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City Networks in Cyberspace and Time: Using Google Hyperlinks to Measure Global Economic and Environmental Crises

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ABSTRACT

Geographers and social scientists have long been interested in ranking and classifying the cities of the world. The cutting edge of this research is characterized by a recognition of the crucial importance of information and, specifically, ICTs to cities' positions in the current Knowledge Economy. This chapter builds on recent "cyberspace" analyses of the global urban system by arguing for, and demonstrating empirically, the value of Web search engine data as a means of understanding cities as situated within, and constituted by, flows of digital information. To this end, we show how the Google search engine can be used to specify a dynamic, informational classification of North American cities based on both the production and the consumption of Web information about two prominent current issues global in scope: the global financial crisis, and global climate change.

I. INTRODUCTION

The lexicon surrounding cyberspace, the Internet and "new" technologies is replete with spatial metaphors and analogies (Adams, 1997): e.g., online *community*, web *site*, information *gateway*, *portal* site, chat *room*. At one level, the reading of this spatial language is straightforward. Spatial/territorial analogy superimposes upon the otherwise intangible (and unintelligible) sphere of bits and bytes a determinate and visible/visualizable *representational* surface. Cyberspace, so imagined, becomes knowable; written in "geographical language" (Kellerman, 2002, p. 31) it becomes definable, mappable and understandable in terms of standard spatial rubrics of distance and proximity, connection and flow (see, in relation to virtual worlds, Hudson-Smith et al. 2007). But an alternative reading of this spatial language suggests a problematization of the supposed separation between underlying reality (intangible/unintelligible) and overlaid representation (tangible/visible) (see Cicognani, 1998). This second reading recognizes that the "virtual" world of cyberspace is already fundamentally imbricated with the "real", material life of the contemporary city (Crutcher & Zook, 2009). It is this more nuanced conceptualization of the relationship between the "virtuality" of cyberspace and the "reality" of cities that we seek to build on in this chapter.

Hyperbolic claims that distance—and with it, place, city, and geography—is, or soon will be, "dead" (e.g., O'Brien, 1992; Negroponte, 1995; Kaba, 1996) belie an important paradox of the contemporary information-based economy: even as ICTs become accessible "everywhere", demand for the physical, corporeal transportation between places, and for prime, proximate real estate within "core" urban locations continues to grow (Denstadli & Gripsrund, 2010). The vision of so-called "post-industrial" theorists of a world without distance, where "everyplace is

everyplace" (Abler, 1974), remains entirely unmet in several key respects. Society and technology shape each other in complex ways. While, at the most basic level, ICT implies a decoupling of simultaneity in time from contiguity in space (Castells, 1996), informational flows—the informational "cloud" of ubiquitous communications—are in fact, underpinned and enabled by a vast, *physical* (placed) ICT infrastructure. Thus, rather than rendering place irrelevant, cities' economic performance and their prominence within the global urban network becomes, increasingly, a product of their positions vis-à-vis all other places in relation to ICT networks. Electronic communication has not and cannot be substituted for the social, cultural and economic advantages of urban agglomeration. Or, as Goldsmith and Wu (2006, p. 56) put it, very simply: "[f]ar from destroying cities by making place irrelevant, the production and consumption of Internet content, and the infrastructure to support it, are concentrated in cities."

This chapter seeks to unpack this question of the positions cities occupy in relation to ICT networks, meaning that we seek to understand "cyberspace" as an *object* of study in the context of global urban networks. In contrast to earlier ICT-based urban research in which analyses tend to trace out a 'cyber' geography via *physical* infrastructure and *material* connection, we suggest two ways cyberspace can be incorporated into global urban network research. First, we consider cities as lived places with attributes—experiential, economic, representational, infrastructural—which are represented in and produced by their cyberspaces. And, second, we consider cities as nodes in transnational networks of capital, ideas, representations, and information. Our focus on cyberspace offers a new take on the methodological question of how to study cities' positions within urban networks, especially, in the context and under the aegis of the information-based Knowledge Economy.

