innovations such as social media, the exponential increase in processing speed, widespread cloud storage, and the emergence of server-side web-mapping (Tagoe and Mantey, 2011). These technological developments, along with the economic imperatives to commercialize geographic information, the regulatory frameworks of particular informational categories, and territorial jurisdictions at different scales jointly articulate the property regimes of geographic information. Analyzing how these property regimes come together is an important step towards understanding the commodification affecting digital geographic information, as well as the broader political economy in which it develops.

In the following section I introduce and explain Schlager and Ostrom's (1992: 249) conceptual schema of property regimes in the contexts of theories of property and the problem of distributed rights in digital environments. I then propose an extension of this schema tailored to the analysis of digital geographic information. Afterwards I show how new property regimes are created through the technological transformations of established informational goods, such as in

the process of digitization. To illustrate this, I use the example of maps, a paradigmatic good in the category of geographic information.

By exploring the transition from printed to digital formats I show the emergence of new property regimes and how this destabilizes existing categories, creates new ones, and in the process rearticulates processes of commodification. I then deploy the property regimes schema to analyze the commodification of geographic information in the case of a good that is a result of the integration of different types of geographic (and non-geographic) information in a networked digital environment: Google Street View.

The analysis shows the various types of rights attached to each component of this good, the allocation of these rights, and the management technologies that mediate this process. One important implication is that the integration of different kinds of information and the emergence of new property regimes in the process of commodification often creates tension between sets of values and logics, which often transcend property rights understood in isolation. A key example of this is privacy rights. As I show in the case of Google Street View, information that points to location and context must inevitably consider the aspects of privacy that arise from its collection and distribution. I conclude the analysis of the commodification of Google Street View by exploring how shifting notions and new constructions of privacy are deeply constitutive of the creation of new geographic information products and the property regimes that come together in this process.

2 Property regimes and the commodification of geographic information

The expansion of geographic information on the Internet should be understood in the context of a wider political economy characterized by the increasing reliance of capitalism on immaterial, symbolic, cognitive-cultural, and informational goods (Lash and Urry, 1994; Schiller, 2000; Scott, 2007), as well as by the dramatic growth of the digital economy (Ng, 2014; Sobel, 2003; Vafopoulos, 2011; World Economic Forum and Boston Consulting Group, 2013). This heterogeneous body of informational products includes commercial databases as well as resources whose primary purpose is not necessarily commercial, such as public information repositories, like the US Census Bureau's American Fact Finder, and collaborative projects like OpenStreetMap. The capabilities of geographic information to provide location and context have fueled its growing demand in a wide range of activities, from retail and advertising to political campaigning (Henttu et al., 2012; World Economic Forum and Boston Consulting Group, 2013). In this expanding economy of geographic information the lines between commercial and non-commercial products are continuously redrawn, and their property regimes reconfigured.

Commodification, or the process of creating goods for the market, implies the delineation of property rights suitable for economic exchange. However, property rights must function within a broader infrastructure that includes legal, political, and technological arrangements. Radin has called this "the legal infrastructure of private-property-plus free contract" (Radin, 2002). This draws attention to the mutual constitution of property rights with social and institutional relations that emerge from and regulate the use, ownership, and exchange of any particular good.

Digital information has posed particular challenges for the definition of property rights. Samuelson identified six characteristics of digital media that challenge and disrupt existing intellectual property systems: (1) ease of reproduction, (2) ease of transmission, (3) ease of modification and manipulation, (4) equivalence of digital works, (5) compactness of digital works, and (6) new methods of searching and linking digital works (Samuelson, 1990). These challenges to existing notions of property rights become even more acute in networked information environments. Overcoming them is a key requirement for the digital economy, which increasingly relies on the monetized exchanges over the Internet. This has led to new approaches in the allocation of distributed property rights. Often these take the form of technical solutions such as the information controls and digital rights management systems mentioned above. These systems have prompted discussions (Becker et al., 2003) regarding their role in privatizing copyright (Lessig, 1999), narrowing property rights (Cohen, 1998), overreaching intellectual property enforcement (Samuelson, 1999), and even their futility in the face of alternative distribution networks –such as peer-to-peer sharing (Biddle et al., 2003).

In challenging and redefining the property rights enforcement, digital technologies have produced new configurations of social relations, institutions, and technologies that come together in various ways for the commodification of particular informational goods. This requires analyses able to integrate the allocation of rights with the commodification of digital informational goods into the multiple dimensions at which these take place: infrastructural (e.g. cables, server farms, terminals), geographical (e.g. territorial jurisdictions, borders), informational (e.g. information management technologies and governance regimes of specific informational categories).

These and other technological challenges have been reinforced by theoretical shifts away from absolutist and individualistic conceptions of property and towards more contextually dependent readings. Perhaps the most influential, cited, and critiqued definition of property has

been Blackstone's definition of private property, from *Commentary on the Laws of England*: "that sole and despotic dominion which one man claims and exercises over the external things of the world, in total exclusion of the right of any other individual in the universe" (Blackstone, 1893: 304). While Blackstone's analysis of property rights was more nuanced than his definition would suggest (Schorr, 2009), the underlying idea of a 'sole and despotic dominion' "rings through the ages, and continues to block clear thinking about private property" (Heller, 2000: 418). This idea of private property has been complemented by two additional categories to settle into what Michael Heller calls the "well-worn trilogy of ownership forms –private, commons, and state property" (Heller, 2000: 418). The first category refers to property owned by particular individuals (or families or firms); the second, by no one in particular; and the third, by the state (Heller, 2000: 418). Yet, while this classification broadens the idea of property to associate it with different actors, it does not reflect the diversity of arrangements that exist in practice.

An alternate conception of property, which challenges absolutist and individualistic notions, is that of a "bundle of various rights, liberties, and powers that can be divided among many parties in numerous ways" (Gaus, 2012: 94). Taking this conception as a point of departure, (Elinor and Vincent) Ostrom, along with other scholars of the Bloomington School of Political Economy developed a systematic approach to the distribution of property rights, the analysis of their different configurations in practice and their theoretical synthesis. A particularly useful and versatile tool among these contributions is the conceptual schema proposed by Schlager and Ostrom "for arraying property-rights regimes that distinguishes among diverse bundles of rights ranging from authorized user, to claimant, to proprietor, and to owner" (Schlager and Ostrom, 1992: 249).

This schema enables an organized analysis of how bundles of rights are distributed in the management of a resource system. In this context, "rights" refers to "particular actions that are

authorized", which are allocated to different "roles". "Rights" are the product of "rules", or the prescriptions that create certain authorizations (Schlager and Ostrom, 1992: 250). Rules refer to three different levels of action: operational, collective-choice, and constitutional. Schlager and Ostrom explain the distinction between the first two categories as "the difference between exercising a right [operational] and participating in the definition of future rights to be exercised [collective-choice]" (Schlager and Ostrom, 1992: 251). The third level of action (constitutional) is where collective-choice rules are defined. The schema proposed by Schlager and Ostrom focuses on the organization of the first two levels of action in a property regime: the rules that create certain rights, and the roles defined by the allocation of those rights to particular actors. These elements, which together constitute any given property regime, are represented in the table below.

Level of action	Operational	Operational	Collective-choice	Collective-choice	Collective-choice
Right (Definition)	Access (The right to enter a defined physical property)	Withdrawal (The right to obtain the "products" of a resource (e.g. graze lands).	Management (The right to regulate internal use patterns and transform the resource by making improvements)	Exclusion (The right to determine who will have an access right, and how that right may be transferred)	Alienation (The right to sell or lease either or both of the above collective-choice rights)
Role					
Authorized User	X	X			
Claimant	X	X	X		
Proprietor	X	X	X	X	
Owner	X	X	X	X	X

Table 1. Elements of a property regime. Compiled by author with information from (Schlager and Ostrom, 1992: 250-252)

The property regimes schema illustrated by the table above is comprised by two levels of action (operational and collective-choice), five rights (access, withdrawal, management, exclusion

and alienation) and four roles (authorized user, claimant, proprietor, and owner) (Schlager and Ostrom, 1992: 249). The incremental allocation of rights to different roles shows how property rights can be disaggregated and distributed in a variety of ways. In this arrangement, the authorized user has the least rights (access and withdrawal) and the owner has the most (full set of property rights, including alienation). While the owner's full set of property rights echoes the Blackstonian definition property discussed above, a key insight from Schlager and Ostrom is that owners are not the only users who "make long-term investments in the development of resource systems" (Schlager and Ostrom, 1992: 249). This is consistent with the more general insight that there is no "one size fits all" model of property regimes which consistently produces "better" outcomes, but rather a multiplicity of ways to manage the rights over resources without over exploiting them (Ostrom, 1990, 2010). This has been the basis for theoretical developments on property and resource management encapsulated by "Ostrom's Law": "a resource arrangement that works in practice can work in theory" (Fennell, 2011: 9). One of these developments has been to explore the construction of knowledge as commons (Hess and Ostrom, 2007). Seeking to complement this body of work, the present article analyzes a movement in the opposite direction of knowledge commons: the commodification of digital geographic information on the Internet.

Coexisting in a networked environment, repositories of government-produced, privately collected, and volunteered geographic information (among other types) are increasingly recombined to produce new market and non-market goods. Each of these informational inputs is often governed by different regulatory frameworks, which are articulated in the development of new property regimes. For example, as is discussed later in the article: the privacy rights related to the collection images and wireless data during the creation of Google Street View have brought this product under a regulatory framework not applied previously to traditional maps. This highlights why the political economy of geographic information requires a detailed and

contextualized understanding of the new property regimes that emerge in the process of commodification.

Specifically in the case of geographic information, Cho advances a notion compatible with 'bundles of rights': layers of property rights over geographic information, which have a technical basis on the model of superimposed datasets used by most Geographic Information Systems (Cho, 2005: 135). While 'bundles of rights' can be thought of as a 'vertical' allocation of partial rights over an entire good, 'layers of rights' in geographic information suggests a 'horizontal' division. The coexistence of these in electronic maps and other geographic informational goods shapes negotiations in the rights attached to discrete sets of information superimposed on each other, but which may each have diverse origins and property regimes. This is a feature that makes digital cartographic products substantially different from print maps, which only showed the graphic output of a specific arrangement of information, while concealing the layers of input required in their production. When digital maps and other types of geographic information are uploaded to the Internet, these complexities are intensified because they become part of an informational environment with great potential for widespread distribution, accessibility, and recombination.

Considering digitized geographic information, this article extends Schlager and Ostrom's property regimes conceptual schema by focusing on three key elements to analyze commodification of geographic information: (1) the role of information technologies (such as the technological composition of particular informational goods, and technologies of access and management, –e.g. application programming interfaces, or APIs), (2) the specific features of digitized geographic information, such as the six features of digital media identified by Samuelson above, and the information layers characteristic of geographic information, and (3) the intersection and conflict between different logics and values resulting from the combination

of informational inputs in the production of digital goods –such as issues with property and privacy rights discussed in the case of Google Street View. Together these elements shape the commodification of digital geographic information goods, by modulating the allocation of rights over them and articulating new property regimes.

The property regimes of geographic information and its commodification take shape within a broader political economy affected by the changing role of the state in the collection and provision of geographic goods. On the one hand, many national and subnational administrations are adopting "open data policies" (Huijboom and Van den Broek, 2011). On the other hand, there is a "roll back" by different governments away from previously publicly provided functions and services, which impacts the production of geographic information (Leszczynski, 2012). This retreat has produced at least two concurrent developments. Firstly, it has transferred mapping capabilities to private corporations and communities of users. This transfer has occurred explicitly through outsourcing and subcontracting, or implicitly through passive non-competition and the creation of market spaces for the development of a geographic information industry. In the past decade this process has been accelerated by the availability of web-based mapping technologies. Secondly, this process has reoriented state capacity towards intensifying the publicly-funded collection and production of restricted-access geographic information, much of it towards the swelling surveillance and security apparatus of various states (Crampton, 2014; Crampton et al., 2014; Howard et al., 2011).

Digital geographic information incorporates key features in contemporary capitalism such as digitization, intellectual property, regulatory restructuring, and the digital economy. This makes understanding its commodification a necessary task. In the following section I begin this task by showing how property regimes are reconfigured through the digitization of information

and focus on the transition from print to digital maps. This lays the groundwork for analyzing the commodification of a particular digital geographic information good: Google Street View.

3 From maps to databases

To illustrate the interdependence between technological change and property regimes in the context of geographic information, consider an example that predates –and prefigures– developments in the 'geoweb': the transition from paper to electronic maps. Since the appearance of Geographic Information Systems in the 1960s, the focus on hand-drawn paper maps as products of the cartographic process has shifted towards the dynamic manipulation of different kinds of geographic information through innovations in computing and geographic information technologies (Cartwright and Peterson, 2007; PF Fisher, 1998). These changes in cartography, geographic information management, and their widening range of applications have fueled an industry with an estimated $USD 75 billion in global revenue in 2012 (Oxera, 2013) and a multiplier effect of $USD 1.6 trillion in U.S. economic growth (Henttu et al., 2012) (Henttu et al., 2012). The digitization of maps and computerization of the cartographic process have also redefined geographic information. This epistemic shift is at the crucible of significant legal changes, such as the emergence of new property regimes involved in the management and commodification of geographic information.

In the United States, maps have been a protected category under Copyright Law since the first Copyright Act (Copyright Act of 1790, 1790). However, the term 'map' is no longer a stable category. For the first two centuries of US Copyright Law, while there were intermittent of arguments regarding what constitutes originality in a map –a requirement for copyright

protection– (Whicher, 1963), these were not focused on the question of *what* a map *is*. Maps were tacitly understood in the legal context as pictorial representations of spatial information. The increased production of maps by digital geographic information systems has destabilized the legal consensus governing the definition of these objects and the protections granted to them.

Copyright Law considers maps the pictorial outputs of the cartographic process. However, maps are increasingly defined not by their pictorial aspects, but by the informational inputs and operations involved in their production. This technological shift has recalibrated the economic valuation of maps. Geographic Information Systems enable the organization, analysis, and transformation of spatial data while making the creation of graphical maps a secondary task. Consequently, the value attributed to the mapping process has shifted to the increasingly complex databases of spatial information and the techniques used to extract meaningful patterns from them. With the expansion of 'big data' (Kitchin, 2014a, 2014b; Mayer-Schönberger and Cukier, 2013), the database components of maps have found ever wider applications (e.g. real-time enhanced navigation such as Waze, and geo-targeted advertising) and market potential relative to the graphical component of maps.

Notwithstanding the growing economic value of databases, contrasting degrees of protection are offered to the pictorial and informational components of digital maps. Whereas pictorial maps are still protected by Copyright Law, databases are subject to a more contested legal regime (Reichman and Samuelson, 1997). The US Supreme Court decision on the case of *Feist v Rural* in 1991 established that databases are not de facto protected by Copyright because they are considered compilations of facts. This ruling disqualified databases from automatic protection for two main reasons: Firstly, facts themselves cannot be copyrighted. Secondly, compilations do not necessarily meet the minimum threshold of creativity required to be considered original expressions (*Feist Publications, Inc. v. Rural Telephone Service Co.*, 1991).

The Feist verdict was reached by concluding that Feist Publications' copy of over 1000 entries from a telephone directory published by Rural Telephone Service did not imply a copyright violation. While the origins of this ruling may seem rooted in a different era, its resonance for the digital economy has become significant due to its impact on the protection of databases compiled in any medium. In the context of geographic information, this implies a discrepancy in the property regimes of the different informational components of the map that has not been fully resolved, and is expected to continue generating debates in the courts.

Furthermore, this decision has generated new ways of managing the value of maps and allocating rights to their use and commercialization. However, since the underlying databases are not de facto protected by copyright, this opens the door for increased use of contracts (Karjala, 1995) or hybrid *sui generis* protections, both of which may be much more restrictive than the most stringent copyright protections and have significant anti-competitive effects while constraining access to essential inputs for knowledge creation (Reichman and Samuelson, 1997).

These developments show that the transition from printed to electronic maps affected much more than the technical aspects of geographic products: it also transformed their meaning, value and regulation. In the following section I deploy the property regimes schema to analyze the commodification of Google Street View, a new type of geographic information product, in the context generated by the technological and regulatory rearticulations discussed above.

4 Constructing Google Street View's property regime

4.1 The commodification of Google Street View images

Released in 2007, the Google Street View platform was not the first service to show a map with linked photographs for specific locations: Amazon launched the short-lived BlockView in 2005 and Microsoft's Streetside appeared in 2006. Yet Google Street View soon developed competitive advantages through extensive primary data collection by Google vehicles and integration with Google Maps and Search platforms. This allowed Google Street View to produce a comprehensive and navigable virtual environment. Initially launched in five cities (San Francisco, New York, Las Vegas, Miami and Denver), it now covers 3000 cities in 54 countries and is expanding to cover features such as the Amazon and the Grand Canyon (Fisher, 2013).

The development of Google Street View also entailed the production of new cartographic perspectives. These perspectives signaled not only new ground in cartographic representation, but also shifts in image processing and delivery technologies, as well as new modes of user engagement with digital maps. An element of this is the innovation of the R orb camera, mounted on Google vehicles is able to produce a continuous 360-degree panoramic high-resolution digital environment (Anguelov et al., 2010). As mentioned above, another element is the integration of this virtual environment into Google Maps and Search (Vincent, 2007). This enables users to navigate space by transitioning between the cartographic "view from above" provided by Google Maps, with its turn-by-turn navigation interface (which directs drivers at each step of their route) and the virtual landscape of Google Street View with its reproduction of the street-level point of view of the car or pedestrian (Anguelov et al., 2010). These features are further enhanced by the inclusion of satellite layers on the Google Maps and with the separate release of the Google Earth application.

Beyond contributing to Google Maps' hegemony of general-purpose web mapping service and mobile navigation applications (Smith, 2013), the significance of Google Street View lies in blurring the lines between digital maps, navigation services, and virtual environments. This

results from expanding the scale (millions of images), scope (growing coverage), perspective (ground level linked to view from above), and usability (navigation function and articulation with search) of digital maps on the Internet. By integrating these elements into a consumer product which users can access through tiered service (involving both informational and monetary exchanges) Google has engaged in perhaps the most thorough and expansive commodification of geographic information ever attempted. Since the tiers of service provision correspond to sets of rights transferred to users in various types of exchanges, a property regimes analysis through an extension of Schlager and Ostrom's (1992) schema can help illuminate how Google Street View and Google Maps commodify geographic information.

A first step in the commodification of geographic information is securing the property rights for the digital images in Google Street View for their assembly into a virtual environment. This constitutes a process of landscape production. According to Cosgrove, since its inception in Renaissance Europe, landscape as a "way of seeing" has achieved "the control and domination over space as an absolute, objective entity, its transformation into the property of individual or state" (Cosgrove, 1985: 46). Landscape production was bound up with activities of power, control and strategic domination of space such as survey and mapping of estates by the urban bourgeoisie, defensive fortification, and cartographic projection (Cosgrove, 1985: 46). Google Street View's particular production of landscape involves the gradual accumulation of geographic information into a new market commodity: a virtual navigation platform which users pay (through monetary or informational exchanges) to access, use, and manage various functions ranging from exploration to API use by third-party applications.

Elements of the environment, such as buildings, streets and parks are framed and captured as landscapes when they are fixed on a visual medium. In Cosgrove's terms, this is the point when each photographic image is "produced by the sovereign eye", into a landscape where

"space is rendered the property of the individual detached observer, from whose location it is a dependent, appropriated object" (Cosgrove, 1985: 48–49). This singular perspective is modified by the personalized production of landscapes enabled through the customized views offered by Google Street View.

The landscape production by Google's cameras results from the appropriation of visual information, the first step in the process of commodification of Google Street View. In terms of property rights, these photographs are protected by copyright in the US and other jurisdictions since they amount to original images fixed on a tangible medium of expression. On the other hand, the production of Google Street View images implies more than the photographs captured by the vehicles. As will be discussed below, regulators have shown that Google vehicles collect wireless communications data from private wireless networks in the course of taking Google Street View photographs. This brings an added layer of complexity to the property regime of Google Street View because wireless communications (and the private information therein) fall under a different regulatory framework to photographs. This highlights how privacy issues have become increasingly intertwined with the commodification of geographic information in the digital economy.

While Google Street View is a result of commodification through landscape creation, each individual landscape image has negligible value for Google. The value creation of Google Street View takes place through the massive integration of individual images into a navigable virtual environment. Google Street View is then made into a commodity through the accumulation of millions of infinitesimally valuable properties, which are assembled into a coherent, fully interactive virtual 'landscape of landscapes'. This product only accrues value once it is functional and released online for users to navigate it. This value is fully realized when

different kinds of users interact with the features of Google Street View and Maps through monetary and/or informational exchanges.

There are two kinds of users for Google Street View and Maps: first, the advertisers, who pay to have their ads shown on the map itself. Second: the end users of the maps and the map API. For the advertisers, Google Street View and Maps represent a way to reach and research geographically targeted market segments at increasingly more detailed scales. On the other hand, end users have a variety of interactions with this product that include monetary and non-monetary transactions and range from exploration and navigation to service provision through the use of the Google Maps API in third party applications.

The first tier of end users engage in a non-monetary transaction involving the collection of their search information by Google in exchange for the use value provided by Google Street View: navigation directions and detailed place-based information. A second tier of users (Standard API users) can integrate the Google Maps API, which includes Google Street View, into their own online services. The paid service for this tier includes a volume of 25,000 map load requests per day for a period of 90 consecutive days. For requests exceeding this limit there is a third tier of service (Premium API users), which charges according to the volume of requests (Google, n.d.). For users to integrate the Google Maps API into their services, access must be open to the public and free of charge, unless an exception is explicitly specified in the agreement with Google (Google, 2015).

In these transactions, governed by licenses, users provide information or money in exchange for different uses of the Google Street View and Maps. Through this triangular exchange between advertisers, end users, and Google (through Google Maps/Street View and Google Search) the commodity realizes its value in different ways for the three parties involved. The users receive the service of navigation and exploration (for first tier end users), or a product

that they can incorporate into their own applications (for second and third tier API end users); Google receives a combination of users' information, money, and the diffusion of their product through third party services (API users). Google then uses this information to sell search engine and map space to advertisers, who in turn receive increased exposure. These exchanges are summarized in the table below (Table 2).

Party	**What they exchange for use of Google Maps/Street View**	**What they receive**
Google	They provide the Google Maps/Street View product	A combination of money, information, and exposure from different kinds of users
First tier of end users	Information	Low-volume use of Google Maps/Street View through end-user platform (no API use)
Second tier of end users (Standard API)	Money (charged for a limit of 25,000 map requests per day, for a period of 90 consecutive days)	Medium-volume incorporation of Google Maps API by their own service
Third tier of end users (Premium API)	Money (charged by volume exceeding Standard API use limits)	High-volume incorporation of Google Maps API by their own service
Advertisers	Money (charged per clicks on the advertisement hyperlinks)	Placement on the map, analytics of a geo targeted market segment

Table 2. Exchanges in the commodification of Google Street View
Source: Author, with information from Google

The production of the Google Street View environment and its appropriation of images into landscapes presents two related concerns that play a fundamental role in shaping the property regime of this commodity: property and privacy. Above I discussed the construction of property through the allocation of specific rights as a result of monetary and non-monetary exchanges. These exchanges in turn create roles that come together to form a property regime specific to Google Street View images. The table (Table 3) below summarizes these exchanges and the rights assigned through to them to various roles, using the terminology of Schlager and Ostrom (1992). In the following subsection I turn to the role of privacy in the creation of a property regime specific to Google Street View.

