Socio-Digital Formations

Constructing an Object of Study

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One of the distinctive capabilities of computer-centered technologies is the rescaling of social relations and domains. What has tended to operate or be nested at local scales can now move to global scales, and global relations and domains can now, in turn, become directly articulated with local settings. As a result of the growing presence and use of these technologies, an increasing range of social relations and domains have become, *de facto*, transboundary. Understanding the place of these new computer-centered technologies and the ways in which they are transforming social relationships is the focus of an initiative launched by the Social Science Research Council in 2000 to contribute to the development of a social science of information technology (IT). The SSRC initiative aims at a specific component of this broad agenda for research on and conceptualization of IT, one that focuses on the work of constructing the object of research that speaks to social scientists as opposed to, for instance, computer engineers.[1]

This task presents several challenges for social scientists. We – SSRC's Committee on Information Technology and International Cooperation – decided to address two of these. One involves avoiding technological determinism or limiting research to the "impacts" of information technology on existing social arrangements. In a nutshell our concern with respect to this issue was to recognize that these technologies have contributed to construct whole new domains of interaction. To gain some closure on the effort, we confined our focus to computer-centered interactive technology and to interactive electronic information and communication structures. A second challenge is to go beyond what is one of the most evident and powerful capabilities that these technologies bring to interactive domains: decentralized access. In practical terms this has meant the possibility of reaching far more people – as consumers, as students, as activists – and firms and institutions. But these technologies evince at least two other basic capabilities that we need to factor into social science research. One is interconnectivity (i.e., each point of access can interact directly with all other such points) and the other, simultaneity (sametime transacting). In combination with the first, these two capabilities have it in them to produce significant qualitative transformations in communication and information structures.

Qualitative Transformations: Two Examples

In my own research, I find electronic financial markets to be a good illustration of such a qualitative transformation that comes about when all three capabilities – decentralized access, interconnectivity, and simultaneity – are in play. One of the key and most significant outcomes of digital technology in finance has been the jump in orders of magnitude and the extent of worldwide interconnectedness. There are basically three ways in which digitization has contributed to this outcome. One is the use of sophisticated software, a key feature of the global financial markets today and a condition that in turn has made possible an enormous amount of innovation. Second, the distinctive features of digital networks can maximize the implications of global market integration by producing the possibility of simultaneous interconnected flows and transactions, as well as decentralized access for investors and for exchanges in a growing number of countries. The key background factor here is that since the late 1980s, the trend has been for more and more countries to de- and re-regulate their economies according to a particular set of criteria that has ensured cross-border convergence, the linking of different markets, and the global integration of their financial centers. Third, because finance is particularly about transactions rather than simple flows of money, the technical properties of digital networks assume added meaning. Interconnectivity, simultaneity, decentralized access, and softwared instruments all contribute to multiply the number of transactions, the length of transaction chains (i.e., distance between instrument and underlying asset), and thereby the number of participants. The overall outcome is a complex architecture of transactions. These three features of today's global market for capital are inextricably related to the new technologies.

As this example makes clear, new technologies are partly embedded in institutional environments that have the power to inscribe such technology. As a result the outcome does not reflect exclusively the features of the particular technology at work. One focus of the work of the SSRC's efforts to develop a social science of information technology (IT) has been to capture the interactions between the technical and social logics at work in producing distinctive outcomes across different social contexts in which information technologies are used. These new technologies have had a deeply transformative effect but they do not dislodge the fact that a substantive agenda organizes market actors. Today's global capital market is a complex formation markedly different from earlier global financial markets partly because of its extensive digitization. But digitization does not replace the financial, as different from digitization, logic driving actors even as it changes the composition of their options. Finance remains embedded in a larger set of economic institutions. The global capital market is a particularly helpful case for examining these dynamics of transformation and embeddedness.

Electronic activist networks provide a contrasting example of the transformative potential of information technologies, illustrating how the local can become embedded in the non-local, specifically global networks and global agendas. Through their practices, these local but globally connected activists are developing a particular type of global politics, one that runs through localities and is not predicated on the existence of global institutions. Simultaneous decentralized access can help local actors have a sense of participation in struggles that are not necessarily global, but are globally distributed in that they occur in locality after locality. Computer-centered interactive technologies facilitate multi-scalar transactions and simultaneous interconnectivity among those confined largely to a locality.[2]

Both of these instances are examples of scaling that incorporate all three capabilities of computer interactive technologies. They suggest that the scale-up of such technologies is not simply a matter of reaching larger numbers of people, but has the potential to transform social structures and relationships. The SSRC's effort to construct a different type of object for research from those that are typical in the social sciences might also be of interest to researchers in other fields pursuing innovative ways of using these technologies. For example, "grid technology" that makes possible scientific collaboration discussed by Foster and Kesselman would seem to factor in all three capabilities of IT.