The remainder of this chapter proceeds as follows. We first turn to debates within the literature on the conceptualization of "hierarchies" versus "networks", "world cities", and "cyberspace". We examine the nature of the global urban network in order to problematize the ontological assumption of horizontality and mutuality between cities. We argue that the world city network of information flows/exchanges presents itself as an altogether messier and dynamic amalgam of hierarchical and networked characteristics wherein cities position themselves simultaneously in terms of both. Given this understanding, we put forward the thinking that the use of "cyberspace" (i.e. placed and georeferenced informational data) is essential in producing meaningful characterizations of the dynamism of cities and their connections. We examine the relationship between "cyberspace" and world cities literature in more detail and review the ways in which flow information has been used in empirical World Cities Network (WCN) research. Thereafter, we evaluate two different approaches to apprehending empirically cities' relative positions within omnipresent ICT networks, detailing the contributions of both infrastructural (or "cyberplace") and informational (or "cyberspace") approaches (Devriendt et al., 2008). While we argue that infrastructure-based accounts of inter-city connection (e.g., Moss & Townsend, 2000; Rutherford et al., 2004; Malecki & Wei, 2009) are valuable, we show that there exists a need to study not only tangible informational infrastructures and their associated material flows between places, but also the evolving cyberspaces of cities in relation to digital information. These cyberspace-based approaches offer new ways of comparing world cities in the knowledge-based "Information Age" based on the nature of their respective cyberspaces.

In order to illustrate this "new way" of comparing cities, we build on our ongoing search engine based project using Google data (Devriendt et al., 2009). We distinguish this contribution by making use of Google's Insights tool to introduce an innovation in world city analysis, viz., a means of operationalizing "dynamism" in WCN inquiry via the introduction of a "real-time" temporal component to our analysis. The major question we ask, in the empirical analysis, is: which U.S. cities are leaders (and laggards) in terms of the popular awareness of/interest in key cultural, political and environmental issues? The largest 51 cities, in terms of population, in the United States (Demographia, 2008), and the global financial and environmental crises will be used to address this central question. A dual-pronged account of information consumption (i.e., Web search activity) *and* information production (i.e. Web information availability) provides additional information about the *nature* and *temporality* of these cities' cyberspaces. Finally, we summarize our main findings and suggest some avenues for further research.

II. WHAT FLOWS? NETWORKS, HIERARCHIES, CYBERSPACE AND CYBERPLACE

In this section we review relevant aspects of the world cities literature to examine critically the ways in which "networks", "world cities" and "cyberspace" have been and can be conceptualized. What are some of the implications for regarding world cities as networked horizontally rather than nested vertically (for example, see Taylor, this volume)? While in some ways—specifically, in terms of the distribution of particular economic functional specialization—the world city network might appear as a horizontal network predicated on the mutuality of cities' functions (i.e. complementarity, rather than competition)—this is a rather

narrow view of a much more amorphous, complex space of power and connection. Following through this argument—that cities present themselves not just as hierarchically arranged, or just as networked, but simultaneously both (or neither)—leads us to specify a means of capturing something of the less tangible connections and identities of places using Google search engine derived data.

2.1 Hierarchies and networks

Fundamental to the trajectory of world city research in recent years has been the shift from treating global space as a hierarchical arrangement of city-entities to a flattened, networked ontology of complementarity. Intuitively, "hierarchy" is held in contradistinction from "network" (Thompson, 2003). While the former—the staple of early world cities literature—implies verticality, a ranking of more-or-less powerful places, the latter (network) suggests horizontality, a flattened space of mutuality and cooperation (Taylor, 2008). Certainly, this view is implicit in Manuel Castells' work on "flows". In his seminal work, Castells (1996) argues that qualitative changes in the nature of contemporary society necessitate a "new spatial logic," that is, one based on networks of informational flows: "flows of technology, flows of organizational interaction, flows of images, sounds and symbols" (Castells, 1996, p. 412). But, even though discussions of urban *hierarchy*—where "senior" cities have power over and control those below them—might be unfashionable or unhelpful (Taylor, 2009), we argue that it makes some sense to examine cities in terms of urban *rank.* That is, some cities are, we observe, simply more important than others in terms of the production and consumption of discourse on definitive world (city) issues such as financial and environmental crises, cultural trends, etc.