Right (Definition)	Access (The right to enter a defined physical property)	Withdrawal (The right to obtain the "products" of a resource (e.g. graze lands).	Management (The right to regulate internal use patterns and transform the resource by making improvements)	Exclusion (The right to determine who will have an access right, and how that right may be transferred)	Alienation (The right to sell or lease either or both of the above collective-choice rights)			
Role							**Who is this?**	**Type of exchange**
Authorized User	X	X					Non-API users	Informational
Claimant	X	X	X				Standard API users, Advertisers	Monetized
Proprietor	X	X	X	X			Premium API users	Monetized
Owner	X	X	X	X	X		Google	Monetized

Table 3. A property regime for Google Street View
Source: Author, with information from Google and Schlager and Ostrom (1992)

4.2 The role of privacy in Google Street View's property regimes

In the preceding subsection I outlined two key issues in the creation of a property regime for Google Street View: property and privacy. The technological means of imagery collection and the very nature of the Google Street View platform make these concerns increasingly difficult to disentangle. In this context the second concern, privacy, stems initially from the capture of Google Street View images as well as from the degree of invasion of someone's private sphere implicated by this action. Since this is a service offered in many countries, the property regimes shaping its commodification will vary across jurisdictions. These variations affect the product itself. For example, the information included on the map can change due to geopolitical considerations, and the various privacy regulations can restrict the collection of certain data. While there are many factors that may influence the local configuration of these property

regimes, a key indicator is the relative weight given in each case to the privacy and property of the images and information involved in the triangular exchange (users – Google – advertisers) explained above.

In order to discuss the privacy implications of Google Street View imagery collection, it must be noted, as Elwood and Leszczynski have done (2011) that the geoweb has catalyzed a reconceptualization of privacy, as well as the associated social (and legal) struggles to define, maintain, and protect it. The fact that large datasets and imagery can be directly linked with particular physical locations creates a qualitatively different context in which to discuss what privacy means and how it is constructed. As Google Street View and other products in the geoweb have shown, large and networked datasets are becoming associated with spatial presence in ways that were unavailable to purely textual, tabular, or numerical data. This fundamentally alters the position and relations between actors who produce, access, use, or control these data (Elwood and Leszczynski, 2011). These relations are technological as much as they are institutional, political, and economic.

In the case of Google Street View, the production of this digital commodity must negotiate shifting conceptions of privacy, which are further transformed by the very act of imagery collection. In the course of collecting imagery, Google Street View vehicles physically navigate public thoroughfares. However, the public status of the information they collect is uneven and contingent. For example, Google has acknowledged that some Street View images may contain sensitive information. In light of this, the company announced measures to blur people's faces and vehicle license plates (Google, n.d.), as well as to comply with individual, community and government requests to omit certain locations from Google Maps and Google Street View (Google, n.d.; IT Security Editors, n.d.).

Furthermore, governments often submit content takedown requests to Google based on a range of criteria. While technically subject to legal oversight, it is Google that executes the content removal. The all-encompassing image capture of Google Street View combined with the power of discretionary removal that ultimately lies in the hands of Google have made privacy a major point of contention regarding the operations of this service in a number of countries. The privacy concerns that began with the collection of imagery intensified in 2010 when Data Protection Authorities in Ireland and Germany pressed Google to admit that in the course of their operations, Google Street View cars also collected information about private wireless networks (Google, 2010), such as router identifiers (SSIDs), computer MAC addresses and even emails and browsing content in the case of unencrypted networks (Stroz Friedberg, 2010). Google Street View has thus been identified as a threat to privacy and received renewed scrutiny around the world through government investigations and private lawsuits (Electronic Privacy Information Center, 2010).

These incidents have highlighted two aspects of privacy associated with the production of Google Street View: the collection of the images themselves, and the collection of wireless network data that takes places during image capture. These two aspects cannot be readily separated since the technology used for navigation purposes and image collection contained the code that collected wireless network data (Stroz Friedberg, 2010). According to Google, their vehicles collected both types of data from 2006 until May of 2010, when they allegedly stopped this practice (Google, 2010).

In the United States there have been private and class action lawsuits from parties who see Google Street View's imagery collection as a breach of privacy (Geissler, 2012). This concern over image collection has been compounded with responses focused on the wireless data collection. European countries have been the most vocal against both types of data collection.

For example, there has been public outcry and massive removal requests in the UK and Germany. In Greece, the Czech Republic and Austria, data protection authorities temporarily banned collection to allow further review (Electronic Privacy Information Center, 2010; Geissler, 2012).

In light of these accusations in the US and the EU, Google argued that their cameras capture the same images that any passer by on the street would be able to see. However, most Street View cameras stand nine-feet tall mounted on top of fast-moving vehicles, have 360-degree vision and produce high-resolution images that can be augmented by zoom. Critics argue that the combination of these features means that "most Street View imagery is created in a way that exceeds normal human capability" (Geissler, 2012: 903), concluding that it should be considered in a different bracket from ordinary public view.

With regards to imagery collection, the courts in Germany and the United States have been asked to decide whether Google Street View's image collection violates individuals' right to privacy. While the plaintiffs' claims have been dismissed in both countries, Geissler points out that an underlying contrast in how the right to privacy has been construed in each jurisdiction. In the United States, tort law places a much higher burden on private citizens to protect their own privacy (Geissler, 2012: 926). In Germany, "courts have interpreted [text in the German constitution] to imply a right to privacy that not only encompasses an affirmative government obligation to protect this right, but one that also constrains private parties' interactions with other private parties" (Geissler, 2012: 917). While Google vehicles continue to operate in Germany, the company reported that as of November 2014 they are not engaged in the collection of Street View imagery for public display, and only use it to improve Google Maps (Google Deutschland, 2014).

The privacy issues raised by the collection of imagery are further complicated by the associated collection of wireless communications data by Google vehicles. While these are developing in different ways across several jurisdictions, they highlight how the property regimes of digital information often transcend both property rights considered in isolation and the regulatory frameworks that govern any one of the inputs into new informational products. The integration of debates on privacy, ownership, and the commodification of geographic information is crucial to understand the generation of value by products such as Google Street View. How privacy is conceptualized, debated, and resolved, plays an important role in how informational commodities are produced and commercialized. Along with the allocation of rights of access, use and ownership of Google Street View images, the particular constructions of privacy shaped by variegated legal challenges across jurisdictions contribute to construct the property regimes governing the production and appropriation of value though this product.

5 Conclusion

The analysis of Google Street View presented in this article applies Schlager and Ostrom's property regimes conceptual schema (1992) to explore an instance of the commodification of geographic information on the Internet. This analysis represents an extension of the property regimes schema by considering the challenges of digital information to the allocation of property rights and by focusing on the role of technologies in the transformation of legal protections. Furthermore, by incorporating the discussions on privacy with the allocation of property rights, this analysis brings into discussion the different values and logics (such as privacy) that have become increasingly intertwined in the commodification of digital information. Finally, by

focusing on the transition from printed maps to digital maps and illustrating the emergence of new property regimes in the case of Google Street View, the article highlights how the characteristics of geographic information and its technological developments affect its new possibilities for its commodification in digital networked environments. The framework presented here can be deployed productively to examine other geographic information platforms (such as Bing Maps or OpenStreetMap) and understand the commodification of different types of information (such as satellite, crowdsourced, and health data).

In a broader context, the arguments in this article contribute to a political economy of geographic information on the Internet. This has been characterized by the reduction of the role of the state in the "cartographic project", a process which has been accelerated by neoliberalization (Leszczynski, 2012). In combination with technological changes such as digitization, the movement away from state-centric cartography towards an expanding geographic information ecosystem is necessarily implicated in the redistribution of power dynamics between the state and other actors. It is at this juncture that we should understand and analyze the emergence of a digital economy of geographic information and its expansion on the Internet through processes of commodification. At a time when evermore information is becoming digitized, and much of it commodified, it remains a necessary task to conduct increasingly granular analyses of the production of value through information and understand their meaning within broader social transformations.

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Chapter 3. Intellectual Property Regimes and the Spatial Constitution of Digital Geographic Information Markets

Abstract

Intellectual Property has become one of the key instruments for the commodification and marketization of goods in contemporary capitalism. However, its spatializing role in these processes has not been explored in detail. Among the categories of goods whose production and circulation is shaped by Intellectual Property, geographic information is increasingly salient in the digital economy due to the strategic and economic value derived from its integration of location and context. This article explores the role of Intellectual Property regimes in spatially bounding, structuring and regulating of digital geographic information markets. This exploration is mobilized empirically by examining the construction of digital geographic information markets in the United States and the European Union. The first part of the article discusses two alternative framings of the configuration of digital geographic information markets and the relationships between their actors: the linear and the networked market models. This part makes an argument in favor of the detailed examination of specific legal frameworks as key factors in the spatial constitution of markets. The second part of the article illustrates this argument by showing how Intellectual Property (and generally information policy) regimes shape specific

configurations of digital geographic information markets within two jurisdictions at the forefront in the development of global regimes for the regulation of digital information: the United States and the European Union.

1 Introduction: markets, spaces and the law

The extent to which digital communications are shaping our world is ever more elusive as these become increasingly integrated into a growing number of spheres of human activity. In a similar way, the digitization of information, goods and services has the twofold effects of enlarging the arena of what can be called the 'digital economy' while simultaneously blurring its boundaries with 'the economy'. However, in this process of expansive intermixing, it is important to identify the specific logics at work that regulate and set in motion the transactions, relations and configurations of digital and non-digital economic activity. This article is centered on the role of Intellectual Property regimes in the spatial constitution of markets that can most aptly be characterized as 'digital', since their defining quality is the constitutive role of digital technologies in their platforms of exchange, the transactions between actors and the very goods exchanged within them. The object of analysis is geographic information: a category endowed with characteristics of location and context, which includes maps, satellite data, spatial databases, and increasingly, georeferenced media on the Internet. Combining old, new, and hybrid informational products, geographic information has become increasingly crucial in the global digital economy due to its expansion and wide range of applications –from construction to navigation, public health, advertising and policy-making.

Commentators from Marx to Hayek have highlighted, each with different inflections, the central role played by law in the development and maintenance of capitalism. For Marx the law was an expression of the relations of production and the will of the powerful classes (Mandel 1986). For Hayek, on the other hand, the law was a 'political ideal' necessary for the existence of a free market (Ealy 2010). Both of these observations share the insight of law as a system of rules that amount to more than extraneous market 'regulation'. Instead, they see law as actively

shaping the very constitution of markets by structuring the relations between actors, creating the conditions for exchange and establishing the (spatial and operational) bounds of the market.

The relationship between capitalism and the law is characterized by constant dynamism and a mutual constitution where the developments in each are enabled by and reflected on the other. Thus the law can be seen as both a stage and a mirror for the construction and operations of markets. It is a stage because it establishes the conditions under which actors can operate, relate to one another and conduct economic transactions through markets, while imbuing in these transactions specific values, priorities and objectives. Simultaneously, the law is a mirror for markets because it must change continuously to address their developments and outcomes. Through this process of mutual constitution, the law adapts to contend with the changed reality it helps create through its influence on market actions and their effects on society.

Through these interactions the law and the market jointly construct and transform spaces of capitalism. For example, as spatial and legal systems, jurisdictions are more than the established and designated spaces for the application of the law. They are, rather, spaces continuously produced through the generative interaction between the law and capitalism. The production of those spaces is also continuous and highly contingent. As legal geographers have shown, there is no space on Earth that is not inscribed with/by the law in some way (Braverman et al. 2013). When the law defines and regulates the normative terms of social action and regulates them, it comes into contact with the specific context of each place, thereby contributing to spatial differentiation (Delaney et al. 2001). These insights have been deployed to understand phenomena such as race relations and the production of racialized spaces shot through with unequal power relations (Blomley 1994); the construction and exercise of sovereignty (Murphy 1994); and, the creation of specific protections and rights under particular legal regimes (Raustiala 2005).

As Barkan has identified, however, the study of economic globalization has curiously lacked any explicit analysis of the structuring role played by the law in this process (Barkan 2011). The goal of developing a comprehensive geographical political economy of globalization is often hindered by neglect of the legal dimensions of the fundamental instruments and institutions that enable, coordinate and accelerate this process. A notable exception to this has been Matthew Sparke, who has clearly articulated the need to understand how the purported 'deregulation' enabling globalization in fact "depends fundamentally on re-regulation through the creation of new transnational legal regimes" (Sparke 2013, loc. 4784). The deep intertwining of law and markets underscores the need to study both of these elements in their mutually constitutive dynamics. However, much like law, the process of marketization, or market-making, has seldom been the focus of consistent inquiry in studies of globalization.

As an growing number of scholars have noted (Berndt & Boeckler 2012; Çalışkan & Callon 2009; Berndt & Boeckler 2009), while markets are instrumental to the deployment of specific ideologies and mechanisms of exchange, governance and even social relations, their constitution has only relatively recently become focus of critical inquiry. Despite studies of market structures such as monopoly, oligopoly, and networks, often the critical study of market construction is disabled, since this process is seen as ubiquitous, natural, and unproblematic.

The explicitly geographical study of markets has focused on the diversity of actors that are assembled in the process of marketization and the spatial dimensions and transformations of this process. Led by Berndt and Boeckler (Berndt & Boeckler 2009) , this approach has framed the study of markets as socio-technical *agencements* through the examination of three key elements intertwined within them: commodities, agencies and encounters (Berndt & Boeckler 2012, p.9). The interactions between these three elements enable the tracing of market construction processes through space while also showing how these processes can participate in the production

of place. An example of these movements is the physical and discursive translation of a Mexican-grown *jitomate* into a *tomato* ripe for consumption in the United States market, which entails cross-border movement from the farm to the point of sale and a reconfiguration through certification processes and increasingly sophisticated packaging and display practices (Berndt & Boeckler 2012, p.9).

The geographies of marketization research program has done much to draw attention to the geographic dimensions of the sphere of exchange, which had taken a secondary role in light of Economic Geography's long-standing engagement with the sphere of production in the past three decades. This research program also represents an opportunity for the inclusion and analysis of key elements that have been systematically overlooked in the study of markets. In this context, recent contributions in Economic Geography have begun to address Barkan's call for a closer scrutiny of the place of law in economic globalization, some of which has focused on examining market-making processes. The work of Brett Christophers is particularly noteworthy in this area, since he has engaged in depth with the ways in which various bodies of law contribute to define, shape and enact different markets and their geographies. These examinations have explored, for example, the role of antitrust law in creating markets in the television, grocery-retailing, insurance and banking industries (Christophers 2014; Christophers 2013). Furthermore, Christophers has advanced a compelling analysis of the countervailing roles of Antitrust and Intellectual Property law in regulating monopoly powers in capitalism over the 20th Century (Christophers 2016).

One of the key insights produced by this research is how specific bodies of law have the power to directly produce, reproduce, and administer market realities with specific values, priorities and ideologies (Christophers 2013, p.17). This article argues that a more complete understanding of markets requires such insights to be taken seriously and built on in order to

further understand the role of a and their roles in market-making processes. Cumulatively this research holds the potential to enrich the development of a geographical political economy of capitalism that has a more fully integrated understanding of the sphere of exchange.

This article contributes to this program by exploring the construction of digital geographic information markets through the role of Intellectual Property regimes. Digital geographic information holds enormous strategic, practical, and operational value for states, firms, and individuals. Furthermore, in a networked environment, this type of information has become fundamental in connecting information flows with particular locations, and reconfiguring digital economies by bringing their geographic dimensions to the fore.

In this context, it is necessary to understand how geographic information is produced and how markets for its circulation are constructed. To do this, the next section discusses two alternate framings of geographic information markets. Each of these framings describes the relations between actors and how they structure the production and circulation of value. These are the linear and the networked approaches, which have been deployed in the literature (Lopez 1998; Crompvoets et al. 2010) as analytical tools to conceptualize different configurations of geographic information markets. Once they have been introduced, the article then mobilizes these two framings to analyze how the Intellectual Property regimes contribute to the spatial constitution of geographic information markets in the United States and the European Union.

2 Framing geographic information markets

Given the costly and large-scale enterprise required for the production of geographic information, compounded with the slow return on its investment, states have traditionally been

the main actors in charge of the production of this –arguably public– good. In order to finance the production of geographic information, states put in place policies that range from the recovery of costs to the pursuit of profit. Due to the scale and complexity involved in managing territories and populations, states are internally differentiated organizations. This institutional diversity plays a crucial role in shaping the production of geographic information for a wide range of purposes and uses.

The general goals of the state with regards to geographic information can be understood as the development of five primary functions, each covering a range of practices and activities: management and bookkeeping, service provision, security, commercialization, and public communication and accountability. These functions are organized in the table below along with some examples of specific practices:

General state function	**Specific practices**
Management and Bookkeeping	census collection, surveying, cadaster, asset management, tax collection
Service Provision	Direct: infrastructure, social and economic policies, public health programs, public security
	Indirect: creation of new knowledge through research and open data policies
Security	foreign and domestic surveillance, military operations, geopolitical strategy
Commercialization	direct commercialization or through partnerships with the private sector
Public Communication and Accountability	E-government, transparency

Table 1. Use of geographic information for state general functions and practices.
Source: Author

The operational importance of geographic information has enabled the production of this good to become generally nestled within those parts of the government that allow it to continue unabated throughout the ebbs and flows of electoral or administrative changes and priorities. As Lopez points out, the production of geographic information usually (though not always) takes

place in agencies and dependencies shielded from voter preferences, which additionally gives them more latitude to set charges for these products (Lopez 1998, p.43). In spite of this stability, however, does not make it immune to internal shifts in priority within government of broader reallocations of government functions, such as those experienced under neoliberal reforms.

Given the historical dominance of the state in the production of geographic information, it would be tempting to overstress the way in which this sphere has internalized the development of markets for this good –with the government as both main producer and consumer of this good, and where distribution beyond its bounds was not only discouraged, but in many cases forbidden, as in the case of various types of classified information. While this characterization sheds light on the circulation channels of geographic information within the state, it nevertheless minimizes the persistent role of independent contractors, experts, tradespeople, innovators and entrepreneurs that helped develop and commercialize standards, machines, technologies, products and geographic and cartographic knowledge that have contributed to the production and circulation of geographic information, and to the development of geographic information markets (Brückner 2006).

While states have been the de facto (and often de jure) centers of the geographic information economy, it is important to acknowledge that today's increasingly diverse geographic information markets have precedent in the private, individual and collective enterprises whose pioneering efforts in data collection and representation predated (and in many ways made possible) the current age of Big Data and digital technologies (Headrick 2000; Thrower 2008).

Depending on the conditions of production and distribution, geographic information can be a market commodity, a public good and a community-produced resource. In this context, regulatory and legal frameworks play an important role in establishing the boundaries of formal markets. This article explores how one type of these frameworks, Intellectual Property regimes,

contributes to the spatial constitution of digital geographic information markets. Below I examine two different framings of how digital geographic information markets are enabled, constrained and spatially constructed through their interactions with Intellectual Property regimes. These two framings are the linear (Lopez 1998) and the networked (Crompvoets et al. 2010) approaches. The linear approach relies on a description of the main actors in the market, their arrangement in a sequential process of production, value-adding, and commercialization of geographic information. The networked approach, on the other hand, sees the market as a non-sequential networked process involving human and non-human actors whose configuration cannot be reduced to discrete roles and where the addition of value cannot be directly traced . An overview of these framings is provided below.

2.1 The linear approach

In examining the spatial constitution of geographic information markets, this article focuses on the role of the state in the production of geographic information. In this context, it is fitting to begin by discussing an approach that has privileges the role of the state as originator of geographic information. The linear approach to geographic information markets presented by Lopez (1998) is characterized by the role of government agencies as the main producers of this good. This approach posits that the production of geographic information is usually financed through taxation due to the high fixed costs. The initial goal is to satisfy the immediate informational needs of government. This information, such as topographic maps and census data, can have extensive coverage and varying degrees of granularity, tailored to particular governmental functions, rather than the needs of individual users. However, after these informational goods satisfy initial government requirements, they can go through successive

transformations where value may be added by other (usually private) actors and targeted a wider range of end users. The types of Intellectual Property protections that regulate this production process are important in determining the possibilities of transformation and commercialization of informational goods.

This next stage, identified in the linear approach to market framing is the process of value addition. It is at this point that for-profit and non-profit intermediaries intervene to add value (both commercial and non-commercial) by enhancing and customizing government-produced geographic information to meet the needs of end users. While this activity can be a product of the combination of different datasets from a variety of sources, it must conform to the information policies and follow the established Intellectual Property framework of each particular jurisdiction. Throughout the value-adding process, which can consist of one or several iterations, geographic information is continuously transformed through enhancement, refinement, or recombination. The output of this process is varied, including goods that can circulate inside markets or in other circuits, such as information commons.. Once the value adding process is complete, the final product is distributed to end-users, who can be private firms, individuals, the public at large, or even government institutions.

The dynamics of value-adding in the GIS industry as depicted by Lopez suggest that the number of spatial data vendors increases over time. In the first stage of production, the number of vendors will be equal to the agencies in charge of producing geographic information. This is because the latter also undertake the role of vendors to distribute their informational goods. When this information is distributed, the channels of data access are broadened from government-only to include non-government actors. This implies the possibility of value-added processes by an increased number of actors and the consequent growth of the geographic information industry. Two requirements for this broadening dynamic to take place are "minimal

Intellectual Property impediments" and "low marginal costs for raw government data" (Lopez 1998, p.51). Just how "minimal" those requirements are and what shape they take is in large part determined by the Intellectual Property regimes, themselves codified in frameworks that regulate the commercialization and ownership of this resource.

The control retained by the government over the information has a strong influence over the shape of the market. The linear approach to geographic information markets conceives of two models, premised on different dissemination strategies: the proprietary dissemination model and the open access model. The proprietary model consists of the government claiming ownership of the information it produces and controlling its dissemination through the enforcement of copyright through license fee agreements (Lopez 1998, p.54). Through this strategy the government can recoup some of the production costs, which are passed on to intermediate and final consumers. An important consequence of this that the government retains a high-degree of control of the information it produces while simultaneously competing in the market for revenues from its sale. This may cause conflict between the stated priorities of government programs and the need to generate revenue (and the possibility of profit) through market competition (Lopez 1998, p.54). However, in neoliberalized states this becomes less a conflict and more a sign of increasingly entrepreneurial forms of governance. Additional downstream effects of this arrangement can include barriers to entry created by the control of the information. These barriers in turn can have chilling effects on the development of informational goods and services (such as mapping or satellite imaging) as well as transparency and information access. Alternately, they can push the private sector to undertake their own efforts to collect primary information.