The SSRC Project: Specifying the Problem

SSRC's project on information technology is designed to capture the distinctiveness and variable weight of computer-centered interactive technologies in a broad range of electronic communication and information structures.[3] A key objective is the development of analytic categories that would allow the researcher to factor in this variability.[4] Models centered on technology as the explanatory variable – a common choice – can capture intensity of impact (weak, strong) but cannot adequately capture other features of this variability (e.g., the formation of new interactive domains). Understanding the place of these new computer-centered technologies and their capabilities from a social science perspective requires avoiding a purely technological interpretation and recognizing the embeddedness and the variable outcomes of these technologies for different economic, political, and social orders. They can indeed be constitutive of new social dynamics, but they can also be derivative or merely reproduce older conditions. Further, while some of their capabilities are distinct and exclusive to these technologies, others simply amplify the effects of older technologies.

Methodologically, this concern required us to go beyond the notion that understanding these technologies can be reduced to the question of impacts. There is a growing literature that examines the impacts of these technologies on specific domains long constructed as objects of study by the various social sciences.[5] But impacts are only one of several forms of intersection of society and technology. Others have to do with the constitution of whole new socio-technical interactive domains – what we call digital formations – which in turn need to be constructed as objects of study. This means examining the specific ways in which these technologies are embedded in (often very specialized) distinct contexts. And it requires examining the mediating cultures that organize the relation between these technologies and users – among which we might include matters as diverse as gendering or the utility logics that organize use. These mediating cultures can be quite diverse and particular; for example, when the objective is control and surveillance, the practices and dispositions involved are likely to be different from those involved in using electronic markets or engaging in large-scale computer based conversations.

If these technologies can transform existing, and even constitute whole new interactive domains, we cannot confine the analytic development of this field of inquiry to framing analyses in terms of independent and dependent variables, by far the most common approach in the social sciences. We also need to develop analytic categories able to capture formations that incorporate into one entity what would be conceived of as mutually exclusive conditions or attributes in the independent-dependent variable framing, a subject I return to later.

How We Went about Specifying Computer-Centered Interactive Settings

We established what we might call disciplining conditions for executing the second step of our project: specifying the properties of actual interactive settings. First, we confined our project to electronically structured interactive domains.[6] Second, we selected actually operating domains, rather than simulated environments, since we were not interested in game-theoretic models but wanted to understand the properties of actual interactive settings, including their possibly erratic character. Finally, we narrowed the choice of researchers and foci for analysis to a specific substantive field: interactive domains that are or are becoming part of the world of transnational and international relations.

Proceeding inductively seemed the most effective option given our aim of understanding key features of actual working domains in order to develop an analytic category or model that could then be used for examining other such electronic interactive domains. Since one of our key concerns is to get at the properties of new interactive domains made possible by these technologies, we decided to focus on multiple and very diverse empirical instances of such interactive domains. To that end we selected researchers (both social scientists and computer scientists) working on, among other topics, large-scale Internet-based conversations; global communication systems of major multinational corporations; early conflict warning systems; electronic financial markets; electronic activist networks; knowledge spaces; and open source software development communities. These are all interactive domains structured electronically, and they are all actual empirical cases.

One way of addressing our concerns in the project was to emphasize the variable interaction between the diverse capabilities (technical and social) involved. First, we defined as technical capabilities those endogenous to electronic information and communication structures. Insofar as these interactive electronic structures involve people (there are those that do not), we defined them as containing endogenized social logics directly affecting the transactions – for example, rationales and utility functions of users, whether traders, open source software developers, or the other actors the project focuses on. Each of the domains we selected contains a specific type of interaction between endogenous technical capabilities and endogenized social logics. Second, we recognized that the weight of each the technical or the social will vary according to the domain and according to the cumulative causation or path dependence (i.e., closing out the full range of possibilities that may have existed at time one) set in motion with each of these combinations.[7] The particular techniques and methods to be deployed to capture this variability will depend partly on the particular digital formation under study. The key is that they should accommodate variability of interaction between technical and social factors (as defined in our project), and tendencies towards path dependence in the development of these interactions.