"Listmania" (Taylor, this volume) is, undoubtedly, a popular international pastime (or affliction) of geographers and others. The top 10 party cities; top 20 weekend getaways: cities are popular subjects to rank. The ordering of cities in such ways, however specious the methodologies and however lacking in rigor the methods, speaks to an underlying political economy of boosterism, but also of information production and consumption. While to some extent these rankings are 'just for fun', the "top 10 party city" headlines (Ibid.) are just the tip of an economic-cultural iceberg beneath the ranking surface: a political economy incorporating press releases, public relations, traditional marketing, Web traffic solicitation, newspaper circulation and so forth. Lists are meaningful to information consumers, and not only a "lay" readership. Peter Taylor laments that, of all the subtle and complex work produced under the ambit of the Global and World Cities (GaWC) Group and Network (http://www.lboro.ac.uk/gawc), it is the list of alpha, beta and gamma cities that is most frequently sought out—and referenced by—urban scholars (Taylor, this volume)[ii]. Once categorized, and once ranked, cities, like sports teams, may assume a particular more-or-less impressive status among the peers with which they are competing. *Forbes* magazine's "most livable city in the US" accolade, for instance, is touted on the official tourism Web site of Portland, Oregon long after the actual methodology, or purpose, of the ranking exercise is forgotten (http://www.travelportland.com/media/portland_in_news.html).

Given an initial 'league table', the impulse to monitor that table through time seems irresistible. Giving consumers—whether urban scholars in the case of the GaWC, or city planners in the case of "livability" rankings—what they want is one (economically sound) argument for producing rankings. Another is to claim that cities are, in fact, related hierarchically to other cities. The so-called "NY-LON" (New York and London) or "NY-LON-KONG" (New York, London and

Hong Kong) phenomenon is, perhaps, the classic illustration offered in favor of the argument that global financial centers are oriented towards carving complementary niches within the global economy rather than simply competing for dominance. The qualitative work of Karen Lai (2009) on the often complementary relationships between China's financial centers (Shanghai, Beijing and Hong Kong) is useful in drawing attention to the complexity of actually existing connections between places. Treating cities as networked places, rather than as placeless nodes, requires us to note that places are peopled with diverse actors with diverse agendas, and are associate too with different "types" of flow (people, information, capital). This complicates notions of agency and claims to unproblematically assert a city's identity/function/type (etc.). As Ranjit Hoskote's (2008) account of the complexities surrounding Mumbai's development and emergence as (among many other things) a "world city" and a "cultural center" makes clear, cities are by no means "unities", or unified actors. That is, the contiguity of actors in space does not necessarily entail commonality of purpose, shared allegiance, or shared understanding of place.

Ranking cities, implicitly ordering them hierarchically might, as Peter Taylor suggests (this volume) emphasize competition rather than cooperation, running against the "spirit" of the GaWC Network but—less optimistically—it also reflects that cities are locked into complex and uneven networks of power. While it is possible to gain a handle, empirically, on aspects of a city's identity, especially in terms of components of its economic activity and specific types of material connection between cities, we would seek to stress differences and, specifically, the less-than-tangible representations and flows of information that represent, mediate and produce place. It is because of, and not in spite of, the dynamism of cities and their connections that the

task of producing meaningful characterizations—including rankings—of cities, using informational data (specifically, cyberspace) becomes important. A network ontology of world cities should, in other words, accommodate cyberspace-based city rankings, not because such rankings unproblematically and intuitively reflect a structural ordering of cities in global political-economic space (though, durability of cities' relative rankings might be suggestive), but because they present instantaneous snapshots of dynamic interrelations.