The open access model, by contrast refers to the government placing on the public domain the information it produces without claiming copyright over it and making it available

for the marginal cost of dissemination or less. This model facilitates the use and circulation of the information by actors outside the government, as well as its transformation into value-added products and services (Lopez 1998, pp.55-58). The open access model relies on the provision of government information as a primary input for the creation of markets, but foregoes the claim of ownership. This ensures the government's role in subsidizing the production of geographic information products as raw materials for the unimpeded addition of value by other actors.

The main distinction between the open access model and the proprietary model is the property regime adopted by the government with respect to the information it produces, along with the source of financing necessitated by said regime. In the proprietary model, the government operates on short time horizon by aiming to recoup the costs of production through licensing fees. This time horizon is determined by how the government intends to recoup the costs of production through the direct sale of the goods. On the open access model, the time horizon is longer, as the production is subsidized and the recuperation of costs takes place indirectly through the taxation of economic activity catalyzed by the subsidy to its inputs (Lopez 1998, pp.55-58).

A crucial aspect of the organization of geographic information markets is the production of value, its enhancement, distribution, and appropriation by a diversity of actors. Often this process has been modeled as a sequence of distinct stages of organization, synthesis, judgment, and decision that whereby data are incrementally transformed into information, knowledge, productive knowledge and, finally, action (Taylor 1982). This vision of a sequence of value-addition processes is analogous to the linear market model discussed above, since they are both premised on a discernible order to the arrangement of actors and a hierarchy of actions and outputs in the market. In the next section I introduce an alternate approach to market framing

that does not rely on the sequential process of value addition, while offering a greater degree of analytical flexibility: the networked approach.

2.2 The networked approach

While there is analytical purchase in identifying a general process of value creation and transformation, the assumptions of linearity and discreteness are not easily satisfied in actually existing markets –particularly in the increasingly diversified informational environment characteristics of the digital information markets, where government-produced information coexists with multiple kinds of user-generated information. Value does not necessarily take place through a linear, incremental and sequential process, but can arise from multiple and changing possible configurations, which themselves can lead to diverse market formations. The linear approach presented above has at its core the role of the government as the main producer of geographic information and the successive addition of value by other actors throughout the production chain.

Even though it is true that governments have been (and continue to be) the principal providers of much geographic information, this arrangement should not be seen as exclusive or static. In fact, the place of government at the source of geographic information has experienced a broader systemic shift in the past decades as part of political reorganizations between state and market under neoliberalism (Leszczynski 2012). Recent developments, both institutional (such as open data initiatives) and technological (such as location-aware mobile technologies, web geospatial platforms and social networks) have diversified the production of geographic information, enabled a number of other actors to produce unprecedented amounts of geographic information.

The rise of globally powerful data-driven firms, such as Google and Facebook, and the surge of volunteered geographic information are indicative of a new environment for the construction of information markets. In this new environment, markets are not developed in linear fashion starting with government production, but through complex networks of user communities, firms, volunteers, data brokers and non-governmental organizations. These networks may include the government agencies as actors in the roles of producer and/or producer, or bypass them and develop outside the government sphere altogether. Some digital goods may also enter into complex relationships of competition and collaboration with government produced informational goods. One such example is Google Maps, which uses government maps as the base layer to develop dynamic and interactive products that often compete with analogous online government geographic services.

These complex configurations present at least two conditions that are not easily captured by the linear market model. Firstly, the creation of value –to the extent it takes place in these networks–, cannot be traced in a sequential fashion from data to information to knowledge and action, or from an exclusive point of origin of government production. Geographic information is construed and valued differently by different actors through individual spatial perception, cognition and sociospatial positionality. With the continuous addition, transformation and intermixing of sources, formats and media that characterize geographic information in digital markets it becomes increasingly clear that to trace this valuation in a linear, incremental manner also implies important trade-offs in understanding this process. The second consequence is that the interconnections able to gather massive pools of human and machine labor may be used for many activities that can both meet and exceed the governing logic of the state as well as the profit-seeking logic of market actors. These activities, which could include community-building, disaster relief, gift-exchange, piracy, interpersonal communication, and scientific enterprise, are

not premised in the creation of economic value to the same degree –or even in the same way— as markets..

To address this complexity, Crompvoets et al (2010) have proposed a networked approach to understanding geographic information markets. This departs from Lopez's linear approach by conceptualizing the geographic information environment as a sociotechnical practice that involves human (buyers, sellers) as well as non-human actors (computers, algorithms). Furthermore, the *networked* aspect of this approach is not premised on the use of networked technologies (Lopez 1998, p.145), but on the web of relations established between different actors in the process of handling geographic information (Crompvoets et al. 2010, p.97). This move de-centers the role of the government (or any one actor). Instead of presuming a diffusion pattern for geographic information, this is open to multiple configurations through which value may be added in non-sequential paths.

These arrangements bring to light the increasing diversity of the digital geographic information economy and its mixture of markets and non-markets. In light of this increasing diversity, it should be noted that neither the networked nor the linear approaches should be taken as pure forms in a dichotomy, or corresponding to specific historical/geographical cases, but rather as heuristics useful to identify competing and coexisting logics of organization in digital geographic information markets. These specific configurations are to a great degree contingent on the role of the state in the production of geographic information at particular places and times.

For example, the network approach could also be applied to understand the production of information in contexts that predate the emergence of the social and interactive Web 2.0 in the mid-2000s, which would shed light on the complex interrelationships between government agencies, private contractors and user groups in the production of geographic information.

However, it is clear that geographic information today is increasingly made up of webs of relations that transcend the government and do not have a strictly sequential arrangement. Nevertheless such networked systems remain significantly shaped by the governance frameworks that apply in each particular jurisdiction. As suggested in the linear model, the difference between proprietary and open data regimes has important effects in the configuration of markets for geographic information. The influence of property regimes and governance frameworks more broadly continues to be fundamental to the construction of markets, regardless of the framing used to understand them. This influence is not deterministic, but rather dependent on the configurations of interaction between actors in particular sociospatial contexts across a multiplicity of scales.

In some places most of the collection of geographic information may take place at the local level. This activity would have to adhere to national regulations, which themselves often may have to comply with those at the supranational governance level –at least in the case of countries signatory to particular treaties. In the following section some of the key features of two globally influential jurisdictions (the US and the EU) will be examined with a focus on Intellectual Property regimes. This will provide an opportunity to examine not only the different rules that shape the production and dissemination of geographic information in two of the largest markets for this good, but how they structure the relationships between actors and contribute to the spatial constitution of these markets. Specifically the next section examines how intellectual property protections, commercialization friendly legislation, and spatial data infrastructures interact to create the conditions for the development of jurisdiction-specific geographic information markets.

3 The spatial dimensions of Intellectual Property law

The two approaches presented above suggest how different configurations in geographic information markets can come together. The key source of variation in these approaches is the role of the government as producer and how this affects its relations to other actors in the market. However, beyond its role as producer, the government has an expanded role in setting the legal and regulatory frameworks that define transactions within a market. This has important implications for the configuration of the geographic information market as well as the derived benefits from the information produced. One of the most salient effects of these governance frameworks is the spatialization of information, or the construction of boundaries and spatial structures for the circulation of information within markets. This aspect, however, is often obscured when information is seen as disembedded from material, local or place-based sources.

Intellectual Property regimes explicitly delineate the capacities of government and private actors over the information produced and their potential market actions over it. The contours of particular Intellectual Property regimes are thus crucial for the relations between these actors and the configuration of geographic information markets. As Scassa and Fraser Taylor have pointed out, "IP law defines and influences the relationships between producers and users of geospatial data" in a number of important ways which include the definition, formats and operations of spatial data infrastructures, the quality and collection of geographic information, and the deployment of licensing agreements (Scassa & Fraser Taylor 2014, p.79). Two key inflection points at which Intellectual Property regimes intervene in the spatial constitution of information markets are pricing and dissemination policies. Taken together these two instruments articulate jurisdiction-specific property regimes, which determine allocation of rights over information and the relations between actors in the market. These instruments thus shape the range of

interactions and possibilities for geographic information as a resource and market commodity. This part of the article explores how this takes place in the context of the United States and the European Union by outlining key elements for the Intellectual Property legal framework of each jurisdiction.

Until recently the production of large scale geographic information had taken place within the sphere or under close scrutiny of governments. The recent proliferation of large data-driven firms and volunteered geographic information has recast the scope and configuration of some of the regulatory mechanisms for the commercialization of this good. In this context, by providing legal tools for regulation and enforcement, Intellectual Property of geographic information has been heavily focused on problems associated with the ownership and commercial exploitation of government-produced geographic information or the addition of commercial value to this resource. The new geographic information ecosystem brings an important shift to the role of Intellectual Property in the creation of markets. One key point in this respect is the fact that the growing diversity of data sources intensifies the existing issues with legal interoperability presented by multiple licenses (Scassa & Fraser Taylor 2014, p.87). This problem has important spatial dimensions where separate legal regimes often apply to different scales of governance and administrative bodies..

In the United States legal interoperability does not pose a large problem for the construction of geographic information markets when it comes to information produced by the federal government. There are legal and technical reasons for this. On the legal side, the designation of 'government works' to information produced by the Federal Government places it in the public domain. With regards to technical factors, the development of standards by federal agencies such as the Census Bureau and its role in the development of topological editing in the 1960s and 70s, led to the widely used standard TIGER files in the 1980s (Cooke 1998), which

greatly increase interoperability of geographic information. At the subnational levels, however, different legal regimes apply to the geographic information produced by states and municipalities, many of which assert property rights over it and choose to commercialize it directly.

In the European Union, legal interoperability is one of the key challenges in establishing a European-wide geographic information market due to the fact that each member state must negotiate levels of governance at scales from small (with subnational administrative unites, such as *Länder* in Germany, or *comunidades autónomas* in Spain), to large (i.e. the requirements for standardization imposed by the European Commission). Technical interoperability is feasible through initiatives such as INSPIRE, which seeks to establish a EU-wide spatial data infrastructure through uniform standards of production and reporting of government information for policy-making purposes. However, the challenge of legal interoperability makes it difficult for this initiative to be leveraged for commercial purposes and towards a EU-wide level information market, since Intellectual Property regimes of government information impose hard limits to commercialization that may vary with the specific provisions of each member state.

Interoperability (both in legal and technical terms) enables the possibility of recombining datasets, products, and services, which in turn allow for the production of value in geographic information markets. This is why the potential lack of interoperability between information produced at different sources or scales limits the spatial constitution of the market as well as the scope of products that can circulate through it. In fact legal interoperability brings to the surface the relatively territorialized nature of many geographic information markets. Since the largest providers of geographic information have been governments, who are tasked with producing information explicitly focused on their territory, the value-adding activities of intermediaries have

been limited by the Intellectual Property regimes and other information policies prevalent in their respective jurisdictions (Onsrud 1995).

Whether a government at a particular scale adopts a proprietary or an open access property regime can affect the number of participants in the market, since this shapes the barriers to entry and thus the possibilities of interaction, recombination and intermediate stages of value addition that can happen within that space. For example, in jurisdictions with open an access model, the barriers to entry are lower and actors of various sizes can participate in the market and compete on the basis of quality and innovation. .In the United States this means that companies can use information produced by agencies such as the Census Bureau, the USGS and NOAA and add value to it by developing products for sale in the national market. However, first movers can also create barriers for others, so the lower barriers provided by the open access model represent only one of the factors shaping access to the market. Another factor to consider is that the barriers to data access do not necessarily equal entry barriers to the market. While an actor may have open access to data and the openness to commercialize it, the knowledge, technology, and know-how to transform them into secondary applications may be more difficult to come by.

On the other hand, firms participating in markets regulated by a proprietary model may face high costs in order to enter in the market due to the barriers to entry posed by the acquisition of data from the government. This may decrease competition by allowing only firms with enough resources to enter the market. While expanding their operations to cover larger markets could represent a potential increase in profits, incurring additional costs by acquiring foreign datasets in the face of uncertain market conditions may be prohibitive for most actors. Thus Intellectual Property regimes, by enforcing particular conditions for the acquisition and

transformation of data, also outline a territorial logic that maps onto the spatial constitution of markets through the deployment of economic dis/incentives.

Another way in which Intellectual Property regimes shape the spatiality of markets is by incorporating in their transactional patterns the territoriality of their home jurisdictions. This becomes relevant when market actors encounter each other outside said home jurisdictions, such as an Internet firm based in California doing online business in France with servers hosted in Singapore. The actors who operate in a market defined by a jurisdiction whose government adopts an open-access model will be in a position to internalize savings that may enable them to make investments in new markets. On the other hand, actors in a jurisdiction dominated by a proprietary model may face higher costs to expand outside of its boundaries due to the up-front costs of acquiring informational inputs.

With regards to the products in the market itself, the collection of information by the government responds to priorities about its needs and the kinds of information that can satisfy them. This can shape the types of information collected as well as what can be done with it by intermediaries. Thus a market developed on the basis on geographic information produced by a government agency within a particular jurisdiction may be shaped by the informational priorities of said agency. The Intellectual Property regime would in turn limit and define how these products can be recombined, enhanced and commercialized. This is particularly the case in activities that are restricted by law to the use of authoritative sources of geographic information, such as surveying, land claims and boundary-making (Scassa & Fraser Taylor 2014, p.81). In these activities what is considered to be authoritative is ultimately vetted by the state, underscoring implicit territorial biases in the government's collection and use of geographic information (Wainwright & Bryan 2009). These possibilities will be examined in greater detail by discussing the key elements of the Intellectual Property regimes in the jurisdictions of the United

States and the European Union with relation to the spatial constitution of geographic information markets. Specifically the following sections will focus on Intellectual Property Protections, commercialization-friendly legislation, and spatial data infrastructures as building blocks of the spatial constitution of geographic information markets in the United States and the European Union. The market framings provided above offer a lens to understand how these building blocks come together in specific configurations in the two jurisdictions discussed below.

3.1 The United States

This section provides a brief overview of three key building blocks of a legal framework structuring the spatial constitution of geographic information markets in the United States. This framework enables the commercialization and privatization of geographic information by incentivizing private sector participation through copyright protections, opening access to data, and ensuring role of government as supplier while limiting its role as competitor in the market. Each of the three selected building blocks emphasizes a complementary aspect of the construction of the geographic information market by the United States Government within its jurisdiction: (1) Intellectual Property (Title 17 of the United States Code), (2) commercialization (Land Remote Sensing Policy Act of 1992), and (3) infrastructure (Plan for the National Spatial Data Infrastructure).

Together these and other policies, initiatives, and technologies articulate a broader regulatory environment that ensures the continued production and fosters the commercialization of geographic information. While these elements refer to a range of elements from paper maps to databases, satellite imaging and reporting standards, ultimately they come together as the scaffolding that bounds the role of the state and regulates the interactions between actors in the

market, as well as the possibilities for commodification of geographic information produced by the United States Government.

(1) Intellectual Property : Most information produced by the Federal Government is in the public domain under the category of government works. This includes the geographic information produced by federal agencies such as the Census Bureau and the USGS. Geographic information that is outside of this category, whether produced by private actors or subnational governments, is regulated under Copyright Law. Title 17 of the United States Code is also known as the Copyright Law of the United States. Geographic information products such as maps, globes, and charts are explicitly included among types of information protected by this statute as part of the broader category of "pictorial, graphic, and sculptural works" (US Copyright Office n.d.). This grants the author a monopoly over the commercialization of these products for at least 25 years, and up to lifetime plus 120 years (Copyright Office 2011). While maps have traditionally been fundamental to geographic information markets, their digitization is changing their very nature as well as the protections that apply to them. In geographic information markets characterized by big data, digital information networks, and geographic information systems, maps have become more valuable for their underlying data than for their graphical or pictorial form. These data can be extracted and recombined into new products, while the graphical output can be automated.

The emergence of digital maps has thus caused a disjuncture in the protections granted to these products because the databases they contain are a different category of information than the graphical output. Since databases are considered to be compilations of facts, rather than works of original authorship, they are not protected by United States Copyright Law. This has led intermediaries to seek other types of legal remedies (such as contracts specifically crafted to

protect individual products), leading to a patchwork of ad hoc protections in geographic information markets left to be resolved by the lower-level courts (Karjala 1995).

(2) Commercialization: The second building block of this legal framework is the Land Remote Sensing Policy Act of 1992. This act reined back some of the commercial thrust of the Land Remote-Sensing Commercialization Act of 1984, which prioritized the commercialization of satellite imaging in the United States. The 1992 act had a central role in preserving the availability of remotely sensed data for public interest while simultaneously managing the construction of a market for remotely sensed data (Gabrynowicz 2005, pp.59-60) through three key actions (a) it secured the role of the United States government (initially through NASA and the Department of Defense) as managers of the *Landsat* program, (b) explicitly required the "support for developing the commercial market for remote sensing data", and, (c) placed the value-added activities in the exclusive realm of the private sector, thus keeping the government in the role of producer, while also allowing for the licensing of private remote sensing space systems (Rep Brown 1992).

These conditions explicitly limit the role of government in the market to the production of information, lower the barriers to entry by private actors both in the stages of production and value-addition and facilitate the creation of a new market by ensuring the continued supply of low-cost inputs for producers within the United States. In 2003 the Commercial Remote Sensing Policy once again accelerated the trend towards greater participation of the private sector in the remote sensing market (particularly by private satellite imaging companies).This policy reduced the role of the government as producer and fostered the outsourcing of imagery collection to U.S. based private firms to meet basic government needs (Williamson & Baker 2004).

(3) Infrastructure: The third building block is Executive Order 12906 of 1994, or the Plan for the National Spatial Data Infrastructure. This was an initiative by the Executive branch

aimed at establishing standards, protocols and timelines for the coordinated production, collection and circulation of geographic information by geographic information agencies of the United States Government. This Plan established a national-level data clearinghouse coordinated by the Federal Geographic Data Committee, funded by the Department of the Interior and to which all agencies at state, local and tribal levels would contribute data in standardized forma, with the objective of making it widely available to the public under a public access information property regime (Clinton 1994). This, along with the two building blocks mentioned above and other pieces of legal architecture had the effect of securing technical interoperability and smoothing out interactions between actors in the United States geographic information market.

While these three building blocks are particularly significant in building the geographic information market in the United States, they are part of a broader architecture built over the years through the interactions between government, firms, non-governmental organizations and the public at large. This architecture relies on a notion of "commercialization" equated with private sector participation, while the government's role is that of a producer and regulator (Gabrynowicz 2007, p.15). The role of the government as producer can be understood in terms of the linear market approach, which privileges the centrality of this actor in the geographic information ecosystem. On the other hand, the networked approach can shed light on the network of market relations established by sub-contractors and government organizations in the production of this good –particularly as some pieces of legislation have increased the space for private participation. This reorganization of the role of the state in the market is consistent with broader governance shifts under the aegis of neoliberalization in the United States characterized by a turn towards increased participation of private actors and the marketization of public goods and services.

In this respect the legal and regulatory architecture discussed above has been successful in achieving the aim of fostering the growth of a geographic information market in the United States. However, this development has resulted in part from a reduced role of government agencies in the production of geographic information. As some researchers have argued, this has come at the expense of the public provision of geographic information (Johnston & Cordes 2003) and affected critical uses of these products, such as scientific research, which are often not competitive in the terms established by the market. While delivering a wide array of options, the growth of the market in this case has not necessarily meant lower costs or unambiguous benefits for all users. The European Union is a jurisdiction that, unlike the United States, must coordinate national governments in the production and regulation of geographic information. While there are initiatives to develop a regional geographic information market, these face important challenges related to the multi-level governance that characterizes the European Union. The next section provides an overview of three key elements in the legal framework and the market construction for geographic information in the EU.

3.2 The European Union

As in the United States, the legal framework for the geographic information market in the European Union seeks to harmonize law and policy in order to coordinate production and distribution of this good. While in the United States there have been important and explicit drivers towards the commercialization of geographic information (such as the Remote Sensing Act Commercialization Act of 1984 and subsequently the Policy of 2003), in the European Union this has been a secondary aim. The developments towards a constructing a market for geographic information in the European Union have come after the need to harmonize and

standardize the production of this resource for the primary aim of policy making at the regional level. It has been once these initiatives are underway that the view towards leveraging them for market-making purposes has been considered more seriously. The following three key building blocks address the aspects of (1) Intellectual Property (European Commission Database Protection Directive of 1996), (2) infrastructure (the European Commission INSPIRE spatial data infrastructure Directive of 2007), and (3) commercialization (2015 Digital Single Market Strategy for Europe). It should be noted that the order of the latter two elements is reversed from the case of the United States discussed above. While Intellectual Property protections of geographic information (particularly databases) are discussed first in both cases due to their chronological antecedence, in the case of the European Union this is followed by infrastructure, because this priority has taken precedence over commercialization at the regional level. The reasons behind this priority reveal as much about the progress of the European Union in terms of data harmonization as they do about the challenges of building a regional-scale geographic information market. The three building blocks presented below outline a legal architecture of the European Union and its broad characteristics.

(1) Intellectual Property: The first building block is the Database Protection Directive of 1996, by which the European Commission established the protection of databases as objects of Intellectual Property. This protection is not absolute, and is contingent on criteria such as independent, systematic collection paired and substantial investment, which can be determined qualitatively or quantitatively. However, these thresholds have proven to be quite low, which has led private actors to file for the protection of databases which have very little creative input. This in turn has contributed to the erosion of the public domain, rising costs of innovation and scientific research, as well as a rise in opportunistic infringement lawsuits (Maurer et al. 2001). While Intellectual Property rights are generally deployed as a way to foster innovation and

develop markets by providing temporary monopolies, the opposite has been the case with the EC Database Protection Directive because users find it increasingly difficult to access informational inputs, which have been fenced off through the use of database protections. This affects in a particularly acute way the construction of a market for geographic information, given its increased reliance on databases of names, places and other location-based features, which are increasingly at risk of becoming monopolized under this Intellectual Property regime.

Unlike the database protection directive discussed above, which is commercial in nature, the initiatives to build a European Spatial Data Infrastructure have derived from efforts conducted largely in the scientific sphere. Here the impetus has been to develop standards and information infrastructures for high-quality and uniform data reporting for policy-making with a particular emphasis on environmental policy. While INSPIRE, the Spatial Data Infrastructure launched by the European Commission in 2007 (discussed below), has advanced uniform data reporting and technical interoperability, legal interoperability remains an important challenge. The coexistence of territorial jurisdictions and multiple scales from the regional to the national and the subnational, with different Intellectual Property regimes, degrees of openness and priorities make it very challenging for a market to be constructed mostly on the basis of technical compatibility.