Let me elaborate briefly on the above. An important issue for us was, as I indicated earlier, to avoid technological determinism yet at the same time to recognize the specific capabilities of computer-centered interactive technologies. One reason for this was, again, that these technologies can constitute whole new domains for social interaction and cannot be confined to the status of an independent variable as is so often the case. In their digitized form, these domains exhibit properties of their own that derive from technical capabilities enabling specific patterns of interaction. These properties are then endogenous to these digitized structures rather than the product of an exogenous con-

text – i.e., financial system, educational system, the interstate system – even though the technologies themselves tend to result from nontechnical rationales (e.g., much of the development in electronic interactive domains has been driven by finance and its objectives). Among these endogenous properties are the simultaneity of information exchange, distributive outcomes, capacity for electronic storage and memory, in combination with the new possibilities for access and dissemination that characterize the Internet and other computer-centered information systems.

But insofar as these are interactive social domains they are also characterized by an endogenizing of social logics. By social logics we intend to refer to a broad range of conditions, actors, and projects, including specific utility logics of users as well as the substantive rationalities of institutional and ideational orders. These endogenized social logics will (a) vary from one domain to another (e.g., electronic financial markets and electronic activist networks both use the three technical capabilities described earlier, but they do so for very different purposes), and (b) will variously alter the straightforward technical effect – that is, they may reduce, enhance, or distort the technical capabilities.[8] Further, social logics can also produce whole new possibilities and push technical advances, as has clearly been the case in electronic financial markets, for example.

This way of approaching our problem allows us to conceive of these electronic information and communication structures as resulting from various mixes of computer-centered technical capabilities and the broad range of social contexts that provide the utility logics, substantive rationalities, and cultural meanings for the particular types of digital interaction involved. In this regard then the digital spaces that concern us in this project are socio-digital.

Digital formation is the construct we settled on in the project to designate these specific types of information and communication structures. Digital formations are then to be distinguished from digital technology *tout court*. Further, not all digital networks are digital formations. The latter are mixed outcomes in that they result from endogenous technical properties and endogenized social logics. They are digitized structures but are partly shaped and given meaning by social, political, economic, ideational, and often visual, conditions that exist typically outside of or, at the minimum, transcend the technology as such.

Digital formations can assume a variety of forms. Among those familiar to the social sciences are networks, markets, and communities. But there are other ways of typifying these formations both within and outside the conceptual framing of the social sciences. We can also expect new types of forms to emerge as the use of these technologies widens. The multiplication of digital formations over the last decade means that these can in turn begin to function as social, albeit digitized, conditionings for new technical developments. From a social science perspective, as compared to a purely engineering one, such digitized information and communication structures and dynamics are mixed domains in that they filter, and are given meaning by, social logics.

The presence of social logics in the structuring of these formations means, from a social science perspective, that the technical capabilities of these new technologies are characterized by both variability and specificity. Technical capabilities are deployed or used in ways that are uneven and contradictory within diverse digital formations. They unfold in particular contexts – that is, they do not exist as purely technological events. This in turn makes it difficult to generalize their transformative effects. Variability and specificity are crucial dimensions emerging from the diverse foci of analysis in our pro-

ject. The choice of researchers in the project sought to address this as each focuses in great detail on a different subject. While variability and specificity make generalization difficult, detailed study can illuminate patterns and structures helpful in hypothesizing future trends and in developing agendas for research as IT continues to evolve.[9]

Beginning the Work of Locating Digital Formations

A key issue in the project is the construction of digital formations as an object for study. There are several analytic vocabularies that can be used to do this. Identifying and also developing such vocabularies is part of the conceptual mapping of this field of inquiry and the effort to generate research agendas on the subject. Each of the researchers in the project worked in a specialized discipline and hence used a distinct analytic vocabulary and focused on a distinct puzzle or theme.[10] Here I will simply discuss some strategies for beginning the work of locating a digital formation in a conceptual field that allows us to capture both endogenous technical properties and "external" social logics. Which ones of these external social logics become endogenized will depend on the particular domain under study.

We identify analytic operations that allow us to factor in the intersection of technologies and social logics. These analytic operations should hold whether these technologies are derivative, transformative, or constitutive. And they should hold for a broad range of specific types of digital formations. Such analytic operations can assume multiple forms. We have opted for three such operations, sufficiently complex as to accommodate a broad range of outcomes. We specify these as a first approximation for locating digital formations by understanding the broader field within which they emerge and eventually get constituted as electronic information and communication structures.