Indeed, the rise of the Internet and the increasing ubiquity of ICTs, especially in the form of portable devices and personal computers, have transformed and complicated the relationship between the materiality of urban places and the virtuality of digital information. While "cyberspace", like informational flows, is, from one perspective, place-less, that is, a horizontal "network" of flows or an informational cloud above (or apart from) material reality, from another perspective, cyberspace is inextricably linked to material reality. Cyberspace reflects/represents and mediates material reality, but it also in part constitutes that reality (Crutcher & Zook, 2009). That which flows (capital, ideas, etc.) is embodied in people and in the enabling material infrastructure of cyberspace, but it also entails decentered patterns of production and consumption of information about cities untethered in respect of physical/absolute space. Central to this way of thinking about an interurban network of connection is the need to complicate (in order to comprehend) concepts such as "cyberspace" and "networks" in ways that recognize the twin qualities of cities as *both* lived places with attributes—experiential, economic, representational, infrastructural—*and* nodes in transnational networks of capital, ideas, representations, and information.

A legitimate question at this juncture then arises, viz., how, can we examine the relationships between "cyberspace" and "world cities" in ways that acknowledge both the importance of placed attributes, infrastructures and concentrations of power *and* the autonomy of a dis-placed cyberspace? In section 2.4 below we consider the insights of both the *cyberplace approach*—concerned with tangible informational infrastructure that facilitates "virtual" flows—and the (here advocated) *cyberspace approach* which is more concerned with the effects and content of information and how these change through time.

2.2 ICT networks and world city research

The current revival in interest in classifying cities and characterizing the links between them can be placed on a long trajectory in the social sciences. As we have already noted, the "ranking" impulse is strong, and, indeed, has been a prominent component of the "world cities" literature, defined broadly, from the outset of modern inquiry into the global urban system in the first half of the twentieth century. Here we locate current cyberspace/information-based analyses of cities within a genealogy of literature examining the interactions between cities.

Concepts such as "primate cities" (Jefferson, 1939) and, later, millionaire cities (Davis, 1959) stressed the hierarchical arrangement of global space. Writing in the context of a globalizing world urban system and, more pertinently to these authors, rapidly urbanizing populations, scholarly interest turned to the question of understanding and theorizing the relationship between cities and their hinterlands, and between cities and other cities. And as change continues apace, especially in terms of the transportation and, more dramatically, ICTs connecting and

reconfiguring cities, interest has once again been piqued in respect of how scholars can begin to get a handle on qualitative changes in the nature of the world city network.

Where population was key, in classic central place theory studies, to determining the "threshold" for certain service functions and thus defining hierarchy, the theoretical underpinnings and empirical validation of such models soon came into question. The inadequacy of population size as a proxy for cities' relative positions and importance in the information world is obvious. For example, in terms of current population, more than half of the world's 30 largest cities are located in Asia, yet few of these rank among the commercial, political and cultural centers of gravity in the global city system (Williams & Brunn, 2004). Few analysts would deny the very real importance of population size, or how the rate of population change influences the nature and intensity of the economic and social challenges and opportunities a city faces. Indeed, such issues as resource sustainability, quality, affordable housing, infectious disease, as well as governance, and disaster preparedness, are more prominently the concern of scholars and policymakers alike in the present era.

Thus, from the 1960s onwards, a succession of geographers and sociologists moved on from the population focus to make use of other proxies for cities' importance/centrality at local, national, regional and global scales. They included: the number of headquarters of major corporations; banking and financial institutions; quantity of NGOs, etc. (Hall, 1966; Friedmann, 1986; Knox, 1994). Derivatives of these studies, especially work on corporate organization (Taylor, 2001, 2004), provide valuable insights into the complex nature of contemporary economies. Taylor's work, and that of the GaWC Group more generally, represent the clearest illustration of the ways