This is a political aspect that reflects the more general challenges of multi-level governance structures, is not unique to the geographic information markets. Similarly, it is not an issue likely to be solved through any action undertaken within these markets. A challenge for the construction of geographic information markets in the European Union has been the narrower definition of "commercial" used in this jurisdiction. In this case, this mostly focuses on "what" can be done with the data, that is, on licensing specific uses or activities, not on "who" the relevant actor is (Gabrynowicz 2010). This contrasts sharply with the dominant conception of

"commercial" in the United States geographic informaiton markets, which is equated with participation by actors in the private sector.

Compounding this, governments in the EU have a history of proprietary models, which create barriers to entry for market actors and tend to favor established ones who can afford high licensing fees. While open data campaigns are changing this, the efforts of civil society and the actions of geographic agencies in opening information repositories are limited by the Intellectual Property regime in each member state, many of which are characterized by the government's ultimate ownership of the information.

(2) Infrastructure: The second building block of the spatial constitution of geographic information markets in the EU is the INSPIRE Directive of 2007. This directive outlines the characteristics, goals and operations of the European Spatial Data Infrastructure. This project is coordinated by two of the European Commission's Directorates Generals: DG Environment on the legislative and policy sides and DG Joint Research Centre on the technical side (European Commission n.d.). The objective of this process is for all EU member states to harmonize reporting of data, metadata and full interoperability of spatial data services. The European Commission has established a timeline of 11 years (2010-2021) for INSPIRE from its first to last milestones (European Commission n.d.). In spite of the challenges in negotiating implementation between member states and sub-national administrations, INSPIRE has made important progress in standardizing the reporting and availability of geographic information across Europe. However, the priorities of INSPIRE lie in the collection of information for policy-making, rather than the construction of a regional geographic information market. While there are market actors at the local level that benefit from the increase in data quality and interoperability, this activity has until recently been outside of the purview of INSPIRE. It has only been in the past year that the interoperability achieved by INSPIRE has been leveraged towards the construction

of a regional market in geographic information and other digital goods.. This initiative, known as the European Single Digital Market, is discussed below.

(3) Commercialization: European Commission President Jean-Claude Juncker introduced the Single Digital Market Strategy for Europe in 2015 with the aim of breaking down the technical and regulatory barriers that currently characterize digital commerce in the EU. This is an ambitious strategy that attempts to articulate a wide range of technical, fiscal and regulatory elements required to establish a functioning digital market across Europe: from rules on contracts and consumer protection, to parcel delivery, geo-blocking, copyright, taxation, and interoperability (European Commission 2015). Part of this strategy stems from the territorial bias in digital markets where the vast majority of transactions take place within national borders of member states and only 4% of online services cross borders (European Commission 2015).

While the Single Digital Market Strategy is currently one of the priorities of the European Commission, it is not yet clear how this market-making exercise will play out. Internal obstacles to this project, such as lack of regulatory interoperability and multi-level negotiations between and within member states, are compounded with external ones, such as the resistance to regulation of US-based market leaders (like Google and Amazon), and the objection of the United States to the possibility of trade barriers around Europe.

At this point it seems that the progress made by INSPIRE towards the interoperability of geographic information can present a template for the daunting task of implementing a single digital market in Europe. However, even if the strategies for the standardization of geographic information prove useful for this project, it is unclear that the establishment of such a regional scale digital market will expand the market for geographic information. Perhaps more than other digital goods, the markets for geographic information –particularly in Europe– continue to be territorialized due to factors such as the localized nature of the information, the predominance of

proprietary Intellectual Property regimes, and local requirements for authoritative geographic information (such as cadastral data), which is often produced by government agencies. The Single Digital Market Strategy is an attempt to leverage the advances in pan-European harmonization by INSPIRE into the explicitly commercial domain of the digital economy. Part of this strategy is to incorporate gains in efficiency (such as e-government portals) into the development of a regional scale digital market that includes but transcends government-produced information.

The current state of the geographic information markets in the European Union can be characterized internally as reminiscent of the linear approach due to the centrality of the government in the production of this good and the prevalence of proprietary information regimes. Within each member state there tends to be a hierarchical structure characterized by government controls of information flows through proprietary regimes and supply it to intermediaries on the basis of licenses. While there is an increasing constellation of actors within each of these markets, and open data initiatives are fostering an expansion in the types of transactions, the Intellectual Property protection have interrupted this process. On the other hand, at the European level the networked approach can characterize the multiple relations, transactions and negotiations that have taken place in the construction of the INSPIRE spatial data infrastructure. The Single Digital Market strategy seems to be an attempt to recast the information market (and the geographic information market along with it) at the regional level with ambitions that tends towards a networked approach. It remains to be seen how this strategy would approach the interscalar negotiations and territorial biases, and property regimes characteristic of each national and subnational market.

4 Conclusion

This article has argued that legal frameworks, and in particular Intellectual Property regimes play a crucial role in the spatial constitution of markets. This argument is built on the premise that on the general level, the law is constitutive for market creation because it both defines and regulates the interactions between market actors by defining their terms and bounding the market spatially and operationally. In addition to this, the law adapts to market outcomes and, in being shaped by them, also regulates their future development.

Digital geographic information has become a crucial resource in the digital economy due to its high value and broad range of applications from logistics to military strategy, public health, and advertising. While these applications transcend the uses of the state, the role of this actor has traditionally been at the center of the production and distribution of geographic information. However, resulting from rounds of de/re regulation in recent decades, the expansion of digital networks, and new practices of data collection (such as user-generated data) new configurations of geographic information markets are emerging.

In order to examine the process of spatial constitution of geographic information markets, the article introduced two alternative framings of geographic information markets: the linear and the networked approaches. While any market can be understood through each of these approaches, they highlight different aspects of market constructions: the linear approach centers on the role of government and the sequential addition of value by intermediaries. On the other hand, the networked approach considers the market a sociotechnical process where actors produce and enact value in different non-sequential ways. Markets analyzed using both of these framings are shaped by the property regime governing the information within them: proprietary or open access. These two market framings were then deployed in combination to uncover the

spatial constitution of two geographic information markets through key elements in their Intellectual Property regimes: intellectual property protections, infrastructure and commercialization in the European Union and the United States, two particularly salient cases due to their influence in the creation of global regimes of information policy, as well as the size and potential development of their digital information markets. In the United States an open data regime characterizes the geographic information production at the federal scale, while the subnational scales and private producers are regulated by Copyright Law. This creates conditions for a market that can make use of a large volume of informational inputs free of cost. On the other hand, in the European Union, the prevalence of proprietary regimes at the national scale has created difficulties for the transnational commercialization of geographic information produced by governments. These barriers set by national Intellectual Property regimes stand in contrast with the technical advances in interoperability made by projects such as INSPIRE, a tension that complicates the construction of the proposed European Single Digital Market.

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Part II

Chapter 4. Interoperability and the EU Digital Single Market: a geographic information perspective

Abstract

This article examines the recent initiative by the European Commission to build a territorially unified digital market spanning the entire European Union. The analysis is centered on two interrelated factors shaping this initiative: technical and legal interoperability in the transactions between agencies in the EU, its member states, and their subnational divisions. These factors are examined in the context of the digital market for a specific good: geographic information in the European Union and three of its member states: the UK, Germany, and Spain. The article examines the development of this market from the perspective of an initiative taken by the European Commission as the blueprint for its construction: the Infrastructure for Spatial Information in the European Community (INSPIRE). This analysis illustrates the technical and institutional mechanisms, the range of outcomes, and the potential challenges and implications of building a general-purpose single digital market in the European Union. The article argues that, while digital information markets ostensibly aim to 'flatten space' and overcome geographical barriers, their very constitution is the result of particular sets of policies, institutional features, and

political negotiations that require both technical and political agreements to achieve integration across multiple scales of territorial jurisdictions.

1 Introduction: Geographic information and the Digital Single Market

The Digital Single Market is one of the ten political priorities of the European Commission, a key priority for the European Council, and a highlight of the 2015 Annual Growth Survey produced by the European Parliament (European Commission, 2015, p. 3). This initiative aims to unify the different territorial markets from member states in areas related to digital and online goods and services. The European Commission has defined it in the following terms:

> A Digital Single Market is one in which the free movement of goods, persons, services and capital is ensured and where citizens, individuals and businesses can seamlessly access and exercise online activities under conditions of fair competition, and a high level of consumer and personal data protection, irrespective of their nationality or place of residence. […]. A fully functioning DSM will present European businesses, particularly small and medium-sized enterprises (SMEs), with a potential customer base of more than 500 million people, enabling companies to make full use of ICT to scale up for productivity gains, creating growth along the way (European Commission, 2015, p. 3).

This initiative comes at a particularly sensitive historical moment for the European project, and is deeply intertwined with the political and economic circumstances emerging out of the post-2008 Eurocrisis. The strategy for the creation of the Digital Single Market, outlined in a 2010 report by Mario Monti, is a direct response to the request of the President of the European Commission, José Manuel Barroso, for "inputs for an initiative to relaunch the Single Market as a key strategic objective for the new Commission" (Monti, 2010, p. 4). As Barroso characterized it, this initiative came at a time where the ongoing European crisis had prompted a temptation to

roll back the Single Market which, he argued, had yet to reach complete integration and deliver its full potential (Monti, 2010, p. 3).

The Monti report presents the Digital Single Market (DSM) as a way to reengineer one of the central institutions of the European Union: The European Single Market (ESM), established in 1992 to "promote trade, increase competition, and promote European-wide economies of scale and scope by eliminating nontariff barriers, such as difference in taxes, regulations, and health and safety standards" (Fligstein & Mara-Drita, 1996, p. 9). The European Single Market is at the core of the European Union political-economic project and has been able to achieve substantial economic integration among its member states, notwithstanding continuing intra-regional disparities and significant political opposition. However, while this project was intended to be wide in scope, it was envisioned and enacted under historical and technological circumstances that preceded today's widespread digital economy.

While the ESM has advanced the integration of European economies in the two decades since its enactment, this process is in tension with the widespread digitization across sectors and industries. In contrast to trade in physical goods, markets for digital goods and services have coalesced much more markedly along national, rather than pan-European boundaries. The territorial fragmentation in digital markets underscores the particular nature of the digital economy and the inadequacy of the ESM to achieve economic integration in this realm. In an attempt to tackle this fragmentation, the European Commission has explicitly advanced the Digital Single Market to remedy the imbalance between digital and non-digital markets and enact durable regulatory and technical solutions and standards for pan-European economic integration that fully encompass the digital economy.

Devised as a 'package deal' to "relaunch" the European Single Market, the strategy in the 2010 Monti report included a number of initiatives ranging from green growth and resource-

efficiency to labor mobility and service integration (Monti, 2010, p. 8-9). As one of these initiatives, the creation of the Digital Single Market is simultaneously a response to a set of specific drivers, and a solution engineered to produce a widespread multiplier effect throughout the EU.

The first of these drivers is the persistence of barriers to consumers and companies conducting digital commerce across international borders inside the European Union. While the role of distance is smaller than for offline commerce, it continues to hinder digital transactions. Additional factors, such as language barriers and different payment systems hold back the consolidation of a pan-European digital market (Gomez-Herrera, Martens, & Turlea, 2014, p. 93). This is striking given the efforts in the EU towards integration in the movements of physical goods and people, as shown by the relative successes of the European Single Market and the Schengen Area in those categories. However, digital commerce is often regulated by different sets of rules and encumbered by particular technological hurdles that set this market apart from that initially envisioned by the European Single Market.

The second driver towards the Digital Single Market relates to existing imbalances specific to the digital economy, in which European firms in the information sector have an acute disadvantage relative to American firms conducting business across Europe. One important dimension of this lack of competitiveness from European businesses is the check placed on them by the high value of privacy and protection of personal information demanded by publics in the European Union (Schwartz, 2013). This is reflected in EU-wide initiatives such as "the right to be forgotten" (Ambrose, 2013) and widespread popular outcry against services considered invasive, such as Google Street View's massive capture of images and wireless data (Bennett, 2012; Geissler, 2011). These values have inspired regulation in the EU to protect privacy, undermining business models in the digital economy that rely heavily on massive data collection.

However, European firms have been unable to build successful alternative business models based on such values, remaining outcompeted by their market-leading American counterparts (Grumbach, Viola, & Kontou, 2013) .

A third driver is the argument that a unified digital market could catalyze economic growth in the European Union, particularly in the aftermath of the 2008 global recession and the ongoing Eurocrisis. According to the European Policy Centre, the Digital Single Market could bring a minimum 4% increase in the EU's GDP. Beyond economic growth, the Digital Single Market has been advertised as a multifaceted solution with the potential to help address many of Europe's most pressing issues, which range from demographics and climate change, to renewal of public services, education, and labor market inefficiencies (European Policy Centre, N.D., p. 1). The construction of the Digital Single Market as a platform for a broad range of goods, services, and developmental outcomes contributes to explain the central role of this initiative in the European Commission's 2020 strategy as an integral step towards building a "digital society" (European Commission, 2010) .

The diversity of goods and services encompassed by the Digital Single Market, compounded by widespread digitization of the economy, makes it a challenge to provide a comprehensive understanding of its actors, institutions, and transactions. This article aims to provide an account of key dynamics in the construction of this market by analyzing one particular category of informational good –geographic information– examining the institutional and technical scaffolding that shapes its production, distribution, and commercialization in the European Union.

Geographic information products, including topographical maps, digital elevation models, pollution data, cadastral maps, spatial databases, aerial orthophotos, and three-dimensional LIDAR point-clouds, constitute a diverse array of products linked by their

fundamental reliance on geographically referenced spatial representations. Since these products are increasingly produced and distributed in digital form, they are also stored and shared through digital repositories and regulated by policies designed explicitly for that purpose. As the geographic information economy integrates with the Digital Single Market, the former's institutional and technical infrastructure has been viewed by the European Commission, as well as national geographic agencies as a functioning example on which to build the latter.

This article explores the extent to which the lessons from the geographic information economy can be transferred to the Digital Single Market. The focus is on two key mechanisms: technical and legal interoperability. Given its influential role in the construction of the Digital Single Market, understanding the institutions, policies, and technologies articulating INSPIRE provides a vantage point for the integration of other digital goods and services.. Furthermore, due the advances in the development of interoperability in the field of geographic information in the EU, policy-makers have adopted this case as an example of working infrastructures across national borders that can guide the harmonization of the Digital Single Market's technical and institutional configuration (Annoni, 2011).

In the next section I examine the construction of a pan-European infrastructure for the production and distribution of geographic information (INSPIRE). I focus this analysis first, on technical interoperability, and, second, on legal interoperability. In subsequent sections I turn to the specific policies and operations put in place to harmonize geographic information in three EU member states: the UK, Spain, and Germany. I conclude the article by synthesizing these findings and outlining how the development of INSPIRE informs the construction of the Digital Single Market more generally.

2 An infrastructure for interoperability: geographic information in the EU

2.1 Two domains of interoperability

Digital markets in the European Union are still fragmented along national lines due to a combination of factors that include regulatory barriers as well as technical ones (Martens, 2013, p. 8). Thus a pan-European strategy to unify these markets should address both the regulatory aspects of market territorialization as well as the technical and logistical challenges of distributing digital goods and services across national borders. This implies coordination between various actors: firms, government agencies, and user communities. I argue here that achieving interoperability is a key requirement to bring these actors together under a Digital Single Market.

Palfrey and Gasser define interoperability as: "the ability to transfer and render useful data and other information across systems, applications, or components" (Palfrey & Gasser, 2012, p. 5). While this encompasses a broad range of requirements, both technical and legal interoperability are crucial to build cross-border digital markets. Technical interoperability refers to the architecture of technologies, tools, standards, and policies enacted to allow the harmonization, sharing and use of digital information, products, and services across borders. Legal interoperability, refers to the compatibility of laws, regulations, and legal codes allowing the unencumbered flow and use of these informational goods across borders, jurisdictions, and political administrations at different scales.

While technical and legal interoperability are currently lacking from cross-border digital markets in Europe, and working examples of both types of interoperability spanning the European digital economy are rare, there is one particular area where substantial progress has

been achieved. For geographic information, or geospatial data, a EU-wide interoperable infrastructure is currently being implemented: the Infrastructure for Spatial Information in the European Community (INSPIRE). Analyzing the interoperability developments of INSPIRE and identifying its challenges is not only important in its own right, but also can provide significant lessons for the feasibility, implementation, and implications of a Digital Single Market across the EU.

2.2 Technical Interoperability

Technical interoperability is both a goal and a key requirement of the development of a common spatial data infrastructure in Europe. The ability of information networks and spatial data services to communicate with each other is necessary to unify various territorialized markets or systems. European Commission Regulation 1312/2014 defines technical interoperability in the following terms:

> The interoperability of spatial data services is characterised by the capability to communicate, execute or transfer data among them. Therefore the spatial data services need to be further documented with additional metadata. To a lesser degree, it also concerns the harmonisation of the content of the service… (European Commission, 2014, p. 1).

As this definition suggests, achieving the seamless communication and transfer of data between different systems requires technical capabilities, documentation, and rules for implementation. These are key characteristics of the multi-lateral coordinated effort to achieve technical interoperability that is INSPIRE. Technical interoperability should be considered as a

component of a broader interoperability framework, however, working in tandem with legal interoperability (discussed in the following subsection).

INSPIRE emerged out of talks held in 2001 by the European Commission, the European Economic Area, and representatives of the environmental and geographic information communities from EU member states. The driver to convene these talks was the need to produce and disseminate harmonized environmental data for improved policy-making. After a process that included open consultation with 185 organizations across Europe, the European Commission adopted the INSPIRE Proposal for a Directive in July of 2004. This process was then opened for wider stakeholder in March 2005 involvement, including diverse Spatial Data Interest Communities (SDIC), –or groups of users, experts, and other parties interested in the use of geographic information and the development of an infrastructure to support it (European Commission, 2016).

These communities, working jointly with national, subnational, and international agencies, formally known as Legally Mandated Organizations (LMO), supported the preparation of the Implementing Rules for INSPIRE. Towards the end of 2006, after negotiations facilitated by the European Commission, the Council of Europe and the European Parliament, agreed to a final directive for INSPIRE. Directive 2007/2/EC of the European Parliament and of the Council, of 14 March 2007, entered into force on 15 May 2007 (European Commission, 2016).

As a Directive, INSPIRE became a binding resolution of the European Commission, whereby states must meet implementation deadlines under penalty of substantial fines. To organize this process, spatial data have been grouped in three broad types of categories: Annexes I, II, and II –shown in greater detail in **Table 1** below. The detailed implementation, running from 2010 to 2021, can be found in the roadmap published by INSPIRE, **Figure 1** below. This roadmap covers the following stages:

(1) Making available the discovery metadata for existing datasets.

(2) Making available the datasets themselves, initially for discovery and view, subsequently for download.

(3) Periodically ensuring that new and extensively restructured spatial datasets be conformant with the new interoperability guidelines, and are available through networked services.

(4) Making all 'invocable'[1] datasets available in the specifications stipulated by the various INSPIRE implementing rules on interoperability.

[1] Invocable datasets are those that fulfill requirements for metadata stipulated in Commission

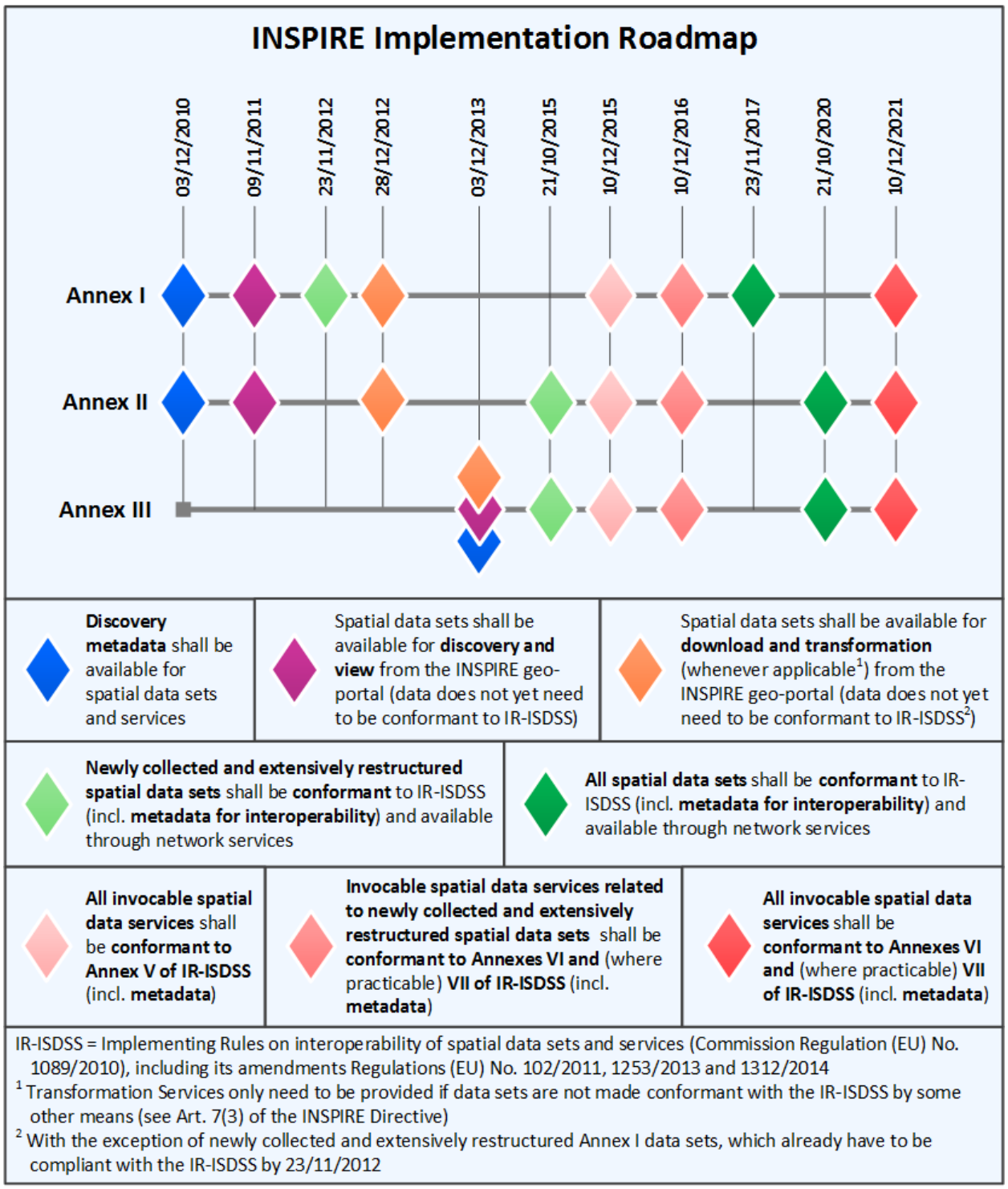

Figure 1. INSPIRE Implementation roadmap. Source: (INSPIRE, 2008)

This roadmap synthesizes the process of building a spatial data infrastructure as envisioned by the European Commission. Its implementation is the cumulative outcome of extensive multi-stakeholder negotiations, and has binding powers exercised by the EC. In this case the technical interoperability required to report, produce, and distribute spatial data in a common format has a very clear institutional dimension: geographic agencies of EU member states, regardless of size, budget, and organizational structures, are accountable for the synchronization of their efforts with a common goal in mind: the full construction of a pan-European spatial data infrastructure by 2021.