At the most general level we want to emphasize the importance of analytic categories and frames that allow us to capture the complex imbrications between the computer capabilities that concern us here and the contexts within which they are deployed or used. A second set of analytic operations concerns the mediating practices and cultures that organize the relation between these technologies and users in order to understand more precisely the social logics at work. (This would seem to be a crucial issue for the implementation of computer-centered interactive initiatives in the educational system.) Until quite recently there was no critical elaboration of these mediations because it was assumed that questions of access, competence, and interface design fully captured mediating experience. A third set of analytic operations is aimed at recognizing questions of scaling, an area where these particular technologies have evinced enormous transformative and constitutive capabilities. In the social sciences, scale (not to be confused with scale-up) has largely been conceived of as a given or as context and has, in that regard, not been a critical category. The new technologies have brought scale to the fore precisely through their destabilizing of existing hierarchies of scale and notions of nested hierarchies. Thereby they have contributed to launch a whole new heuristic, which, interestingly, also resonates with developments in the natural sciences where questions of scaling have surfaced in novel ways. The next three sections develop these issues very briefly.

Digital/Social Imbrications

Using the term imbrication is a way of specifying an interaction that is not characterized by hybridity or blurring: the technical and the social can shape and condition each other but each is and remains specific and distinct.[11] And such interactions can occur in often short or long chains, where one outcome (social) contributes to a new technical element which can contribute to a new social condition that in turn behaves like a conditioning for the technical. Throughout these interactions the specificity is maintained even as each is transformed, and in that sense this process can be described as one of imbrications.

As a first approximation we can identify three features of this process of imbrication. To illustrate, we can use one of the key capabilities of these technologies, that of raising the mobility of capital and thereby changing the relationship between mobile firms and territorial nation-states. This is further accentuated by the "de-materialization" brought about by the digitization of much economic activity. Digitization raises the mobility of what we have customarily thought of as not mobile, or barely mobile. Once digitized, an economic activity or good gains hypermobility – instantaneous circulation through digital networks with global span. Both mobility and digitization are usually seen as mere effects or at best functions of the new technologies. Such conceptions erase the fact that achieving this outcome requires multiple conditions, including such diverse ones as infrastructure and legal changes.

The first feature, then, is that the production of both capital mobility and dematerialization takes capital fixity – state of the art built-environments, a talented professional workforce on the ground at least some of the time, legal systems, and conventional infrastructure from highways to airports and railways. These are all partly place-bound conditions. Once we recognize that the hypermobility of the instrument had to be *produced*, we introduce non-digital variables in our analysis of the digital. Such an interpretation carries implications for theory and practice. For instance, simply having access to these technologies does not necessarily alter the position of resource-poor countries or organizations in an international system with enormous inequality in resources.[12]

A second feature that needs to be recovered here is that the capital fixity needed for hypermobility and dematerialization is itself transformed in this process. The real estate industry illustrates some of these issues. Financial services firms have invented instruments that liquefy real estate, thereby facilitating investment and circulation of these instruments in global markets. Yet, part of what constitutes real estate remains very physical. At the same time, however, that which remains physical has been transformed by the fact that it is represented by highly liquid instruments that can circulate in global markets. One way of capturing the difference would be to call it a form of extreme landlord absenteeism. It may look the same, it may involve the same bricks and mortar, it may be new or old, but it is a transformed entity.

The nature of place-boundedness here differs from what it may have been one hundred years ago when it was far more likely to be a form of immobility. Today it is a place-boundednesss that is in turn inflected or inscribed by the hypermobility of some of its components, products, and outcomes. Both capital fixity and mobility are located in a temporal frame where speed is ascendant and consequential. This type of capital fixity cannot be fully captured through a description confined to its material and locational features.

A third feature in this process of imbrication can be captured through the notion of the social logics organizing the process. Many of the digital components of financial markets are inflected by the agendas that drive global finance, and these are not technological per se. The same technical properties can produce outcomes that differ from those of electronic financial markets. Much of our interacting in digital space would lack any meaning or referents if we were to exclude the non-digital world. It is deeply inflected by the cultures, the material practices, the legal systems, the imaginaries, that take place outside digital space. It is necessary then to distinguish between the technologies and the digital formations they contribute to make possible. The types of digital spaces of concern to our project are not exclusively technical conditions that stand outside the social. They are embedded in the larger societal, cultural, subjective, economic, imaginary structurations of lived experience and the systems within which we exist and operate.