in which recent research on world cities has moved beyond the attribute-based comparative research model[iii]. In other words, earlier classificatory schema treated cities as discrete entities with attributes, analyzing the internal "structure" of individual cities, or comparing their attributes. This mode of inquiry has come under sustained scrutiny only recently, and most prominently following the work of Castells (1996 & 2000). Today, the "standard" mode of inquiry in the world cities literature is, as we have identified, a variant on the "network" approach, characterizing the WCN as, if not a system, then certainly an interconnected assemblage. Although the earlier world cities literature did not seek to imply that cities exist in a vacuum, apart from and unconnected with other cities, it is only with the advent of the "new" knowledge economy, and within the context of rapid and far-reaching economic fluctuations, that the necessity of dynamic approaches emerges. The quickening and deepening connections— that is, flows— between places, held to be characteristic of the contemporary globalizing world, called for and calls for new ways of apprehending the relative importance of cities in an "Information Age" (Castells, 1996). In the present "Knowledge Economy" it is crucial that measures of global urban linkages take into account the flows of knowledge and informational between, and about, cities.

2.3 Specifying "connection"

Manuel Castells' (1996) call for a "new spatial logic" based on networks of informational flows is, perhaps, the founding battle cry of the "new" network approaches to world cities. For Castells, flows were defined as: "flows of technology, flows of organizational interaction, flows of images, sounds and symbols" (Castells, 2000, p. 442). In this section, we draw out the major implications of this flow-based "spatial logic" for the study of world city networks. Perhaps the

most striking feature of the Castellian approach—which rapidly established itself as central to world cities literature—was the gulf, until relatively recently, between the theoretical complexity of world city research and the absence of empirical elucidation. We, therefore, consider the (types of) data that can and have been used in world cities research. The inquiry into cities' cyberspaces, via search engine data—the method illustrated here—begins to introduce the intangible flows of information which at once bear traces of cities' qualities, and work to produce and mediate the experience and (therefore) material reality of cities.

According to Castells, physical proximity and face-to-face interaction were definitive of industrial society, whereas the (present) Information Age entails the fundamental reconfiguration of previously taken-for-granted relationships between time and space. At the most basic level, the Information Age, enabled by ICTs, entails a decoupling of simultaneity in time from contiguity in space (Sheller & Urry, 2006). Castells (1996) suggests that the global urban system should be apprehended not as a *space of places,* but as a *space of flows*. In the former, "place"—as constituted by Castells' space of places—is defined as the historically rooted spatial organization of common experience, fixed in space and invariant through time. The latter, the focus of "network" approaches to world cities, acknowledges both the multiple, overlapping spatialities of information in material and "virtual" spaces, and their continuous reconfiguration through time. Mindful of charges of a globalist hyperbole, we would note that change is a constant in the global economy and (thus) in the relations between world cities, even outside of "crisis" moments such as global recessions and credit crises. Friedmann's noting of this basic fact of continuous change in the global urban system led him to conclude that establishing hierarchy is futile (1995, p. 24):

> "establishing such a hierarchy […] may, in any event, be a futile undertaking. The world economy is too volatile to allow us to fix a stale hierarchy for any but relatively short stretches of time. Assigning hierarchical rank may therefore be a less compelling exercise than recognizing the existence of differences in rank without further specification and, based on this rough notion, investigating the articulations of world cities with each other."

Friedman's call anticipated the present shift towards network based analysis in world cities research. His cautionary note against "stale' hierarchies are well-stated. But investigating the "articulations of world cities with each other" also entails, we would suggest, characterizing the quality and type of connections between cities in terms of their relative importance (rank), *and* the qualities of cities as places in and of themselves.

Friedmann (1986), Sassen (1991), and Castells (1996) all advocated using "flow" (or relational) data in the study of the global urban system. But the challenge of operationalizing this prioritization of networks—flows and relationality—over place—entities with attributes—was rarely addressed (Derudder, 2006). The absence of empirical elaboration that we note here has not gone unnoticed in previous studies. The so-called "data deficiency problem" (Taylor, 1997) is described by Short et al. (1996) as "the dirty little secret of world cities research". It is a truism of the Information Age that information is everywhere, but when it comes to information relevant to world cities scholars, finding and utilizing "good" data are relatively new developments. Indeed, one of the founding premises of the GaWC Network was precisely this observation: "although there has never been as much data for describing the world as exists