	Annex I	**Annex II**	**Annex III**
Themes	1. Coordinate reference systems 2. Geographical grid systems 3. Geographical names 4. Administrative units 5. Addresses 6. Cadastral parcels 7. Transport networks 8. Hydrography 9. Protected sites	1. Elevation 2. Land cover 3. Orthoimagery 4. Geology	1. Statistical units 2. Buildings 3. Soil 4. Land use 5. Human health and safety 6. Utility and Government services 7. Environmental monitoring facilities 8. Production and industrial facilities 9. Agricultural and aquaculture facilities 10. Population distribution – demography 11. Area management / restriction / regulation zones & reporting units 12. Natural risk zones 13. Atmospheric conditions 14. Meteorological geographical features 15. Oceanographic geographical features 16. Sea regions 17. Bio-geographical regions 18. Habitats and biotopes 19. Species distribution 20. Energy resources 21. Mineral resources

Table 1. INSPIRE Data Annexes. Source: (INSPIRE, 2008)

As shown by the Annexes in the table above, INSPIRE encompasses an enormous volume of data, practices, and technical resources. Its implementation is a significant collective effort that that requires the overhaul of existing data production, reporting, and dissemination structures. In some cases this may increase the quality by pressuring geographic agencies to improve their operations while harmonizing production with the rest of Europe. This has been the case in countries where much of this upgrading was done in the context of a broader institutional reorganization, such as in former communist countries and recent EU member states like Poland and the Czech Republic[2]. However, in other cases INSPIRE's harmonization is a perceived threat to the continuity of established institutional practices, particularly in the case of states that have a deeply rooted history of data collection and reporting embodied in national mapping, geographic, and environmental agencies, such as the UK and France.

Another factor affecting the country-specific implementation of INSPIRE is the degree of market orientation and commercial success of geographic information agencies. The incentives to produce for a national –or international– market may be at odds with INSPIRE specifications and the eventual harmonization of data at a pan-European scale. In the case of the United Kingdom, the Ordnance Survey (OS) has developed a greater market orientation than other mapping agencies in the European Union. This has endowed it with autonomy and versatility that in many ways exceed and depart from the traditional mandate of public information agencies tasked with producing information for internal consumption of the government. A significant consequence of this commercial orientation has been to make the incentives and operations of the Ordnance Survey less compatible with EU-wide collective initiatives focused on public information, such as INSPIRE.

[2] Interview with executives at CNIG and IGN, 9/1/2015.

The OS has developed expertise in producing commercial goods and services in addition to those released to the general public. The adoption of INSPIRE introduces a strategic conundrum for the commercial prospects of the OS: while in the long-term this project presents the opportunity to reach a pan-European market, in the short term it implies the diversion of resources from their core competencies, as well as the downgrading of standards to meet middle-of-the-road specifications suitable for the rest of the EU member states[3]. This highlights the tension between developing interoperability as a precondition to unifying a regional market and building competitive advantages for that market. It is at this juncture that the logic behind implementing a pan-European infrastructure for the dissemination of government information may be in significant tension with the construction of a Single Digital Market in the EU.

The drive to harmonize spatial data reporting, production, and distribution was born out of the need to improve environmental data for better policy-making in Europe across scales of government, national, and sub-national boundaries (Craglia & Annoni, 2006, p. 6). In order to achieve this, INSPIRE must first develop guidelines and requirements for technical interoperability between spatial datasets, such as those described above. While technical interoperability is key for the success of INSPIRE as a whole, this is enabled by legal and institutional arrangements across administrative scales. The next subsection explores the development of legal interoperability in the context of INSPIRE.

2.3 Legal Interoperability

While INSPIRE is making substantial progress in developing technical interoperability through the coordination and standardization of government-produced spatial data in the EU, its impact

[3] Interview with Licence Developer at the Ordinance Survey, 08/24/2015.

is contained because it does not entail a comprehensive alignment between the overall regulation of spatial data by the different national legal systems. Beyond the adoption of new reporting standards and the implementation of common procedures, the limits of a project such as INSPIRE are set by broader information policies at the national scale, which include Intellectual Property regimes and regulations codified by the laws of each country. The low correspondence between national systems suggests that a lack of legal interoperability persists in spite of successful pan-European initiatives.

Defined as the "process of making legal norms work together across jurisdictions" (Palfrey & Gasser, 2012, p. 178), legal interoperability requires a much broader and deeper transformation than technical interoperability, which can be undertaken by single-issue agencies and other associated parties without disrupting jurisdictions at a systemic level. This is a reason why INSPIRE has made strides in setting data production and sharing standards, while remaining within the confines of established national informational policies. More generally, this speaks to the increasing popularity of technical solutions, and technology itself as a regulatory tool, which in realms from crime prevention to climate change is becoming a preferred alternative to multi-lateral negotiations and regulatory change (Brownsword & Yeung, 2008; Hulme, 2014; Morozov, 2014).

Legal interoperability can reshape how states and other administrative scales function, while also rearticulating how they relate to each other. As Tréguer notes, legal interoperability "enables us to assess the capacity of legal systems to work with one another, and is a critical building block towards establishing an international order that can accommodate the interconnected nature of the world in which we live." (Tréguer, 2012, p. 2). The European Union is built on various mechanisms for the implementation of legal interoperability among member states, particularly aimed at achieving economic integration. As Palfrey and Gasser

note, the unprecedented and ambitious nature of the EU project means that it is simultaneously defined by "soaring successes and crushing failures" in the realm of interoperability (Palfrey & Gasser, 2012, pp. 185–186).

The European Union is "unrivaled as an institutional system seeking to achieve legal interoperability, due to its ability to adopt and effectively enforce a supranational legal order" (Tréguer, 2012, p. 3). Nevertheless, the alignment of proprietary information regimes and other information policies has fallen behind the development of common technical standards in the efforts to create a spatial data infrastructure (INSPIRE) and a Digital Single Market. In other words, even a region defined by its unparalleled advances in legal interoperability, such as the European Economic Area, the European Single Market, and the Schengen Area has difficulties translating them to the digital realm. In developing a Digital Single Market, integration must first overcome diverging approaches to the ownership, distribution, and commercialization of informational goods –particularly those in digital formats. These divergences will be explored in greater depth through the case studies in the following section.

Legal interoperability can be achieved in the EU by three main mechanisms:

1) Directives and regulations issued by the European Commission, which are binding on member states. While regulations are directly binding in their entirety and override national laws, directives are 'transposed' by member states into their own legal systems within a specified timeframe using the channels they deem appropriate and overseen by the European Commission (Tréguer, 2012, p. 5-6).

2) Coordination between analogous enforcement agencies across national boundaries and their work towards specific issues or projects.

3) Interpretations by national courts in accordance with the European Court of Justice (Tréguer, 2012).

Often these sources of legal interoperability are combined to different degrees to achieve coordination on a particular issue or set of issues, such as in the case of INSPIRE. As a European Commission directive, INSPIRE establishes guidelines and deliverables that can be met by the member states through strategies specific to their technological, institutional, and political conditions. The implementation calendar and binding nature of the directive (with the corresponding fines for delays) ensure the progression of the project.

Given its complex and heterogeneous nature, INSPIRE requires a second source of legal interoperability: continuous coordination between geographic agencies of different member states. While not strictly aligning the legal systems of various EU member states, the cooperation and coordination of analogous agencies is a necessary process for the implementation of Directives set by the European Commission. Thus, in this sense it is also a key requirement for the achievement of legal interoperability. This takes place within the institutional structure of the European Commission (through the Directorates-General of the Environment, Eurostat, and the Joint Research Centre), in cooperation with the European Economic Area, and through Eurogeographics, the non-governmental forum established for this purpose by member state geographic agencies and other interested parties (Huijboom & Van den Broek, 2011).

In Europe the bargain for a political-economic union has required that states give up parts of their sovereignty to a supranational body that can ensure legislation and governance with a significant degree of legal interoperability. This is a source of tension with national courts, which do not necessarily recognize the superiority of the interpretations of the European Court of Justice. However, in practice, disputes tend to favor the concentration of power by institutions of the European Union:

> [T]he political will was such that, where and when judges ruled it necessary, constitutions were amended to recognize the constitutional nature of EU law and to allow

> for the targeted transfer of more sovereign powers to the EU. Thus, a major obstacle to legal interoperability was solved. (Tréguer, 2012, p. 10)

While this trend has reinforced legal interoperability in the European Union, it is counterbalanced by two important limitations: Firstly, it is by no means universal, and can vary depending on specific issues. Secondly, it is shaped by the political moment, and the variable degree of popular and political support for the EU in individual member states, as illustrated by the separatist pressures in the UK, France, Greece, and even new member states in recent years. Interactions between EU and national courts show a key source of complexities in achieving legal interoperability: the vertical transfer of power between scales –in this case between national and supranational institutions. While this process tends to reinforce the EU structure, it is often beset by significant (and potentially destabilizing) contestations, which have come to characterize pan-European projects.

In light of the preponderance of public information and policy-making in INSPIRE, the commercialization of spatial data has not played a principal role in this project. However, this is the central objective of the Digital Single Market, whose planning is influenced by the success of INSPIRE. The commercialization of government-produced spatial data brings to the surface a new dimension of a significant existing challenge to achieving legal interoperability: the variability of national information policies on key issues ranging from privacy to intellectual property. This issue is being addressed through integrated projects such as the European Location Framework (ELF), intended to provide a cloud-based single source of dependable geospatial information for Europe with full e-commerce facilities (Eurogeographics, 2015, p. 2).

For the moment, however, there is no pan-European standard for the commercialization of geospatial data –or indeed other informational goods. This makes ownership of data one of the

key issues in the development of information markets. In this regard the various Intellectual Property regimes of spatial data (and other informational goods) across member states create a disjuncture between national and pan-European markets. These regimes determine how the information can be used, who can own it, who can derive economic gains from it, and how those gains can be allocated. For example, in the UK the Crown owns the copyright on most government works, exerting a strong protection on geographic information (*Copyright, Designs and Patents Act 1988 (UK)*, 1988; Onsrud & Lopez, 1998, p. 2). Similarly, in Spain Crown-sanctioned laws establish which information produced by geographic and other government agencies can be 'reutilized' (Jefatura del Estado, 2015; Ministerio de la Presidencia, 2011). In the following section, focusing on the UK, Spain, and Germany, I will show how the information policies and laws of each country interface with INSPIRE, and examine implications of this for the European Digital Single Market.

These case studies have been selected because they represent three advanced countries with well-developed governmental geographic information infrastructures, three different modes of engagement with INSPIRE, and three configurations of their respective geographic information economies. In the UK, the geographic information economy has been successfully cultivated by the Ordnance Survey. However, the level of engagement with INSPIRE is lower in part due to tensions with this commercial success. In Spain, while there is a developed geographic infrastructure, the geographic information economy is at a formative stage. In this context, the Instituto Geográfico Nacional, and its commercial arm, the Centro Nacional de Información Geográfica, are attempting to break new ground. The engagement with INSPIRE is serving to strengthen the operations of both and to expand the possible reach of the market. In Germany, the federal structure introduces a set of important challenges for the commercialization of data, which is primarily produced and owned by each of the states, or

Länder. In spite of this, Germany sees itself as an early adopter and leader in INSPIRE. Furthermore, the geographic information economy, highly developed at the national level, can find a potential expansion route through the deployment of this pan-European project.

3 Geographic information policies across EU member states

3.1 UK: the Ordnance Survey

The Ordnance Survey (OS) is the main producer of geospatial data in the United Kingdom. Throughout its history, it has played a strategic role in the British state as the central repository and producer of cartographic knowledge. In large part due to its success in commercializing its products, the OS was primed for institutional transformation through neoliberal policies from the 1980s. These have reduced Government funding and increased the charges of information recovery costs to the public. The OS became self-sustaining in 1999[4] when it recovered 101% of its annual expenditures. This commercial viability catalyzed a fundamental review by the Government, which transformed the OS into a Trading Fund –an Executive Agency that, though still a Government Department, is not funded by taxes. In 2015 this market orientation was taken one step further when the OS became a GovCo, an organization with an explicitly commercial aim. While this new structure orients the OS towards increased profit seeking, it also introduces an important tension with its public mission[5].

The Ordnance Survey produces a wide array of maps and geographic information products, ranging from road atlases to its 'crown jewels' of high resolution maps at the scales of

[4] Interview with Pricing and Licensing executive at the Ordinance Survey, 08/24/2015.
[5] Interview with Pricing and Licensing executive at the Ordinance Survey, 08/24/2015.

1:50,000, 1:25,000, and 1:10,000[6]. These maps are especially valued by the OS because they embody the organization's core competitive advantages of quality and accuracy[7]. However, in today's informational environment, where consumers are able to access mapping and navigation applications on demand (e.g. Waze, Google Maps) high-quality primary data and high accuracy are secondary to most users relative to connectivity, responsiveness, and an accessible user interface.

Through institutional reorganization and relations with private firms, the OS has become a market actor that simultaneously pursues profits while satisfying its mandate as a provider of public sector information. This dual position as a market actor and government entity is key to understanding how the OS approaches pan-European initiatives such as INSPIRE and the Digital Single Market. On the one hand, the OS is one of the most experienced institutions in navigating (and constructing) a market for geographic information. Its mostly domestic market is built on the OS's primary geospatial data for the UK, which has solidified its reputation as a quality provider. This has afforded the OS political legitimacy and market appeal, leading to a large user base that comprises government, private firms, and the public.

The OS has accumulated the technical expertise and the market position to expand towards a pan-European market. However, the legal and technical foundations of this market are not entirely compatible with the OS's competitive advantages. This is because the construction of both the European spatial data infrastructure (INSPIRE) and Digital Single Market (DSM) are premised on the harmonization of the basis of standards that substantially differ from those developed by the OS for their domestic production. While this applies to other EU members, in the UK the OS has developed a market position highly reliant on the technical specifications and

[6] Interview with Pricing and Licensing executive at the Ordinance Survey, 08/24/2015.
[7] Interview with Licence Developer at the Ordinance Survey, 08/24/2015.

high-resolution of its products. From the perspective of the OS, these competencies are at odds with the development of pan-European standards. Thus, while the UK participates in INSPIRE, and must implement each of its components, this initiative is often considered to be in tension with the objectives, priorities, and operations of the OS. As one senior Licence Developer in the OS put it:

> What has become the INSPIRE specifications is the bare bones, the bare minimum of what could be agreed and what can be done. That's because there is such a spectrum of data quality throughout Europe. […] There are organizations who are still doing pretty much the same thing they always did because their mandate hasn't necessarily changed; particularly those that are still very ministerially driven. […] INSPIRE in itself has been a challenge to us and a challenge to any organization who has a view of commercialization of their data. […] We realized that as it's originally drafted, you're essentially saying 'all of this this information has to go out for free and you are going to back the policies of various organizations, and the UK government would have to pay the bill. Some of these things raised alarms, and red flags and so on. […] [The OS's] current position is that it [INSPIRE] has been drafted, it's been transposed, it is there. Where does it go next? I think that is being very, very closely examined and discussed...[8]

This puts the development of pan-European initiatives in stark contrast with the commercial imperatives developed at the national level by the OS. Its concentration of expertise combined with a commercial orientation has made it a dominant market player that doubles as a government organization entrusted with the distribution of public sector information. The tension between these roles becomes manifest when the creation of an information infrastructure

[8] Interview with Licence Developer at the Ordinance Survey, 08/24/2015.

(and potentially a market) at a European scale requires the cooperation of this organization in the development of common standards, which contrast with its commercial products. Now that the OS has become a GovCo, it remains to be seen whether its public mission retains enough weight to counterbalance its commercial drive. As suggested by the statement quoted above, this may directly affect the OS's involvement in pan-European initiatives such as INSPIRE, and eventually the Digital Single Market.

However, regardless of its position in the domestic UK market, the OS may have to shift its strategy in light of new competitors in the geospatial economy. Through licensing schemes, private firms are transforming the OS's data and endowing it with features such as accessible user interfaces. In light of this, explained a Products and Innovation Executive at the OS, this organization is attempting to pivot from a focus on 'cartography' to 'geographic information', or the production of interconnected datasets in addition to maps[9]. While the implications of this shift are not yet clear, there are efforts underway to redefine and reinvent the products and services at the core of the OS, such as incorporating into them user-generated and 'vernacular' geographies. This reorganization in the OS has led to avenues of engagement at the European level for the development of new products. One of them is the European Location Framework (ELF), a prospective pan-European map. While the European Commission intends to make this project profitable, staff at the OS has identified significant challenges to this: "The market –if it exists– is for project funding; that's the source of revenue. […] The money tends to be available for research funding, not for commercial products. It's not a traditional market at all"[10].

In addition to the lack of revenue streams, the ELF faces other long-term challenges to its expected commercial viability, as explained by a Licence Developer at the OS:

[9] Interview with Products and Innovation Executive at the Ordinance Survey, 08/24/2015.
[10] Interview with Products and Innovation Executive at the Ordinance Survey, 08/24/2015.

> [This] is where this specific project has a challenge: one of the objectives, from the Commission's perspective, is to create a sustainable product set behind it. That could mean that the Commission will fund it for the next twenty years, or it could mean that it will be able to go out in the marketplace and hold its own water. Those are particular challenges when there isn't an established European-wide market. […] A lot of the expectation is that these things are open…Even if things are made open, it doesn't mean that attribution, provenance, and Intellectual Property are forgotten about. They're not. Everyone is retaining their Intellectual Property.[11].

The challenges that lie ahead with the development of the ELF are indicative of key issues in developing a EU-wide market: those related to Intellectual Property and a broader lack of legal interoperability in the EU. While the OS can transform its products and data, it can only do so within the property regimes established by law in its home jurisdiction: the United Kingdom. Conversely, while INSPIRE can harmonize the reporting and production of data across Europe, it cannot rewrite the property laws of each country, which ultimately places important restrictions on the development of secondary data markets that use information goods as raw materials for the development of new products. As I will show in the next subsections, this tension affecting the OS also characterizes data and property regimes across Europe, regardless of the varying levels of competency and involvement in pan-European projects. In this sense, the role of Intellectual Property Regimes for pan-European initiatives sucha as INSPIRE, and potentially the Digital Single Market, can be seen as a hard limit for advances in technical and legal interoperability. Without harmonization at the broader level of Intellectual Property Regimes,

[11] Interview with Licence Developer at the Ordinance Survey, 08/24/2015.

the commercialization of information and the creation of markets across national borders are unlikely to succeed.

3.2 Spain: The Instituto Geográfico Nacional and the Centro Nacional de Información Geográfica

The Instituto Geográfico Nacional (IGN) is the national geographic agency of Spain. Over time it has developed expertise in full coverage of the country with increasing accuracy, as well as the construction of (passive and later active) geodesic networks across the territory. The adoption of digital technologies allowed the IGN to shift its approach of upgrading its map coverage of the country from individual paper sheets to data 'themes', as digital vector files that can be added into Geographic Information Systems[12].

This technological change produced a paradigm shift in the Spanish geographic establishment, which was encapsulated in the words of a top executive at the Centro Nacional de Información Geográfica (CNIG), an organization created to commercialize the output of IGN: "The map is dead; long live geographic information"[13]. His assessment indicates that, like the OS in the UK, Spain's IGN is reorienting its cartographic trajectory towards geographic information production. CNIG's role in this transformation is to find commercial avenues for IGN's products, and leverage them towards growing the Spanish geospatial market. Thus, while the IGN is focused on meeting its mandate to produce geographic information for the government and the general public, it also coordinates with CNI to expand commercial opportunities.

[12] Interview with top executives at IGN, 9/1/2015.
[13] Interview with top executive at CNIG, 9/1/2015.

Unlike the OS in the UK, the IGN has not shaped the geospatial market in Spain by pursuing the commercialization of its products as a central goal. In fact, the IGN's production remains targeted not to end-users, but towards the supply of intermediaries –mostly within government. In this context, the commercial role of CNIG as a separate agency suggests a broader reorganization of the institutional ecosystem around the production and distribution of geospatial information. This requires increased coordination between agencies at the supranational (the EU) and subnational (autonomous communities) scales due to wider availability of mapping technologies and an increased variety of applications for geospatial information and products. As another executive at CNIG characterized this position, "the IGN used to be a data producer; today it is also the leader of a community of data producers."[14]

In this diversifying landscape, new actors such as Google Maps appear to have advantages over the IGN in their ability to satisfy commercial needs. However, while commercial online mapping services have focused on providing accessibility and ubiquity, the IGN has developed other competitive advantages stemming from a history of primary data collection and its institutional mandate. According to executives with experience at IGN and CNIG, the former is positioned to offer continuously updated information, ensured by its legal mandate and official commitment, making it a sustainable source of high-quality comprehensive primary data, which is unlikely to be guaranteed by third-party private actors like Google, whose coverage updates prioritize urban areas, and can shit dramatically due to the potential and incentives to provide service to particular markets.[15]

While the European geospatial economy is less developed than in the United States, there has been a significant increase in the use of geospatial reference data. According to a senior

[14] Interview with executive at CNIG, 9/1/2015.
[15] Interview with executives at CNIG and IGN, 9/1/2015.

member of CNIG in Spain there is now rising demand for IGN data and products such as orthophoto and cartography from such sectors as legal and administrative, energy, and agriculture[16]. This economic potential carries a tension for the IGN, which is still defined by its role as a government agency charged with producing information mostly for non-commercial uses. Changes in the geospatial market for IGN data lead to an increased role for CNIG, which must navigate the process of commercialization.

Ministerial Order FOM/956/2008 establishes the general policy guiding the distribution of geographic information produced by the IGN. It affirms state ownership of government-produced geographic information, and establishes a dual system of licenses for its use: the first kind is free and open for non-commercial use, and the second is on a specific, contractual, basis for commercial use (Ministerio de Fomento, 2008). While state ownership of geographic information underpins this property regime, its dual licensing system addresses rising demand for open data, commercial, and non-commercial uses. The strategies developed by IGN and CNIG to increase the commercial use of their information rely on the use of open licenses modeled after the Copyright Commons by Attribution model, which establish that informational products can be distributed free of charge on the condition that credit must be given to the content creator[17].

This combination of open and proprietary data characterizes a Spanish geospatial economy in discontinuous marketization. On the one hand, the number of actors and uses for geospatial data has increased in recent years. On the other hand, the property regimes established by the Spanish legal framework continue to safeguard the ownership of information by the government thereby limiting the commercialization of a majority of geospatial data and their use as inputs to develop secondary products.