In this regard then digitization is multivalent. It brings with it an amplification of both mobile and fixed capacities. It inscribes the non-digital but is itself also inscribed by the non-digital. The specific content, implications, and consequences of each of these variants are empirical questions – objects for study. So what is conditioning the outcome when digital technologies are at work and what is conditioned by the outcome? We have difficulty capturing this multi-valence through our conventional categories which tend to dualize and posit mutual exclusivity: if it is immobile, it *is* immobile, and if it is mobile, it *is* mobile (a type of endogeneity problem). Using the example of real estate signals that the partial representation of real estate through liquid financial instruments produces a complex imbrication of the material and the de-materialized moments of that which we continue to call real estate. And so does the partial endogeneity of physical infrastructure in electronic financial markets.

Mediating Practices and Cultures

One consequence of the above is that the articulations between digital space and users – whether social, political, or economic actors – are constituted in terms of mediating cultures and/or practices. They result partly from the values, cultures, power systems, and institutional orders within which users are embedded. Use is not simply a question of access and understanding how to use the hardware and the software.

There is a strong tendency in the literature to assume use to be an unmediated event and hence to make it unproblematic (once access and competence are given). There is in fact much more of a critical literature when it comes to questions of access. At best, recognition of a mediating culture has been confined to that of the "techie", one that has become naturalized rather than recognized as one particular type of mediating culture. Beyond this thick computer-centered use culture, there is a tendency to flatten the practices of users to questions of competence and utility.

From the perspective of the social sciences, use of the technology should be problematized rather than simply seen as shaped by technical requirements and the necessary knowledge, even though this might be the perspective of the computer scientist and engineer who designed it. For instance, in his research on use of the Internet by different types of Arab groups, Jon Anderson (2003) found that the young "westernized" Arabs in his study made the same use as many youths in our societies: cruising, chat

clubs, shopping. In contrast, scholars of the Koran, the most traditional group in his study, made a far more sophisticated use of the technology as they hyperlinked their way through the text and prior text annotations. Being scholars of the text, they had a complex mediating culture that allowed them to use the technology (no matter how "traditional" the activity) far more intensely and to derive a far greater utility. These mediating cultures also can produce a subject and a subjectivity that become part of the mediation. For instance, in open source networks much meaning is derived from the fact that these practitioners contest a dominant economic-legal system centered in private property protections; participants become active subjects in a process that extends beyond their individual work and produces a culture. There are multiple ways of examining the mediating cultures organizing use. Among others, these can conceivably range from small-scale ethnographies to macro-level surveys, from descriptive to highly theorized accounts, from a focus on ideational forms to one on structural conditions.

Scaling: The Transformative and Constitutive Capabilities of New Digital Technologies

Narrowing the discussion of scaling to the formation of transboundary domains (e.g., transnational civil society, transnational corporate networks, regional integration) – the overall focus in our project – we can identify four types of scaling dynamics in the constitution of global digital formations. These four dynamics are not mutually exclusive, as becomes clear when we use the example of what is probably one of the most globalized and advanced instances of a digital formation, electronic financial markets. A first type of scaling dynamic is the formation of global domains that function at the self-evident global scale, for example, some types of very large scale conversations (see, e.g., the chapter by Sack in Latham and Sassen, eds., 2005).

A second type of scaling can be identified in the local practices and conditions that become directly articulated with global dynamics, not having to move through the traditional hierarchy of jurisdictions. Electronic financial markets also can be used as an illustration here. The starting point is floor- or screen-based trading in exchanges and firms that are part of a worldwide network of financial centers. These localized transactions link up directly to a global electronic market. What begins as local gets rescaled at the global level.

A third type of scaling dynamic results from the fact that interconnectivity and decentralized simultaneous access multiplies the cross-border connections among various localities. This produces a very particular type of global formation, one which is a kind of distributed outcome: it resides in the multiplication of lateral and horizontal transactions, or in the recurrence of a process in a network of local sites, without the aggregation that leads to an actual globally scaled digital formation as is the case with electronic markets. Instances are open source software development, certain types of early conflict-warning systems, and worldwide activist networks (see, e.g., chapters by Weber, Alker, and Sassen in Latham and Sassen, eds., 2005).