today, the vast majority are collected for states and are about states and as such facilitate international comparisons but not the study of trans-state processes" (http://www.lboro.ac.uk/gawc/mission.html). Leading examples of the ways in which scholars have transcended the limitations of these "*state*-istics" to generate meaningful information about city (rather than nation-state) linkages include the outcomes from the GaWC group on corporate organization in advanced producer service firms (e.g., Taylor, 2001, 2004), along with infrastructure-based studies on "global reach" such as Internet infrastructure (e.g., Rutherford et al., 2004; Malecki & Wei, 2009) and airline networks (e.g., Zook & Brunn, 2005, 2006; Derudder et al., 2007). These are important studies that address in some detail various dimensions of the physical connections between cities and in the global urban system. Further, they comprise part of the ongoing information-based research agenda that contributes to our understanding of the extent and complexity of inter-city connections.

The further challenge, spinning off from the discussion of Castells (1996), is how to acknowledge that among the connections between cities are flows that are intangible and *not* simply embodied in people (in the case of airline network analysis) or places (in the case of studies that focus specifically on the physical, enabling infrastructure of electronic communications). Partially addressing this "absence" are studies that use content analysis to examine news sources (e.g., Pred, 1980; Beaverstock et al., 2000) or analyses of conference proceedings in respect of the changing salience of specific topics through time. Beaverstock (2000) argues that "by recording place mentions in a sample of business news stories one can derive a surrogate measure of a city's external relations." Earlier studies based on hyperlinks between cities—operationalized as the number of web pages jointly referencing city pairs—

conceptualized city relationships in similar ways, while pointing towards the potential of additional search engine data for world city research (Brunn & Williams, 2003; Brunn, 2004). We reiterate the importance of up-to-date information, and particularly the focus on "information" in its own right—in the case of Beaverstock et al (2000), the newspaper. Popular publications undoubtedly function as a barometer of issues' salience—at least insofar as their editors have access to sufficient information, and we trust their abilities to judge "salience". However, newspapers represent a tiny and declining slice of the political economy of knowledge production and consumption, and the information selection decisions of an editor represent the partial views of one person (or very small group). By contrast, the World Wide Web, accessed by one in four of the world's population (internetworldstats.com), entails millions of decisions by millions of "editors" daily—all of them gatekeepers of information. People make selection decisions both in terms of information production, by choosing what information to publish (via blogs and personal web pages) and, more frequently, in terms of information consumption, by searching. Web search engines provide us with up-to-date, detailed documentation of these decisions regarding information production and consumption. This information database is updated continuously; it is not a static time slice. In section 3 we return in detail to a consideration of the specific methodological challenges and implications of utilizing search engine data—a little-used (in the world cities literature) resource.

2.4 Cyberspace and cyberplace

Against the backdrop of the a shift towards a Knowledge Economy or "Information Age" it is, as we have suggested, both desirable and necessary that digital communications and their enabling networks—the very "stuff" of the Knowledge Economy—should have entered into the purview

of world city scholars' concerns. There is, of course, more than one way to examine such information networks. Indeed, following Devriendt et al. (2008), we can identify two broad typologies into which Information-based descriptions of the trans-national city network fit. We label and describe these approaches as CP (cyberplace) and CS (cyberspace), both of which offer promise in examining world city networks. Both, however, have some associated limitations.

Cyberplace. Here, we consider the body of work dealing with physical interconnections and material flows, viz., capital flows, corporate organization, and the distribution of airline passengers on a trajectory towards more recent work on Internet infrastructure. Infrastructural approaches are concerned with the physical infrastructure, such as fiber optic cables on which electronic communications depend and provide the framework in which to examine how high tech service and quaternary sector firms choose their locations. These physical connections can be considered reasonable proxies for the relative importance of cities in relation to digital flows as they reflect the architecture of the transnational infrastructure enabling ICT communications across the globe. In other words, global (tele)communication technologies are largely "tied to" key cities (Derudder, 2006), making a persuasive case that the flows of information and knowledge between these key cities defines the global urban network.