[16] Interview with executive at CNIG, 9/1/2015.
[17] Interview with executive at CNIG, 9/1/2015

IGN and CNIG have taken active role in pan-European initiatives such as INSPIRE. According senior members from both organizations, this is an opportunity to increase the visibility and use of geospatial data within the government and the broader public, at scales from local to regional[18]. Their hope is that this will lead to increased use of ING products, triggering consequently, greater budgetary and political support for this institution. This is a key difference with the case of the Ordnance Survey in the United Kingdom, presented above. In the UK the OS has enjoyed considerable autonomy and financial independence as a result of its long-standing commercial viability. However, while INSPIRE has made substantial progress in its implementation, according to a top executive at CNIG, this project is at a critical moment for three main reasons:

1) Most policy is still based on alphanumeric, rather than geographic, information – despite INSPIRE's push to the contrary;
2) INSPIRE implementation is very expensive, and entails multilateral, multi-scalar coordination of considerable complexity;
3) Different implementation speeds create tension between member states[19].

Future directions of the IGN prioritize maintaining fundamental geospatial information, its richness and quality. Its core operating principle is that the move to digital and online mapping must retain the quality achieved through previous mapping technologies[20]. Simultaneously, this institution is invested in ensuring interoperability of their production with pan-European initiatives such as INSPIRE and potentially the Digital Single Market. While the OS in the UK is focused on maintaining its competitive advantages and has not prioritized multilateral initiatives that could lead to market expansion, the IGN sees itself as a leader in the

[18] Interview with executives at CNIG and IGN, 9/1/2015
[19] Interview with top executive at CNIG, 9/1/2015.
[20] Interview with top executives at IGN, 9/1/2015.

European community of geospatial data producers, backing INSPIRE from the outset. According to executives at both CNIG and IGN, these institutions can ensure their relevance and funding through expansion in multilateral European and international initiatives –a situation which considerably differs form that of the Ordnance Survey in the UK and its commercial success, which allows its relative disengagement from INSPIRE[21].

CNIG and IGN have pushed for innovative ways of making their data available to the public, implementing open data initiatives to promote commercialization but within the limits allowed by Spanish Law. These initiatives aim to increase IGN geospatial data use by government institutions and the public in general while highlighting the differences in quality and supply sustainability between the IGN's primary data and competitors such as Google.

The market position adopted by the IGN in this context is defined by its central role in the geospatial economy of Spain, which remains tied to its functions within the government, and depends on public funding. While the OS has shifted to operate more freely within the market, the IGN competes in the market chiefly in order to defend its continued position as government data producer. This hybrid role relies on leveraging market success into funding to secure its permanence within the government. In other words, since the geospatial economy in Spain is still developing, the IGN relies on demand from government organizations to ensure its continued existence. As expressed by a top CNIG executive: "If the IGN fell today, it should be defended by others [government agencies, due to the services it provides to them]"[22]. Through this market strategy the IGN seeks expanded use of its products within the government (such as the mobile application for environmental data used by the Ministry of Environment) in exchange for continued support.

[21] Interview with executives at CNIG and IGN, 9/1/2015
[22] Interview with top executive at CNIG, 9/1/2015.

In market competition with private firms, the IGN and CNIG locate their strengths in the production of quality primary data, rather than accessible end-user applications. While there are initiatives to develop increasingly comprehensive portals for online distribution of these data, they also aim to balance cooperative and competitive relations with actors with a strong market position, such as Google Maps. Moving forward, the strategy articulated by a senior CNIG executive is to ensure the relevance and continued survival of the organization by avoiding transitioning to a fully commercial role, as has been the case for the Ordnance Survey. As one CNIG executive put it: "To center on the sale of data is the best way to become an irrelevant organism"[23].

3.3 Germany: the Bundesamt für Kartografie und Geodäsie

The production of geographic information in Germany is coordinated by the Federal Agency for Cartography and Geodesy (Bundesamt für Kartografie und Geodäsie, or BKG). This organization acts as a central service provider for geographic information produced both at the federal level and in each of the sixteen states, or Länder. In an arrangement mirroring Germany's federal system, each land has substantial degree of autonomy to produce most geographic information, over which it exercises ownership and distribution rights. This arrangement allocates responsibility to the Länder for the collection of large-scale data (from 1:5,000 to 1:100,000), while smaller scale data (1:225,000 to 1:1 million) are collected by the BKG and provided as open data to federal and interested parties. While each land collects its own large-scale data, their financing varies according to their individual legal frameworks[24].

[23] Interview with top executive at CNIG, 9/1/2015.
[24] Interview with senior BKG researcher and executive, 9/11/2015.

The BKG has agreements to use and provide Länder data specifically to address Federal Government issues. Federal Agencies, in turn, work together in the Association of Mapping Agencies where they have developed a common data model and formats for Germany. While the aim is to standardize geographic information nationwide, Länder's autonomy over data collection creates differences in data collection due to institutional, technical, and physical conditions (such as topography). This information is then gathered by the BKG and disseminated to the public from a single point of distribution.

While the BKG coordinates and manages standards for the entire country, Länder have final say on the allowed uses of the information they collect. In fact the local data collected by them is sold to the BKG, who act as vendor to third parties on the Länder's behalf. In 2013 new legislation was adopted in Germany allowing the free and open distribution of all federally produced geospatial data, including unrestricted commercial and non-commercial use. This is line with the Open Data charter adopted by G8 (now G7) countries in 2013. While these open data provisions apply at the federal level, the Länder retain autonomy to enact different revenue-generating strategies. The Länder's autonomy to levy remains a key challenge to developing legal interoperability across all scales in Germany (Hisham, 2014). Furthermore, this challenge extends to developing a broader and more effective open data framework in Germany: in spite of signing the 2013 G8 charter, it ranks as the least open of all seven remaining countries after Russia's exit due to the fact that it does not release open data by default, it often does not use standardized metadata, and it has not 'substantially promoted data innovation' (Castro & Korte, 2015, p. 4).

The distribution of most geographic information collected outside of the federal level in Germany is regulated through a licensing model, which often causes debate between the BKG

and the Länder[25]. However, recent changes in federal law are supported by research showing that revenue-generating strategies recoup a very low percentage of their bureaucratic operating expenses (around 0.24% at the Federal level). For this reason the BKG, followed by Länder such as Hamburg, Baden-Württemberg, Nordrhein-Westfalen, and Berlin have transitioned to an open data model since 2013 (Sandmann, 2013).

The effects of opening data are still being analyzed by federal and Länder agencies. Releasing open data presents an important conundrum for public agencies, encapsulated by the practice of tracking. The open data released by the BKG does not have a tracking tool, which restricts the organization's ability to measure the effects releasing it. This makes it more difficult for the BKG to demonstrate the societal and economic benefits of open data. Paradoxically, this situation is precipitated by the very conditions of the open data regime: when data are released, the government agency is faced with the choice whether or not to track data use. While tracking can allow the BKG to improve impact measurement and support decision-making, to a certain extent this activity defeats the purpose of opening data due to the substantial degree of control they retain over their circulation[26].

The paradox presented by tracking open data use has important policy implications. Government agencies must justify these policies based on their economic impact –which can be ascertained most directly through measurement tools such as tracking the circulation and use of geographic information. In order for agencies such as the BKG to uphold the principles of open data without implementing tracking would instead require a more comprehensive restructuring. Current institutional logic puts agencies on permanent alert due to cutbacks and requires them to continuously justify their existence by showing the economic and social impact of their programs.

[25] Interview with senior BKG researcher and executive, 9/11/2015.
[26] Interview with senior BKG researcher and executive, 9/11/2015.

In the case of information-producing agencies, responses to this logic –such as monitoring use– can in turn affect the quality, distribution, and use of data because it constrains the distribution mechanisms and may discourage some users from developing secondary applications. This issue is currently an important consideration at BKG, where a senior researcher argued that promotion and awareness about the data produced by this organization are better solutions in the long term[27]. On a regulatory level, however, the push towards open data in Germany has not been followed with more substantial institutional transformations in the way geographic data are collected, or in changing its prevailing Intellectual Property Regimes, still characterized by government ownership.

The INSPIRE initiative plays a key role in the development of interoperability and geospatial information infrastructure in Germany, particularly through the legal obligations it creates for uniform data reporting (Hisham, 2014). Currently the Federal Government, through the BKG, coordinates INSPIRE at the national level as well as coordinating the sixteen Länder agencies and their individual regulations. Germany's involvement in INSPIRE is characterized by a strong commitment and a leadership position, as well as the projection of this initiative on a European scale. In contrast to the UK and Spain, the engagement of Germany with INSPIRE consistently includes representatives from each of the Länder, in addition to those from the BKG. Together they coordinate to enact a policy of early implementation in order to leverage the benefits of standardized data, and avoid paying late penalties.

Germany's role in INSPIRE reflects what a senior BKG researcher characterized as Germany's perception of itself as "Little Europe", or a collection of sovereign states"[28]. In the context of INSPIRE this means that Germany and the BKG have undertaken efforts to support

[27] Interview with senior BKG researcher and executive, 9/11/2015.
[28] Interview with senior BKG researcher and executive, 9/11/2015.

this project with both domestic and regional objectives. Domestically the goal is to harmonize public geographic information through the involvement of the Länder as autonomous producers. Regionally, Germany's role in INSPIRE is to leverage their own internal experience and strengthen a pan-European project while simultaneously building capacity to act in a potentially expanded digital market: Digital Single Market.

Germany has a large and dynamic geospatial economy, which has global projection through events such as the INTERGEO trade fair, the largest in the world, hosted annually in a different German city (INTERGEO, n.d.). While this fair brings together firms and organizations from over 100 countries, Germany uses it as a showcase for advances by its public and private geospatial sectors. In addition to this, the BKG hosts an informational conference and forum once per year where visiting government and industry groups can discuss geographic information issues with government agencies. The BKG also has a strong relationship with other branches of government such as the Police, Military and resource management agencies. These relationships are translated into partnerships aimed at joint efforts towards increase quality in quality, coverage, and timeliness of data while avoiding duplication.

These collaborative relations have allowed the BKG to identify a broad range of key market applications for geographic information in Germany, including planning, building, infrastructure, and transportation. Due to the expansion of these industries and their transnational operations, the German government has supported pan-European projects that make high-quality geographic information available to them. The European Location Framework, or ELF, is one of these projects. The BKG is particularly interested in using ELF to produce real time information for transportation systems, such as topography, planning journeys in real time in changing conditions, which is particularly useful in cross-border applications. However, while these 'use cases' –as they are referred to across geographic agencies– have been

identified by the BKG, they have not been expanded or pursued in depth, since the present focus is to continue effective implementation of INSPIRE. Yet, such use cases are crucial for INSPIRE to have the desired broader impact once it is implemented. A senior BKG researcher and executive attributed the current scarcity of use cases in large part to INSPIRE's lack of diffusion beyond the government and environmental sectors[29].

While INSPIRE focuses on standardizing and making available government-produced geographic information, the BKG and the German Federal Government are exploring how to leverage their participation in this project into the Digital Single Market through initiatives such as e-government. The challenge is to make geospatial information available in web formats that can reach broader user communities beyond government agencies. This project, however, is beset by the lack of legal interoperability arising from the regulatory differences between national and subnational levels in Germany (and other countries), as well as those between EU member states.

With respect to technical interoperability, while reporting is well underway, researchers at the BKG have identified an important challenge that may prevent INSPIRE and other geographic agencies from making geospatial data usable by broader audiences: the GML open data format required by INSPIRE is not widely used by GIS systems. Additionally, working with data in this format is significantly more complex than the more common shapefile (which is owned by ESRI, a private firm), and requires higher user proficiency. In this instance the technical interoperability developed for one pan-European project (INSPIRE) may not be leveraged for the development of a second one (the DSM), since it may present a challenge for the use of INSPIRE-compliant geographic information in the Digital Single Market[30]. At the

[29] Interview with senior BKG researcher and executive, 9/11/2015.
[30] Interview with senior BKG researcher and executive, 9/11/2015.

moment, however, most efforts in Germany are focused on implementing the INSPIRE guidelines and having the first full datasets ready by 2017. This situation illustrates how, while Germany's leadership in INSPIRE is contributing to the enactment of this project, this very commitment may hold back the country's ambitions to translate such leadership into the European Digital Single Market.

4 Conclusion

Interoperability is a key element in the construction of sociotechnical systems that cross borders and scales, such as INSPIRE and the European Digital Single Market. However, as Schuurman and others have demonstrated, interoperability involves a much broader field of social forces that are entirely captured by legal and technical aspects (Palfrey & Gasser, 2012; Schuurman, 2005). In the case of INSPIRE and the Digital Single Market, expanding the scope of the project from geographic information to the wide array of digital products and services that would characterize the DSM has the potential to make interoperability even more difficult by including a broadened array of social forces at play. With this in mind, the lessons from the ongoing implementation of INSPIRE can be useful in building the DSM, as well as indicative of some of the key challenges it may face. Since the DSM aims to build on INSPIRE's experience in implementing a regional geospatial infrastructure and broaden its scope to include other digital goods and services, these challenges are likely to multiply.

Interoperability is not an end in itself, but "a means to accomplish other societal goals" (Palfrey & Gasser, 2012, p. 7). In the case of geographic information, the goals guiding the development of interoperable infrastructures for government-produced information in the

European Union are not necessarily aligned with those of the Digital Single Market: the dissemination of geographic information by (and mostly between) governments prioritizes non-commercial applications and is mostly coordinated geographic agencies. On the other hand, standardizing the creation of a market for digital information that may include a broad range of products and services introduces issues that are often at odds with the experience of INSPIRE, such as the commercial development of secondary applications.

The prevailing differences and restrictions in Intellectual Property Regimes between countries and subnational administrative scales in the EU play a key role in this respect. In addition to this the focus of INSPIRE on government-produced geographic information prevents many of its provisions to expand to commercial activities. This brings into question the technical and political choices made to create an environment where communications and transactions are possible. In the case of INSPIRE, the primary goal is to ensure interoperability in the production of environmental and other scientific information for improved policy-making at the European level. This informational infrastructure represents the significant step in building a truly interoperable system at a regional scale capable of information sharing, reporting, and collection. While this achievement has provided inspiration for the construction of the European Digital Single Market, it is an open question whether the interoperability of INSPIRE is translatable for this purpose. In technical terms, issues with the broader use of open data formats are compounded with much larger challenges posed by the proprietary nature of much of the government-produced information in European countries.

The regional disparities in internet access, online commerce, broadband connectivity, and other factors important to the establishment of a digital economy show how even two decades after the establishment of the Schengen Area, borders are still relevant (albeit in variegated ways) in the European Union. In the construction of a pan-European digital economy,

spearheaded by the Digital Single Market, borders between and within countries take on renewed significance in the process of building legal and technical interoperability at a European scale. The creation of digital markets requires a vast array of infrastructural, political, and technological negotiations and implementations. Such requirements, expressed in the policy to explicitly *create* a Digital Single Market spanning the 28 member states of the European Union bring into sharp focus how digital technologies' compression of space is not an inherent condition, but needs to be actively constructed through technical as well as institutional means that simultaneously operate at all scales of governance. As the national case studies presented and their experience with INSPIRE illustrate, the state matters greatly for the construction pan-European initiatives. However, variations by nation state compound with supra- (EU) and sub- (Länder) national scale articulations to produce different outcomes and present renewed challenges for which legal and technical interoperability are necessary, but not quite sufficient conditions.

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Chapter 5. Intellectual Property, interoperability and the construction of a Geographic Information Market in the United States

Abstract

The goal of this article is to examine the construction of the geographic information market in the United States. The focus is on two key building blocks in this process: 1) Intellectual Property regimes and 2) the development of (legal and technical) interoperability in the collection and dissemination of geographic information. These elements are explored in the context of the institutional configuration between government, the private sector, and the general public. This configuration, which in the United States bounds the role of government as a producer of geographic information and limits its actions in the market, creates suitable conditions for the continued production of geographic information as input to a growing market, as well as its consumption, circulation, transformation, and use by government agencies, private firms, and the public in general. Lastly, the article characterizes the geographic information market in the United States as relying on the legally delimitated role of the federal government as a de jure producer of informational inputs that foster the development of secondary applications in addition to fulfilling its primary mission of public information. Understanding of the institutional,

legal, and technical dimensions of the geographic information market will enable a clearer analysis of the linkages, transactions, and logics between government agencies, private firms, and civil society groups in the production of value through geographic information and other informational resources.

1 Introduction

This article explores the construction of geographic information markets in the United States by focusing on two key elements. These are (1) the role of Intellectual Property regimes and (2) the development of mechanisms for two kinds of interoperability: legal interoperability (such as the acquisitions process between different government agencies at different levels) and technical interoperability (such as data formats and spatial data infrastructures). The article mobilizes these elements to show how the geographic information market is shaped by the institutional, legal, and technical frameworks that allocate property rights, enable the dissemination of standardized data, and create conditions for the development of commercial informational products within a given jurisdiction.

In the past years geographers have been directing their attention to the study of markets in their own right. This has been particularly productive for economic geography, which had hitherto exhibited a historical bias towards the sphere of production, to the relative neglect of the sphere of exchange. Berndt and Boeckler have made a compelling case to study markets and marketization as geographical processes (Berndt & Boeckler, 2009, 2012; Boeckler & Berndt, 2013). Although this research agenda promises to deepen our understanding of the spatialities of capitalism, I argue in this article that further attention must be paid to the geographical dimensions present in the development of information markets, particularly in light of how commonly used concepts such as 'the cloud' and 'cyberspace' obscure the material dimensions of information.

Even though the marketization of information is one of the defining qualities of capitalism in the first decades of the 21st Century, scarce attention has been paid to how (and particularly where) this process takes place. Geography in particular has much to contribute to the state of

this knowledge, since there is, in culture and practice, an assumed separation between information and the places in which it is produced, distributed, and consumed. As suggested above, this has furthered mythical notions of information, and in particular that which circulates through digital networks, as detached from the material conditions of concrete places. Economic geographers have been articulating an understanding of the place-specific nature of information for the better part of the past decade and half. For example, they have examined its infrastructural dimensions, its sociospatial divides (M. Graham, 2011), its co-constitutive nature with space (Kitchin & Dodge, 2011) –particularly in urban, increasingly wired areas (S. Graham, 2005)–, and they have also examined the intensified representation of places through digital technologies and social networks (Crampton et al., 2013).

While these contributions have increased knowledge on several dimensions of the influence of digital information technologies on our daily lives, social interactions, and political economic conditions, there are important points that remain underdeveloped. One such area is the intersection between the regulation of information and the development of information markets. In this article I argue that a particularly productive point of intersection is the market-making functions of Intellectual Property regimes. These act as mechanisms that that define the roles of market actors and bound them to operate with circumscribed functions within jurisdictional constraints. This argument is inscribed within a budding research agenda in Economic Geography that focuses on the role of the law in economic globalization (Barkan, 2011; Sparke, 2013). Specifically the present article builds on recent examinations that illuminate particular functions and geographic dimensions of Intellectual Property and other specific laws in the process of market-making, and capitalism at large (B. Christophers, 2015; Brett Christophers, 2014, 2015).

In this article I engage with this research agenda focusing on the market-making dimensions of law and place it in the context of recent calls for a more developed political economy of the geoweb, or geographic information on the Internet, which is in its initial stages of development (Leszczynski, 2012). Thus my goal here is to argue that studying the regulation of geographic information on the Internet can be fruitfully conducted by focusing on the role of Intellectual Property assembling markets within defined jurisdictions, and that this process is complemented by the development of legal interoperability, a multidimensional process which includes legal as well as technical instruments that combine to allow for the flow and standardization of informational inputs, generating suitable conditions for a market.

The first section focuses on the Intellectual Property regime of geographic information in the United States. This examination begins with a focus on the national scale, and particularly on the works produced by the Federal Government. The article proceeds to examine the commercial aspects of the geographic information collected by two of the principal Federal agencies engaged in this activity: the United States Geological Survey and the United States Census Bureau. At the subnational level, the article explores the different types of property regimes that apply to geographic information collected by state, county, and city governments in the United States. These are illustrated through an examination of the commercial linkages of the National States Geospatial Council and a number of state, county, and city governments.

The second section of the article focuses on the development of interoperability and its implications for building a market for geographic information in the United States. Two specific types of interoperability are analyzed through their impact in the process of market creation: legal and technical interoperability. The article explores first the issue of legal interoperability, or how laws and policies regulating geographic information at different scales (national, state, county, city) operate together in the commercialization of this good. The focus then shifts to

explore technical interoperability, or the mechanisms that enable the production and dissemination of standardized and homogeneous data. Two specific elements are highlighted: the TIGER file format developed by the United States Census Bureau, and the National Spatial Data Infrastructure, an overarching architecture for the standardized production and distribution of geographic information.

Together, the Intellectual Property regimes of geographic information produced by governments at different scales, combined with the mechanisms developed for legal and technical interoperability, provide the architecture of the geographic information market in the United States. By focusing on the relations and interactions between these elements, the present article advances our understanding of information markets as grounded in technical and institutional dynamics shaped by the legal and political economic context of each particular jurisdiction. In the case of the United States, the dynamics between the legal foundations of Intellectual Property, the relationship between different branches and levels of government, and their role in the market as producer and/or competitor, interact with the institutional logics regulating data production to create the conditions for a growing geographic information market and geospatial economy. Understanding the production of these informational inputs, as well as their nature as public or private goods and their process of commodification, is crucial in the context of a capitalist economic system that is increasingly reliant on informational goods and industries. This article shows how the construction of digital information markets is far from an automatic or technical process, since it is shaped directly by the legal, political, economic, and institutional conditions at different scales and in particular jurisdictions.

2 Government works and the Federal level

2.1 Legal status of Federal Government works

Under Title 17, section 105 of the U.S. Code, the category of Government works[31] in the United States is part of the public domain, which means that no actor can exert copyright protections and thus ownership over it. This allows for the dissemination, transformation, and use of this resource by anyone, for commercial and non-commercial purposes, both within and outside the United States –although the U.S. government may assert copyright of its works abroad (US Copyright Office, n.d.; U.S. Government, n.d.). This covers informational works of any kind produced by the Federal Government of the United States not considered 'classified' due to national security.

Historically, to maximize the public access to government information, U.S. Federal agencies have only charged users for reproduction costs. In the late 1980s and early 1990s there was a policy shift to pricing based on the public's willingness to pay, which was met with stiff resistance from civil society groups. Soon after, through Circular A-130, the Office of Management and Budget reversed this trend, instructing "government agencies to recoup only the costs of reproduction of government information and not to derive additional financial resources to recover development costs" (Branscomb, 1994, p. 161). Thus, while the government may charge for information, it may only do so strictly to cover costs of reproduction. This limitation in revenue generation is the defining quality that establishes the Federal Government's role as an information producer and prevents it from competing in the market. Its information production is financed through taxes and made publicly available to fulfill three main goals: 1)

[31] With the exception of Standard Reference Data produced by the Secretary of Commerce, as indicated in the Standard Reference Data Act of 1968.

disseminate public information, 2) support government decision-making, and 3) produce inputs for commercial development.

This third point is of particular import for the informational economy of the United States. As noted by Wells Branscomb, this is further emphasized in OMB circular A-130, which "also warns government agencies not to interfere or attempt to restrict secondary uses of information resources, leaving the private sector to take what it will and reproduce it either as is or with value-added services" (Branscomb, 1994, p. 161). Such explicit delimitation establishes a clear division of labor in the U.S. information economy where the Federal Government is the supplier of raw informational inputs, subsidizing the private sector.