A fourth type of scaling dynamic results from the fact that global formations can actually be partly embedded in sub-national sites and move between these differently scaled practices and organizational forms in a continuous two-way flow. For instance, the global electronic financial market is constituted both through electronic markets with global span, and through locally embedded conditions – that is, financial centers and all

they entail, from infrastructure to systems of trust. So are the global communication flagships of multinational corporations (see chapter by Ernst in Latham and Sassen, eds. 2005).

The new digital technologies have not caused these developments, but they have in variable yet specific ways facilitated them and shaped them. The overall effect is to reposition the meaning of local and global (when internetworked) in that each of these will tend to be multi-scalar. For example, much of what we might still experience as the "local" (an office building or a house or an institution right there in our neighborhood or downtown) actually is a microenvironment with global span insofar as it is internetworked. Such a microenvironment is in many senses a localized entity, but it is also part of global digital networks which give it immediate far-flung span. To continue to think of this as simply local is not very useful. It is a multiscalar condition. Part of the work of constructing electronic information and communication structures as an object for socio-scientific study entails locating these structures against the scalar complexity that the new technologies have made possible rather than taking scales as givens and self-contained.

Notes

1. The results of this initiative can be found in Latham and Sassen (eds.), *Digital Formations: Information Technologies and New Architectures in the Global Realm (*Princeton University Press 2005). Details about the various components of the initiative can be found on the Committee on Information Technology and International Cooperation's website at ssrc.org. See also *Items* (the official publication of the SSRC), Spring 2004. We thank The Ford Foundation for its generous support.
2. Both of these examples are developed in detail in my chapter "Electronic Markets and Activist Networks: The Weight of Social Logics in Digital Formations", in Latham and Sassen (eds.), *Digital Formations: Information Technologies and New Architectures in the Global Realm* (Princeton University Press 2005).
3. We do not assume that technology and society are actually separate entities, and accept many of the propositions in the critical social science literature that posit technology is one particular instantiation of society – society frozen; that is to say, one moment in a trajectory that once might have been experienced as simply social. Without losing this critical stance we want, nonetheless, to isolate the variable we will refer to as technology.
4. We are, to some extent, working against a profuse scholarship centered on the technical properties of the new interactive computer technologies and their capacities for producing change. These technologies increasingly dominate explanations of contemporary change and development, with technology seen as the impetus for the most fundamental social trends and transformations. Such explanations also tend to understand these technologies exclusively in terms of their technical properties and to construct the relation to the social world as one of applications and impacts.
5. For critical examinations that reveal particular shortcomings of technology-driven explanations, see, e.g., Wajcman 2002; Loader 1998; Nettime 1997; Hargittai 1998; and more generally Latour 1991; Munker and Roesler 1997; MacKenzie 1999; MacKenzie and Wajcman 1999; and World Information Order 2002.
6. There are important types of capabilities inherent to these technologies that fall outside the focus of this project, notably robotics, data processing, and the design of virtual environments.
7. Just to recapitulate, by the technical we mean here the digital technologies in play, and by the social, the logics or utility functions that drive users – whether individuals or organizations.
8. Factoring in endogenized social logics and capturing their effect on technical properties is a crucial methodological element in the project. I have examined some of these issues in "Electronic Markets and Activist Networks: The Weight of Social Logics" referred to in note 2. This type of understanding also would contest the still common assumption that a new technology will *ipso facto* replace all older technologies that are less efficient, or slower at executing the tasks the new technology is best at.

9. The uneven and often contradictory character of these technologies and their associated information and communication structures also leads us to posit that these technologies should not be viewed simply as factor endowments. This type of view is present in much of the literature, often implicitly, and represents these technologies as a function of the attributes of a region or an actor – ranging from regions and actors fully endowed, or with full access, to those without access.
10. It is clearly impossible to summarize this material here, and summaries would be of little use. We can only refer the interested reader to the forthcoming volume (see note 1). Each chapter in the volume that resulted from the project is concerned with a distinct digital formation and illustrates a particular research strategy and theoretico-empirical specification.
11. Please refer to the qualifications in note 4.
12. Much of my work on global cities has been an effort to conceptualize and document the fact that the global digital economy requires massive concentrations of material and social resources in order to be what it is (see e.g., Sassen 2001). Finance is an important intermediary in this regard: it represents a capability for liquefying various forms of non-liquid wealth and for raising the mobility (i.e., hypermobility) of that which is already liquid. But to do so, even finance needs significant concentrations of material resources.

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