Always lurking in the background of infrastructure-based (CP) studies is the question of the proper conceptualization of cities both terminologically and in terms of "scale". As Derudder (2006) points out, there are methodological consequences of defining cities in particular ways, for example, as "world cities" (Friedmann, 1986) or "global cities" (Sassen, 1991). The "world cities" terminology is used to signal an approach to urban hierarchy based on the definition of a

city as a territorially defined and "spatially integrated economic and social system at a given location or metropolitan region" (Friedmann, 1986, p. 70). Couched in the language of world systems theory, world cities literature emphasizes the international division of labor as materialized in and through the reproduction of core, peripheral, and semi-peripheral zones (cities) at the global scale.

By contrast, the sign "global cities" (Sassen, 1991) denotes a more explicitly knowledge-based focus, often concerned with agglomerations of advanced producer service firms (e.g., banking, law, accountancy, advertising, management consultancy, etc). Here power is reconceptualized not as the command-and-control power of world cities theory—in which more powerful core cities exert economic, ideological, and symbolic/representational control over their subordinates (Derudder, 2006)—but as practiced through inter-city networks. The global city perspective is based on the active production of economic power via flows of knowledge and information. The adoption of a global cities perspectives has major implications for studies of inter-city linkages. First, the focus on knowledge flows implies an untethering of cities' economic functions from their physical location. In other words, major agglomerations of service functions such as downtown New York City are more connected with other similar agglomerations throughout the world than they are with their own metropolitan and suburban hinterlands. Second, and related, the patterns of hierarchy between cities are not necessarily fixed, and do not necessarily reflect "old" spatial/territorial hierarchies between North and South or core and periphery. That is, as telematics and ICTs more generally gain still further in importance, the most successful (and "powerful") cities will be those that are best placed with respect to ICT networks. These new "centers" might be in the developing or developed worlds. As Derudder (2006) flags, for

example, Jakarta would not, perhaps, rank highly from a world city perspective, but its critical mass of high-technology, highly-connected financial and service functions downtown make it more prominent from a global cities perspective. Thus, even if one does not necessarily "buy" fully the more excitable post-industrial hype about the transformative potential of technology, the global cities approach is undoubtedly useful in identifying explicitly the importance of knowledge and information flows in the contemporary urban system. It is this information focus that the cyberspace approach seeks to build upon.

Cyberspace. In contrast to the cyberplace approaches in which knowledge/information flows are measured, by proxy, in terms of the physical connections between places, cyberspace approaches seek to deal with the virtual/digital world as an object of study in itself. It is a cyberspace approach to the study of world city networks that we seek to develop in this paper. Broadly, cyberspace approaches are based either on the structure of cyberspace or the content of cyberspace. Structural approaches to cyberspace are concerned with mapping out the hyperlinks between Web sites. For Web users, hyperlinks are the most obvious way in which two Web sites—and thus two pieces of information, two corporations, two places—are linked together, aiding navigation. Further, as Devriendt et al. (2008) point out, organizations must be extremely careful about which external Web sites they link to given that hyperlinks to external sites often denote endorsement of the external entity. Companies might, therefore, choose not to link to external sites for this very reason—a decision not without consequences. Indeed, search engine algorithms examine the structure of hyperlinks between Web pages, and rank pages, in part, on the importance of other Web sites with which they are connected (Zook & Graham, 2007). The structural approach to cyberspace is, therefore, useful for tracking the connections between

corporations within the global knowledge economy. The structural approach is also a key component of search engine algorithms—the procedures by which the Web is "mapped" and Web pages ranked—and thus of the "optimization" of Web pages on the part of content-producers. The basic argument in favor of a structural approach to cyberspace is the expectation that, as more and more "business"— including social interaction via social networking services and the like—takes place online, the structure of hyperlinks (and equivalent digital connections) between people, corporations, and cities, will ever more closely approximate—and constitute—"real" interconnections.