Geographic information is a vast category defined by georeferenced data linked to a wide array of spatial representations that range from maps to aerial and satellite photography to climatologic, demographic, statistical, and economic datasets. Increasingly, geographic information includes data produced by users through digital technologies such as mobile phones and social media applications. These data are stored on the web and disseminated through online portals, which allows for their rapid and efficient transmission, transformation, and recombination.

The technological change introduced by digital and later networked technologies has important implications for the geographic information economy, and particularly for the role of the Federal Government as a producer of this good. These technologies make it easier to collect, organize, and distribute information. This lowers the cost of public distribution from single access points, such as the Census Bureau's American FactFinder, which hosts demographic, economic, and statistical data, or the USGS's Landsat Earth Explorer, an online archive of satellite imagery.

On the other hand, these technologies place an increased burden of immediacy, expediency, and efficiency on government information producers. While strictly speaking they

are not market actors, U.S. Federal agencies often compete with private services for the online attention of users. These services, such as Google Earth, Google Maps, and ArcGIS.com, generally offer the same government-collected primary data repackaged into more accessible user interfaces and supplemental features. This supplier/competitor online relationship between private firms and the government exemplifies some of the reshuffling precipitated by new technologies in the geographic information economy.

While the role of the Federal Government as producer in the information economy is clearly delimited by regulations such as OMB Circular A-130, it is also subject to change through its relations and linkages to other market actors. In the face of technological change and new demands placed by society in terms of access and distribution, Federal agencies often partner with private firms for the collection and dissemination of public information. While this is a common practice, partnerships with the private sector have raised important questions about the control of the informational resources and the role of those private firms as competitors in the market.

A suggestive example is the merging of data from two online portals of the Federal Government, Data.gov and Geodata.gov, in 2010. In 2005 the Department of the Interior had awarded the contract to develop Geodata.gov to the private firm ESRI, the market leader in geographic information systems (U.S. Department of the Interior, 2005)[32]. In 2010 it awarded the same firm a contract to link Geodata.gov with the existing government portal Data.gov (Schutzberg, 2010). This represented an important step in developing a "one-stop shop" for the concentration and distribution of all types of geographic information produced by the Federal Government.

[32] This is known as Version 2 of the Geodata.gov portal. ESRI had previously been awarded the contract for Version 1, launched in 2003.

However, ESRI's involvement in linking the data and maintaining this service led to a controversy due to the firm's status as leader in the provision of GIS products and services, and the favored access and control of inputs suggested by the its maintenance of the Geodata.gov portal (Fee, 2010; Pomfret, 2010). Specifically this was due to the position that ESRI would acquire in redirecting user traffic to their free online service ArcGIS.com, which would allow users to create map mashups using data layers from Geodata.gov (Sternstein, 2010). The government would pay ESRI $50,000 to undertake the data linkage project. This was an unusually low figure compared to the true cost, which was estimated by the firm's president, Jack Dangermond, in the tens of millions of dollars –an amount which, as he explained, would be supplemented through the revenue generated by their software licenses (Sternstein, 2010).

The connection with ESRI's online service, compounded by the low cost of the contract drew criticism from other members of the geospatial community, who saw this as preferential treatment to a market leader that amounted to funneling users of a public service to a private platform while indirectly generating traffic and advertisement benefits for the firm in the process (Fee, 2010; Pomfret, 2010). While ESRI later issued a clarification stating that Geodata.gov was to be only one of the many sources of spatial data available to users of ArcGIS.com (Schutzberg, 2010), this episode highlights the tenuous line separating the production of public information by the government and the commercial implications that can arise from the involvement of private companies in its online distribution.

2.2 Geographic information practices of the United States Geological Survey and the US Census Bureau

The United States Geological Survey, or USGS, is part of the Department of the Interior. It is a scientific agency whose principal mission is to collect and distribute reliable geographic information for the understanding of the Earth, hazard mitigation, resource management, disaster prevention and quality of life improvement (United States Geological Survey, 2014). The USGS furthers these goals through such outputs as topographic maps, digital elevation models, soil analysis, orthophotography, aerial and satellite imagery. As a Federal agency, its informational products are considered "government works" under section 105 of Title 17 of the U.S. Code, and thus constitute public information, with the exception of certain primary data sourced from private firms under contract. This depends on the term of the contract under which a firm provides data products or services to the government[33].

Part of the mission of the USGS is to maintain a public access point for their informational products. In recent years the USGS has pioneered a number of online initiatives to make comprehensive spatial datasets available to the public. One of the USGS's principal projects is the National Map, made in collaboration with local, state, and federal agencies. This online portal hosts "a seamless, continuously maintained set of public domain geographic base information that will serve as a foundation for integrating, sharing, and using other data easily and consistently" (Dewberry, 2012, p. 31). In addition to the National Map, USGS has partnered with NASA to administer the Landsat satellite program and to offer the entirety of their imagery archive through the Earth Explorer portal. While most of the data can be directly downloaded, imagery that is not yet online can be requested for digitization for the charge of reproduction

[33] Interview with senior executive at the USGS National Geospatial Program. March 21, 2016.

costs (USGS, 2016). This constitutes a peerless archive of publicly available satellite data going back four decades and spanning the entire globe.

The USGS engages with a large number of government local, state, and federal agencies, as well as and private actors and other sectors of the public, to determine their needs for geographic information, and assess the potential benefits. While its aim is to further scientific endeavor, it does so with a keen eye on the applications, societal, and economic impact of its informational products. For example, for the National Enhanced Elevation Assessment, which collects updated elevation data for the entire country, the USGS conducted a detailed cost-benefit analysis that included the full documentation of "business uses for elevation needs across 34 Federal agencies, agencies from all 50 States, selected local government and Tribal offices, and private and not-for profit organizations" (USGS, 2014). The final report, conducted by the consulting firm Dewberry, prominently features 27 business uses for the NEEA, ranging from management of flood risks, infrastructure, and construction, to urban and regional planning as well as health and human services. The table below reproduces the 27 business uses considered in this National Enhanced Elevation Assessment. The estimated benefits across these business uses ranged from a conservative figure of $1.18 billion to a potential of $12.98 billion. According to this report the annual combined highest net benefit for federal, state, and non-governmental actors had a benefit/cost ratio of 4.728 for every dollar spent, yielding $795 million per year (Dewberry, 2012, p. 8).

Business Use	Conservative Benefits	Potential Benefits
Flood Risk Management	$294.706M	$501.576M
Infrastructure and Construction Management	$206.212M	$941.951M
Natural Resources Conservation	$159.225M	$335.152M
Agriculture and Precision Farming	$122.330M	$2,011.330M
Water Supply and Quality	$85.288M	$156.351M
Wildfire Management, Planning and Response	$75.700M	$158.950M
Geologic Resource Assessment and Hazard Mitigation	$51.750M	$1,066.750M
Forest Resources Management	$43.949M	$61.655M
River and Stream Resource Management	$38.422M	$86.582M
Aviation Navigation and Safety	$35.000M	$56.000M
Coastal Zone Management	$23.785M	$41.740M
Renewable Energy Resources	$10.050M	$100.050M
Oil and Gas Resources	$10.000M	$100.000M
Homeland Security, Law Enforcement, Disaster Response	$9.975M	$126.469M
Sea Level Rise and Subsidence	$5.780M	$21.660M
Urban and Regional Planning	$4.197M	$68.569M
Resource Mining	$1.686M	$4.864M
Wildlife and Habitat Management	$1.510M	$4.020M
Education K-12 and Beyond	$0.264M	$2.264M
Land Navigation and Safety	$0.191M	$7,124.875M
Telecommunications	$0.185M	$1.850M
Recreation	$0.050M	$0.050M
Cultural Resources Preservation and Management	$0.000M	$7.000M
Health and Human Services	$0.000M	$1.000M
Marine Navigation and Safety	$0.000M	$0.000M
Real Estate, Banking, Mortgage, Insurance	$0.000M	$0.000M
Rangeland Management	$0.000M	$0.000M
Total Estimated Annual Dollar Benefits	**$1,180.224M**	**$12,980.707M**

Table 1. Business Uses and Estimated Benefits of the National Enhanced Elevation Assessment (in $US Millions). Source: (Dewberry, 2012, p. 3)

This economic calculation is indicative of the general operating practices of the USGS and shows awareness of the agency's role as the centerpiece of a 'system of engagement'[34] in which geographic information is the key resource and catalyst of economic activity. As indicated

[34] Interview with senior executive at the USGS National Geospatial Program. March 21, 2016.

by a senior executive at the USGS National Geospatial Program, this and other federal agencies have adopted an 'entrepreneurial' strategy, seeking a return on investment, which in this context means maximizing the scientific, social, and commercial uses of their informational products. In order to do this, the USGS and other agencies have avoided competing to do things better than the private sector, but rather doing them 'differently'[35]. This is consistent with the USGS's complementary role in the market as information producer whereby it connects the interests of local, state, and national actors, private and public while aiming to balance their needs. As suggested by the wide range of business uses indicated above, one of its priorities is developing the market for geographic information by supplying informational inputs with an explicit consideration for the development of secondary applications.

The Census Bureau is a Federal Agency whose mission is to "serve as the leading source of quality data about the nation's people and economy" (United States Census Bureau, 2016). These data are collected through projects such as the constitutionally mandated Decennial Census, the Economic Census, the Census of Governments, the American Community Survey, and a number of other surveys and economic indicators (United States Census Bureau, 2016). While the Census Bureau is not strictly a mapping agency, it has played a fundamental role in the production of geographic information in the United States. This is a function of the Bureau's need to aggregate and georeference their data at scales ranging from states to census tracts, block groups, and blocks, which is essential to accomplish its four principal uses:

1) the constitutionally mandated distribution of congressional seats to states
2) make planning decisions about community services
3) facilitate the annual distribution of federal funds to local, state, and tribal governments

[35] Interview with senior executive at the USGS National Geospatial Program. March 21, 2016.

4) provide age search information for activities such as Social Security qualification, passport applications, relationship verification for real estate stales, and historical research, etc. (United States Census Bureau, 2016)

The comprehensive mapping of the Bureau has been enabled by its development of technical innovations, such as the TIGER/LINE format, which is now a standard for the manipulation of topologically integrated geographic information. The contributions of this format in building technical interoperability in the U.S. geographic information economy will be discussed in the following section of this article.

Like the data produced by the USGS, that collected by the Census Bureau is considered government work and cannot be copyrighted. However, to a greater degree than other federal agencies, the Bureau places a clear boundary around what is publicly available, in order to safeguard the privacy of respondents by enforcing confidentiality over data that may be personally identifiable. Publicly available data comprise only certain data, scales such as state, city, highly populated census tracts, and block groups. On the other hand, data from thinly populated census tracts and smaller scales such as blocks are considered confidential.

The operations of the Census Bureau are bound and regulated by two laws: Title 13 and Title 26 of the U.S. Code. Title 13 specifies the operations of the Bureau and establishes its mandate of confidentiality, while title 26 regulates the provision of tax information to other federal agencies, including the Census Bureau. The specific content of the questions in the Census and the budget to carry it out are subject to Congressional approval, which entails a continuous process of negotiation.

While the Census Bureau is a federal agency, its data collection and operations throughout the national territory require engagement with agencies at all levels of government. A key reason for this is that much of the geographic information at the local scale, which is

considered the most valuable, is sourced directly from counties and municipalities. This is a challenging endeavor for the Bureau, since it must often negotiate the acquisition of the rights and licenses to data that, unlike at the federal level, are not covered under the government works designation, but by a patchwork of property regimes.

Unifying and standardizing these diverse data sources requires a combination of organizational and technological strategies. For this purpose the Census Bureau has developed an in house a platform to verify addresses using GPS. Furthermore, organizationally, each regional office coordinates the acquisition of data with local governments and performs quality controls over each dataset. The following section will explore in greater detail the interactions between local governments and the Census Bureau in the production of standardized datasets.

While the Bureau produces these data following its constitutional mandate, which sets a rigid schedule and well-defined objectives, like the USGS, this agency is very much aware of the commercial value of its informational products. As indicated by a senior geographer from the Census Bureau, it is clear that the informational outputs of the Bureau have helped catalyze the development of widely used cartographic services, such as the Thomas Brothers Atlas (later purchased by Rand McNally), and Google Maps, both of which use TIGER/LINE topography data as primary inputs[36]. Furthermore the economic, demographic and social statistics produced by the Census Bureau are of great value for decision-making within the government, and for private industry. The Economic Census is particularly suitable for the development of commercial applications by a wide range of market actors. The Bureau defines this project as "[t]he foundation for business activity across the U.S. economy". Recognizing its value, the Bureau has divided Economic Census data in five categories for which they have outlined a corresponding set of specific uses, totaling fifteen. These uses cover a range of activities

[36] Interview with senior geographer at the U.S. Census Bureau. March 25, 2016.

measuring GDP to promoting small business and furthering local economic development. These uses are reproduced in the table below, aggregated by the data categories they belong to:

Data Category	Specific Uses
Data to Understand Business Competitiveness	Business Marketing & Performance Metrics
	Business Investment Planning
	Local Economic Development
Accurate Benchmarks for Economic Indicators	Gross Domestic Product (GDP)
	Producer Price Index & Productivity
	Retail Sales & Other Indicators
Consistent, Comparable, Comprehensive Measures	Statistics by Industry
	Statistics by Geography
	Employment, Payroll, Sales, Locations & Firms
Information on Business Location and Size	Transportation Uses
	Energy Impacts
	Promoting Small Business
Characteristics of U.S. Businesses	Industry Concentration by Firm Share
	Franchising
	Owner, Sex, Race, Ethnicity, and Veteran Status

Table 2. Data Categories and Specific Uses of the Economic Census. Source: (US Census Bureau, 2015)

It should be noted that the label of specific "uses" outlined for Economic Census data outlined by the Bureau in the table above conflates two different classifications: entries such as Business Marketing can be considered direct applications of the data, while others such as GDP can be interpreted more directly as data categories. This categorical fuzziness notwithstanding, the language employed by the Bureau in identifying these as "uses" suggests an attention to the 'actionable' qualities of the data collected by them, and particularly to their potential in catalyzing economic activity. This rhetoric surrounding the collection and distribution of data by the Census underlines much of the role played in the market by this and other Federal agencies, such as the USGS –whose data uses were catalogued above. Beyond encouraging the diversified application of Economic Census data, this utilitarian rhetoric has a key function in the

institutional logic of the Census Bureau when it is leveraged in budgetary and funding negotiations with Congress to bolster arguments for project financing[37].

In sum, while the Census Bureau and the USGS are Federal agencies bounded by law and limited in their market action, they are nevertheless also embedded in market logic. This is reflected in their attention to the market circulation of the informational goods they produce, and the influence of their commercial potential in defining the types of data that are produced and how they are disseminated. This leads them to deliberately take on the role of information producers and, beyond dissemination public information to for government and public use, provde inputs directly aimed at developing a broad cross-sectional geographic information economy. While this market logic is not the main guiding force of their actions, it underlies their strategy and action. In fact, while the rhetoric advancing the commercial potential of Census and USGS data is not necessarily front and center, it is rather pervasive in their documents and operations. This is in large part due to the legal and regulatory status limiting them from explicitly participating in market action and orienting their information production of 'government works' for the public domain.

Such limitations do not apply in the same way to subnational actors, whose information production is regulated through diverse property regimes, which often allow (and even incentivize) direct commercialization. In the following subsection I will explore the production of geographic information at the subnational level through the lens of its property regimes, focusing on the activities of key actors such as the National States Geographic Information Council and a number of city and county governments.

[37] Interview with senior geographer at the U.S. Census Bureau. March 25, 2016.

3 Variations and implications of geographic information production at the subnational level

While federal agencies such as the Census Bureau and the USGS collect vast amounts of geographic information, in doing so they often rely on local inputs collected by state, county, and metropolitan government agencies. Data collection at the subnational level differs in some key respects from that undertaken by the Federal Government. Unlike data from the USGS and the Census Bureau, municipal, county and state data are not legally mandated to be in the public domain and can be regulated by a wide range of distribution and property regimes. For example, the city of San Francisco's open data portal is branded by a copyright symbol assigned to the City and County of San Francisco. The site's Terms of Use further clarify this status by declaring to the users that "If the City claims or seeks to protect any patent, copyright, or other intellectual property rights in any Data, the website will so indicate in the file containing such Data or on the page from which such Data is accessed" (City and County of San Francisco, 2009). Similarly the City of Chicago's data portal states in its Data Terms of Use that the City "voluntarily provides the data on this website as a service to the public" and it "reserves the right to claim or seek to protect any patent, copyright, trademark, or other intellectual property rights in any of the information, images, software, or processes displayed or used at this website" (City of Chicago, 2016).

These conditions of data distribution and ownership markedly differ from those mandated by Copyright Law (Title 17 of the U.S. Code, section 105), on federally collected data, which are by definition public in the United States. The fact that they are not 'government works' allows cities and counties to distribute them under 'open access' regimes that, in contrast to 'public data' reserve rights of ownership and dissemination to the data producer, who is under

no legal obligation to provide it to the public but does so "voluntarily" and "as a service to the public". Furthermore, this gives local administrations greater freedom to enter into contracts and licenses for the provision and consumption of these data services. An example of this is the Commonwealth of Virginia that, like other state governments, has uploaded an important number of geospatial resources online. Many of these are aggregated in Virginia GIS Clearinghouse, a site hosted in an 'arcgis.com' domain, which is owned by the private firm ESRI. While the site identifies itself as a "repository of geospatial data produced and used by state agencies in Virginia, localities in Virginia, our Federal partners, non-profits, and colleges and universities in Virginia" (Virginia Information Technology Agency, n.d.), it is governed by ESRI's standard Licensing Terms of Use. These terms specify that the 'products' on the site are licensed, not sold, and assert ESRI's ownership of "Products and all copies" (ESRI, 2014, p. 1). While this applies to the functions of the site and the 'products' contained therein, the specific datasets hosted on the repository can have different owners, including the Commonwealth of Virginia, while some of them may be in the public domain. These examples illustrate degree of flexibility granted to subnational administrations in the allocation of various rights to the geospatial data they generate.

The diversity of licensing agreements and distribution schemes at the state, county, and metropolitan scales creates a disjuncture in the property regimes that regulate the datasets collected at different levels of government. Since many geographic datasets and informational products, particularly at the federal level, are created by assembling data from multiple sources – each with regulated by its own property regime– this disjuncture can have important effects on how geographic information is produced distributed, used, and commercialized. Thus when federal agencies complement their data collection through the acquisition of data from states,

counties, or cities, there are legal negotiations as well as technical considerations that must be aligned in order for geographic information to be made available to the public.

Often these negotiations are shaped by the larger degree of influence held by market logic on the collection practices of subnational administrations. While federal agencies such as the Census Bureau must negotiate with Congress for funding on a cyclical basis, they hold greater leverage due to the scale of their projects and their nationwide economic and social impact. This provides federal agencies a relatively sustainable degree of resilience from budgetary constraints and political pressures. On the other hand, subnational agencies –particularly at smaller or less financially endowed scales such as local governments and rural counties– often struggle to maintain consistency in their operations. This logic, which applies in varying degrees to cities and states, creates incentives for subnational agencies to charge for data in amounts that exceed the costs of recovery.

Subnational agencies thus often enact prohibitive charges for the distribution of geographic information. This both reduces public access to geographic information, and creates tensions in the transactions between subnational and national-scale agencies. An example of this is the Census Bureau, which continuously relies on updated local data. The Bureau's regional offices periodically conduct negotiations with county administrations to lower or waive their data charges over and above recovery costs, in order to acquire data for updating nationwide projects such as the street topology necessary to conduct the decennial Census[38].

In recent years there has been rising public interest in access to digitized geographic information produced by local governments. This has put pressure on local governments' proprietary regimes and licensing practices, since the growing availability of information from federal agencies and other sources, compounded by the low costs of digital reproduction, make it

[38] Interview with senior geographer at the U.S. Census Bureau. March 25, 2016

difficult to justify data charges that exceed this cost. In 2013, in the case Sierra Club v. S.C. (County of Orange), the Supreme Court of California issued a decision to this effect that is expected to set legal precedent on the availability of locally produced geographic information (Judicial Council of California & Administrative Office of the Courts, 2013). The state Supreme Court reversed decisions, made by trial and appellate courts, which had upheld Orange County's right to charge the Sierra Club a licensing fee of $375,000 to access OC Landbase, a GIS database containing land parcel, ownership, and boundary information. This decision is a reaffirmation of the right to public access to local GIS databases, which the state Court of Appeals had already supported in a 2008 decision against Santa Clara County in the case CFAC v. Santa Clara County, filed by California's First Amendment Coalition because Santa Clara County charged $100,000 to access to its public geographic information.

The Orange County lawsuit resulted from the Sierra Club's request in 2007 of the county's geographic information "in order to identify land that could be saved from commercial development" (Maxwell, 2013). When the county attempted to charge the aforementioned fee to access these data, Sierra Club argued that they should be a matter of public access protected under the Public Records Act of 1968. However, Orange County countered that the GIS database was exempt from this Act by virtue of being in an electronic format. Furthermore, they argued that OC Landbase constituted 'computer software' rather than 'data', which "would exempt [it] from disclosure under the state Public Records Act" (Barboza, 2013).

After a lengthy court battle that lasted from 2007 to 2013 the Supreme Court reaffirmed the status of GIS databases as 'data', creating a legal precedent that makes it increasingly difficult for local governments in the state to charge substantially more than the cost of reproduction for access to digitized geographic information. At the time of the decision, 47 out of the total of 58

counties in California provided GIS parcel maps for 'nominal fees', such as Los Angeles County, which charged the Sierra Club "less than $10 for a disk containing the files" (Barboza, 2013).

While this California Supreme Court decision may change conditions of distribution of locally collected geographic information in one state, there remains wide range of variation across the country in the economic strategies, and market positioning of subnational administrations with respect to this resource. Furthermore, any changes in the distribution of information do not necessarily affect property regimes that regulate its use and ownership. These factors are significant in shaping the relationship between local administrations and federal agencies engaged in the collection of geographic information. The practical result of this is that federal agencies must negotiate with local data providers on a case-by-case basis to ensure the continuous flow of subnational level data required to assemble nationwide projects such as those undertaken by the USGS and the Census Bureau.

Another significant consequence arising from interscalar regulatory differences is the variability in data quality. The diverse budgetary constraints across state, county, and local administrations create conditions where it becomes difficult to enforce and verify uniform standards of quality for geographic information. As recounted by a senior geographer at the Census Bureau, counties collect datasets containing roads in their jurisdiction, which they share with the Bureau in order to the update the national road topology. Often these county datasets contain anomalies known as 'paper streets'. These are streets and roads that only exist on paper and cannot be located physically[39]. This is most likely a result of developers indicating to local governments that they will build a road at a particular location, and even submitting the plans to do so (leading to their incorporation into official datasets) but failing to follow through with the project.

[39] Interview with senior geographer at the U.S. Census Bureau. March 25, 2016

This creates difficulties for the Census Bureau: in order to assemble a national dataset they must combine data from 50 states and over 3000 counties (and county equivalents). The Census Bureau is unable to carry out ground-truthing across the country to ensure that every single street or road submitted by local governments exists in the real world. To address this problem, the Bureau has begun using satellite imaging to verify road topology more efficiently.

The logistical issues caused by the variations in local data quality highlight the tangible impacts of the various institutional and budgetary logics that prevail at different scales of government. These issues are addressed through a combination of mechanisms focusing on the internal workings of particular agencies (such as data verification by the Census Bureau, mentioned above), and inter-institutional practices aimed at developing interoperability in the production and distribution of geographic information at various scales.

The National States Geographic Information Council is an association that brings together state administrations, territories, and tribal governments with a specific focus on issues related to geographic information. It's stated mission is to "to promote statewide geospatial coordination activities in all states and to be an effective advocate for states in national geospatial policy and initiatives, thereby enabling the National Spatial Data Infrastructure (NSDI)" (National States Geographic Information Council, n.d.). In order to promote this coordination, the NSGIC "provides a unified voice on geographic information and technology issues, advocates State interests, and supports its membership in their statewide initiatives…actively promotes prudent geospatial information integration and systems development… reviews legislative and agency actions, promotes positive legislative actions, and helps inform public and private decision-makers" (National States Geographic Information Council, n.d.).

Responding to the mosaic of policies and practices described in the previous subsection, NSGIC seeks to enact a semblance of coherence to the production, distribution, and regulation

of geographic information undertaken by states. As will be explored in depth in the following section, the development of legal and technical interoperability at all administrative levels in the country is a requirement to assemble comprehensive quality geographic datasets, which in turn are also necessary for decision-making at all scales, but in order to be effective, require the inclusion of local data collected by subnational administrations. Thus the NSGIC plays a key role in linking the federal level and the different regimes regulating and standardizing the production of geospatial data across all 50 states.

This organization however, is a necessary, though not sufficient element in the development of more general mechanisms of interoperability (such as the National Spatial Data Infrastructure) that include states and other jurisdictions and comprise legal as well as technical measures for the collection and distribution of uniform geographic information datasets. The following section covers in greater depth some of these key mechanisms in the development of legal and technical interoperability for geographic information in the U.S.

4 Interoperability

4.1 Legal Interoperability

Legal interoperability, depending on its state of development, can be either an impediment or a facilitator to the adequate circulation and use of geographic information in society (Harlan J. Onsrud, 2010; H J Onsrud, 1995). Creating such conditions is critical for the efficient operations of states, as well as markets, which more directly rely on the continuous recombination of informational inputs and their transformation into innovative applications. Therefore, in order to understand the configuration of the geographic information economy of the United States it is

essential to trace the elements that come together to enable its interoperability. This subsection focuses on legal interoperability; technical interoperability is covered in the following subsection.

The legal landscape regulating geographic information in the United States is characterized by the interaction between rules set at various levels by an institutional configuration that includes, among others, federal and state laws, governmental initiatives, federal, state, and municipal agencies, administrations, and decisions made by courts at various levels in the state and federal systems. Statutes such as Copyright Law (Title 17 of the U.S. Code) outline the different protections that apply to geographic information depending on factors such as its producer and the format. For data produced by a private party or a subnational government, copyright applies differentially depending on the type of geographic information and the location of the jurisdiction. Maps are protected category in Copyright Law since the first Act of 1791. However, as maps have become digitized, they are often divided into various components, principally the pictorial or graphic map and the database.

While Copyright Law in the U.S. continues to protect pictorial maps, the protection of databases, which increasingly make up the most (and most valuable) part of geographic information, are not necessarily protected. Since the Supreme Court of the United States decision in the case of Feist v. Rural in 1991, databases are considered compilations of facts and therefore do not meet the originality requirements to be protected by copyright. As a result, databases are often protected under Contracts Law, which can have a greater degree of variation and may result in more stringent protections than Copyright Law (Karjala, 1995; Reichman & Samuelson, 1997).

The distribution of geographic information produced by the government is in principle regulated by law. However, there is often flexibility for practice which is clarified by policy documents such as the OMB Circular A-130, discussed in the first section, which prohibits

federal agencies from deriving additional financial resources from the distribution of government information (Branscomb, 1994, p. 161).

However, depending on the jurisdiction in which a case is heard, it can move through the federal or state court systems. Some of these cases may eventually be adjudicated in the Supreme Court of the United States. This was the trajectory of the landmark case on databases, Feist v. Rural, which was initially decided in the United States District Court for the District of Kansas in 1987, and subsequently overturned by the Supreme Court of the United States in 1991. Due to the jurisdictional hierarchy in the judicial system, decisions made in the nation's Supreme Court can set a legal precedent for the entire country. Thus, while lower courts adjudicate cases and rule on specific issues relative to geographic information, these are not necessarily consistent or all encompassing, and may be contingent on particular case histories and jurisdictional trajectories.

As a result of this complex patchwork of regulations and jurisdictions, organizations such as the National States Geographic Information Council work in the interstitial space provided by the judicial system and focus on developing a standardized set of practices for geographic information across the country. While the legal aspect of interoperability remains an elusive project given intrinsic variations in the government system of the United States, it is complemented by technical advances that facilitate the production and use of standardized geographic information. Overarching projects such as the National Spatial Data Infrastructure (NSDI) can bridge part of the gaps created by the contingencies of the legal regime(s) of geographic information in the U.S. The NSDI seeks to streamline processes, enforce standards, and harmonize practices in the production, distribution and use of geographic information throughout the country. This and other initiatives to advance technical interoperability have become key elements in the geographic economy of the United States. A significant practical

reason for this is that the distribution and application of geographic information require up to date guidance regarding specific protocols, technologies, and formats, which the law is often unable to deliver due to its broad scope and the pace of its development.

While legal interoperability is a desirable objective, it must be complemented in practice by technical interoperability. The development of both should take place in tandem, even though they move at different rhythms and focus on different elements. Yet there is a high degree of interdependency between them that drives the development of standards, formats, rules, and practices for geographic information throughout the country. In the next subsection the article focuses on two key advances in the development of technical interoperability for geographic information in the U.S.: the TIGER/LINE format created by the Census Bureau and the National Spatial Data Infrastructure.

4.2 Technical interoperability: standards and formats

4.2.1 TIGER format

The TIGER format is a key technology in the geographic information economy of the United States. Its name stands for Topologically Integrated Geographic Encoding and Referencing. This process, initially known as DIME (Dual Incidence Matrix Encoding, later Dual Independent Map Encoding) was first developed during the 1960s and 1970s by the United States Census Bureau and continued into the 1980s with its current name. This technology was a product of the parallel drives to digitize the Census sand to develop a national cartography of roads and boundaries for the decennial Census that could be linked to all other data collected by the Bureau (Bevington-Attardi & Ratcliffe, 2015; Cooke, 1998). The impact of the resulting database greatly exceeded its initial objectives; it "has generated the largest civilian use of maps and

mapping technology supported by the U.S. federal government" (Bevington-Attardi & Ratcliffe, 2015, p. 63). This technological innovation was due to a number of research teams in the Census Bureau, and is a result of the productive interaction between staff and resources at this federal agency and research universities –particularly between the Bureau's New Haven Census Use Study of 1967 and Yale University (Cooke, 1998).

The institutional geography of the Census Bureau itself played an important role in creating the conditions for this breakthrough. As Cooke has argued, the reconstitution of the New Haven Census Use Study into the Southern California Regional Information Study, and its consequent relocation to Los Angeles, provided relative freedom to innovate within the centralized governance structure of the agency (Cooke, 1998, p. 54). The result was a file format able to represent topology in a practical and efficient way that was easily adapted to new computing technologies. The fact that it was created by a government agency, as government work, made a crucial difference in the diffusion, national coverage, and massive use of this format.

Since their appearance in the 1980s, TIGER format files have become crucial in collecting, organizing, and distributing topological geographic information, particularly by government agencies. Its development by the Census Bureau, use as a store for all topology, and linkage to its vast catalog of statistical data made the TIGER format a de facto standard across government agencies and administrations. Furthermore, its impact is a catalyst for the dynamism of the geographic information economy: "[TIGER's] success has put the world's most useful general purpose spatial database into the hands of more users than any other GIS data resource. The current boom in business geographics is only possible because of the groundwork laid by the Census Geography Division in building TIGER" (Cooke, 1998, p. 56).

In the private sector another format became the standard for non-topological geographic information: the shapefile, developed by the Redlands, California-based firm ESRI for their software ArcView in early 1990s (Theobald, 2001). While this format is proprietary with its development and evolution ultimately controlled by ESRI, the company has published its specifications, adding a degree of openness to the format. The shapefile has become a standard of use due to a combination of its feature-centric manipulation enabled by an increase in computing power and the market dominance of this company's feature-oriented software packages, such as ArcGIS and ArcView (Dibiase, 2014; Theobald, 2001).

Given the concurrent nature of these developments –TIGER, by a government agency, and shapefile, by a private firm– is that they have been often combined and distributed together, as the Census Bureau has done since 2007 through the distribution of TIGER/LINE shapefiles. This increases the dissemination and use of both formats and makes them easier to download and manipulate by the majority of GIS users. While their combination has yielded practical benefits, it must be remembered that, their openness notwithstanding, shapefiles are still a proprietary format and their projection is a mostly a pragmatic decision resulting from the widespread use of ESRI's software package ArcGIS.

4.2.2 The National Spatial Data Infrastructure

A second key element in developing technical interoperability for geographic information in the United States is the National Spatial Data Infrastructure (NSDI). This nationwide project was initiated by President Clinton through Executive Order 12906 of 1994, or the Plan for the National Spatial Data Infrastructure. Behind this was a recognition that digitized geographic information was not only increasingly valuable but was rapidly becoming essential for all types of

public and private sector decision-making in government as well as in industry. This project responded to the necessity to standardize the collection and distribution of geographic information across government agencies and scales of government in the United States. The NSDI is a collection of technical standards, policies, and procedures, coordinated by the Federal Geographic Data Committee, and aimed at aligning institutional practices over geographic information. This is particularly important in light of the different regulations, capacities, and incentives that shape the practices of production and distribution of geographic information across governmental institutions.

While the TIGER format developed by the Census Bureau represents one type of component of technical interoperability centered on the technical specifications of geographic information digitization and encoding, the NSDI encompasses the broader architecture through which said information is collected and transmitted within the government. In order to achieve a substantial degree of technical interoperability, initiatives in this respect must enact a combination of these two types of elements. This can imply trade-offs between usability and openness. As was mentioned above, the Census Bureau opted to distribute TIGER shapefiles due to their compatibility with most Geographic Information Systems. Opting to favor the proprietary format of the leading software provider, however, implies a degree of restrictiveness that is thought to be offset by the widespread usage it may foster. Yet, this is a political as well as a technical decision that can have ramifications for an entire spatial data infrastructure. An example of this is the choice made by INSPIRE, the spatial data infrastructure of the European Union.

INSPIRE has developed a collection of standards and procedures aimed at producing uniform geographic information datasets across all member states. Part of this overarching project is the use of the GML, or Geographic Markup Language, file format. This is a type of

encoding for spatial data based on XML language and developed by the Open Geospatial Consortium and selected by INSPIRE due to its status as an open data format. In the hopes of making the geographic information in INSPIRE as open as possible and accessible by the broadest number of users, the choice of GML format inadvertently made it more restrictive in practice because the this file format requires a high degree of technical expertise and is not compatible with the majority of GIS programs.

In contrast to the decision made by INSPIRE, the NSDI's support of the GML format has been more gradual. While the openness of the format is an asset in allowing technical interoperability between geographic information users and producers, its technical specifications remain beyond the reach of most users. A recent pilot study conducted at the Geography Division of the Census Bureau attempted to "utilize the GML standard to organize and present national scale TIGER data" (Guo, 2013) and found major issues related to data volume, comprehensive data organization, and document naming (Guo, 2013).

In light of the difficulties in transitioning to and enforcing a truly open format that can operate across a National Spatial Data Infrastructure, the trade-offs made by the majority of government agencies in the United States are suggestive of a pragmatic approach that privileges distribution and usability over strict openness. While the Census Bureau's TIGER database is still the "the most comprehensive geographic dataset with national coverage in the US" (Guo, 2013), it is noteworthy that the Bureau has supported its release in shapefile format as well as a variety of other popular formats, such as Google's KML, which became an open standard in 2008 (Kirkpatrick, 2008).

This decision by the Census Bureau to opt for widespread distribution over strictly open standards in turn illustrates the larger philosophy characteristic of governmental agencies' involvement in the geographic economy. In the development of technical interoperability, they

have opted to maximize the circulation of geographic information produced by the government, even if that means generating positive externalities towards individual firms and their proprietary formats. This practice aligns with the role of government as producer of informational inputs, which is delimited by the legal instruments discussed throughout this article. In this way, the geographic information economy in the United States receives a continuous influx of informational inputs from the government producers. These producers, such as the Census Bureau and the USGS, in turn operate through a strategy underlined by pragmatism and informed by the potential commercial applications of the data they collect and distribute.

5 Conclusion

This article has shown how Intellectual Property regimes and other regulations have the power to shape information markets by defining actors and outlining their functions within specific jurisdictions. In particular it has demonstrated the mechanism by which the Intellectual Property regime of geographic information in the United States assigns the role of information producer to the U.S. Federal Government and limits it from participating in the market as competitor. By enforcing the public information regime known as 'government works', United States Copyright Law simultaneously creates the conditions for the Federal Government to fulfill its mandate to serve the public and engage in the production of inputs for the information economy.

This Intellectual Property regime is characterized by a separation between the production of information and its consumption, where the government subsidizes the former and implicitly enables the private sector to undertake value-added activities and engage in market competition. Furthermore, this article has also shown that this division is differentiated at various levels of

government, since subnational administrations have greater freedom to operate in the market and enact various licensing schemes. In tension with this, the article highlighted the power of the judicial branch of the government to place checks on local governments in limiting the extent to which they can operate in the market.

In light of the interscalar differences in the production and regulation of geographic information, this article has demonstrated the multidimensional nature of interoperability where legal and technical components work together and allow the aggregation and standardization of information from various sources, facilitating their circulation for commercial and non-commercial purposes. By highlighting the role of interoperability, this article has shown that the geographic information economy in the United States is characterized by a coexistence of diversity (of regulations, conditions of production, relationships between state and market) and coherence, which is bridged through instruments such as the use of common information formats produced by the government (the Census Bureau's TIGER format) and their integration with proprietary formats (such as ESRI's shapefile). These technical developments, aimed at maximizing the distribution and use of information, are loosely coordinated through the development of cross-scalar and multi-sectoral initiatives (such as the National Spatial Data Infrastructure) aimed at developing standards, but whose relative laxity in enforcing a single set of technical prescriptions actually benefits the development of flexible solutions that can be mobilized for the marketization of geographic information.

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Conclusion

This dissertation has provided a geographical theory of the spatial constitution of digital information markets. This theory assembled, through building blocks of Part I (Chapters 1-3) a systematic approach that uses Intellectual Property Regimes as an integrating vector that connects broad level dynamics of variegated global capitalism with the mid-level institutional logics of regulatory institutions, and the mechanisms by which specific geographic informational goods are transformed into market commodities. This theory was empirically mobilized in Part II (Chapters 4 & 5) to analyze the construction of geographic information markets in two jurisdictions that present diverging configurations, and serve as alternative models for the integration of scales of governance, the role of government as information producer, the regulation of information, as well as its forms of commodification. These jurisdictions are the European Union (Chapter 4) and the United States (Chapter 5). In the case of the European Union, the focus is on the interactions between the supranational institutions and their counterparts in the member states of the United Kingdom, Spain, and Germany. In the case of the United States, the dissertation analyzes it by focusing on the construction of information markets through the Intellectual Property regimes at the Federal level and at subnational levels, as well as the tensions and interactions between them.

The opening chapter of the dissertation provided a high-level explanation of how the digital economy integrates into variegated globalized capitalism. This explanation highlighted the uneven territorialization and the multiplicity of forms adopted by the digital economy in its capitalist expansion. An argument was made that the digital economy must be understood in its

embeddedness with socio-spatial formations at various scales, ranging from the supranational to the national, subnational, and local. This argument was illustrated by showing how geolocation technologies enable various types of jurisdictions to regulate the flows of digital information. By showing how information flows are fixed to particular locations and regulated by jurisdictions, this dissertation has demonstrated the need to understand the digital economy as an integral part of capitalism and a force capable of restructuring the space-economy across scales and places.

After showing how the digital economy integrates into the dynamics of capitalism, the dissertation presented a specific account of how digital information goods become commodified. The second chapter of this dissertation analyzed geographic information as a category and specifically took the case of Google Street View in order to demonstrate the emergence of new property regimes in the process of commodification. By extending Schlager and Ostrom's property regimes conceptual schema (1992), this chapter showed how property rights are allocated in the context of digital goods and highlights the role of technological mechanisms in the process of commodification. The chapter also revealed that the logics of property and privacy often intersect in the process of commodification due to the integration of different kinds of information (such as imagery, wifi network data, and location data) and the logics, values, and property regimes that define them. Furthermore, this chapter demonstrated that the property regimes of geographic information (and by extension other types of goods) are contingent upon the technological means of production and distribution, and they directly shape the conditions for their commodification, as well as the production, circulation, and appropriation of value. These arguments represent a significant contribution towards the political economy of geographic information on the Internet, and more generally the understanding of the increasingly central role of information in capitalism.

The third chapter of this dissertation showed how legal frameworks, and particularly Intellectual Property regimes, are fundamental to the spatial constitution of markets. Following insights from research on legal geographies, this chapter argues that, more than merely 'regulating', the law is fully constitutive of the process of market creation. This is because it both defines *and* regulates the interactions between market actors by establishing their terms of their transactions and marking the spatial and operational bounds of the market. This chapter further argued that the definitional role of the law in the constitution of markets is an interactive and adaptive process that is continuously fed back by market outcomes. These arguments were deployed through two alternative market framings used to understand the constitution of information markets: the linear and networked approaches. The first approach is dependent on the role of the government as producer and a linear process of value-addition. The second approach is characterized by non-sequential processes of value-creation. These two approaches were combined to analyze the construction of geographic information markets in the European Union and the United States. This provided a theoretical perspective on the prevailing logics that shape the creation of information markets in each jurisdiction and the role of Intellectual Property Regimes in this process.

Part II of this dissertation centered on the empirical analysis of the construction of geographic information markets in the European Union (Chapter 4) and the United States (Chapter 5). The first case was analyzed through the interaction between European supranational institutions and national governments and agencies in three of its member states: the United Kingdom, Spain, and Germany. The focus of this analysis was the development of interoperability, a key element in the construction of sociotechnical systems that cross borders and scales. Specifically the chapter examined the planned construction of the Digital Single Market in Europe and how this project is informed by the ongoing development of INSPIRE,

the EU's Spatial Data Infrastructure, and a prime example of technical interoperability. While this serves as a blueprint to build the technical infrastructure for the European Digital Single Market, the chapter argues that such a project necessitates the development of robust legal interoperability in order to succeed. However, as the chapter shows, this is a requirement that far exceeds the current capacities of the European Union, as is evidenced by discrepancy in Intellectual Property regimes and the tensions present in the various attempts at commodifying geographic information across EU member states.

The final chapter of the dissertation centers on the case of the United States and examines how Intellectual Property regimes have shaped the formation of the geographic information market in this country. Specifically, the chapter argues that at the federal level, the Intellectual Property regime of 'information works' has served the dual goal of producing public information and defining the role of government as a producer of informational inputs and limiting its action as a market actor. The article shows that there is a discrepancy between scales by highlighting the diversity of property regimes that regulate state, county, and local administrations in their production and distribution of geographic information. The chapter shows that the institutional and budgetary logics that prevail at the subnational level (particularly in smaller and weaker administrations) incentivize government actors to engage in the direct commercialization of the information they produce. However, this creates tensions with federal level information producers (such as the Census Bureau), who rely on local information to update their datasets. The article then showed the significant role played by the judicial system in developing legal interoperability through court decisions that have placed checks on the direct commercialization of geographic information by the subnational administrations. In this way courts have maintaining a status quo of low cost information supply that approaches the public information regime of the federal level in the absence of the 'government works' designation.

Finally, the article showed that the tensions and discrepancies at the various levels of information production by the government are bridged by the development of technical interoperability such as the TIGER format created by the US Census Bureau and the National Spatial Data Infrastructure. These are elements that loosely regulate the homogenous production and distribution of government without enforcing a single standard, and often supporting the development and use of proprietary solutions, such as ESRI's shapefile. These elements in combination contribute to a geographic information economy in which the government is the de facto (and often de jure) supplier of subsidized informational inputs to the public and private firms, leaving to the market the development of secondary applications.

The present work has been an effort to provide a systematic approach to the multidimensional geographies underpinning and emerging from the digital economy. The focus on Intellectual Property Regimes and geographic information presented a fruitful avenue of analysis that promises to continue yielding insights through future research. Geography in general, and Economic Geography in particular, are well positioned to take this research forward in order to continue building an a comprehensive understanding of the digital economy and its role in reconfiguring the spatial organization of capitalism. This dissertation has proposed a set of tools drawn from the intersection of legal geographies, Economic Geography, and critical data studies, which provided insights about the constitution and regulation of digital economies. There are significant areas related to these questions that will benefit from further geographical investigations such as the spatial dimensions of the various legal, technical, and political tools for the governance and regulation of information flows. Another key area for future geographical research is the incremental role of Artificial Intelligence and automated processes in the organization of societies and the economies, as well as the sociospatial implications of algorithmic

deployment and its role in the sorting, classification, and monetization of information integral to the functioning of society.

This dissertation has opened the door for two interrelated research projects that continue research on the new geographies of information. These are linked by the common goal of furthering knowledge of the mutually constitutive relations between capital, space, and information. The first of these projects concerns the link between volunteered geographic information through social review networks such as Yelp! and the restaurant industry in various metropolitan areas. This industry has been selected due to its locational bias and its continued reliance on the brick-and-mortar business model. The objective of this research is to uncover how digital information networks interact with economic activity that is seldom considered part of the digital economy. This research is designed to provide further clues regarding the transformation of the space-economy through the widespread use and incorporation of digital information networks.

The second project continues the scrutiny of Intellectual Property Regimes in the spatial constitution of markets and economies. While this dissertation has focused primarily on objects of copyright protection, patents offer new and different insights into the economic value of information and the regulation of knowledge flows, technology, and innovation by territorial jurisdictions. This future study will explore the relationship between patenting patterns and trade treaties in North America, specifically focusing on the ratification of NAFTA and the Intellectual Property content of the TPP. Examination of the locations of inventors, firms, and patent filing in Mexico, the United States, and Canada will provide another dimension of the increasingly important role of informational assets and Intellectual Property protections in the configuration of this regional space-economy.