In addition to structural approaches to cyberspace, content-based approaches to cyberspace are concerned with the material contained within Web sites. Centrally, content-based approaches to cyberspace are concerned with the textual content of Web pages. Web users seek information by inputting keywords into search engines such as Google. For example, in the context of the current study, Web users seeking information about the global financial crisis and its effects on the economy of New York City might enter "global financial crisis New York" into a search engine in order to return a listing of pages containing information on this topic. Which Web pages appear or, rather, the order in which they appear, is, as we have seen, partly a product of the hyperlinked structure of the World Wide Web as interpreted by the opaque algorithms of the search engine. But content-based analyses do not necessarily make reference to the underlying structure of hyperlinks or to the rank of pages (though see Devriendt et al., 2009 for a discussion of qualitative content analysis of highly ranked Web pages). Rather, they are concerned—as is the search algorithm—with the actual content of Web pages. Connections between topics are made textually rather than via hyperlink structures.

3. A CYBERSPACE ANALYSIS OF U.S. CITIES

The present study builds, in particular, on the content-based approach to cyberspace analysis. Previously, content-based analysis of cyberspace has been used to trace out the dyadic interconnections between cities by obtaining counts of Web pages jointly referring to those cities (Brunn & Williams, 2003; Brunn, 2004; Devriendt et al., 2008). An innovation to this approach is the inclusion of topical information in hyperlink analysis (Devriendt et al., 2009). We build upon the content-based analysis of Web information by asserting the importance not just of information production/availability (how much information is "out there"?) but also information consumption (what information is actively being sought?). [iv]

In the discussion of "global cities" literature above, we noted that it is to be expected that cities' "ranks" vary according to which criteria are used. That is, the world airline network differs in some respects from the world fiber optic network, which in turn is not a straightforward reflection of the locations of producer service firms (Taylor et al. 2007). Likewise, in terms of content-based cyberspace analyses, it is to be expected that different cities would be positioned differently with respect to different informational measures. In this section we introduce, based on data from the leading and de facto standard Web search engine Google, two dynamic, informational city classifications, which we label the "Web content" and "Web activity" analyses, both exploring the production and the consumption of Web information about two prominent current issues global in scope: the global financial crisis, and global climate change.

The *Web Content Analysis* (WCA) illustrates some of the latest ways in which knowledge/information is produced *about* urban places. That is, we examine the information prominence on the two above-mentioned global issues for the 51 largest US cities (in terms of population, Demographia.com, 2008). The *Web Activity Analysis* (WAA), on the other hand, illustrates the urban *interest* in knowledge/information on these topics *over time*. That is, we investigate which cities (of the 51 largest) have the highest reported levels of search interest—based on the number of user searches made from each city—between January 2004 and August 2009. In short, we argue, this empirical section provides real time "snapshots" of the U.S. space of informational flows taking into account the *content*, the *spatiality* (geography), and the *temporality* of global Web information.

3.1. Web Content Analysis

Method. In seeking to understand the U.S. cities' positions within the space of informational flows, we firstly ranked the cities via a quantitative hyperlink analysis (for more information, see Devriendt et al., 2009). That is, we recorded the absolute numbers of hits or hyperlinks, according to Google.com, for each of the 51 largest US cities, in terms of (a) population (Demographia.com, 2008), (b) the combination of the city name and two financial terms ('economic slowdown' and 'global financial crisis') and (c) the city name in combination with two environmental topics ('climate change' and 'global warming'). For example, querying Google for the number of Web pages that jointly mention "Seattle" and "climate change" resulted in 1,750,000 entries. This search procedure resulted in four data entries for each city: that is, the number of hits for the city name in conjunction with, in turn, each of the four topical search terms. Given the high degree of correlation between the two financial and the two

environmental search terms is high (Pearson's r value exceeds 0.97), we derived a Global Financial Score (GFS) and a Global Environmental Score (GES) based on the average hyperlink volume of the pairs of financial and environmental terms respectively. The cities with the twenty highest urban hyperlink volumes in terms of GFS and GES are shown in Figures 1 and 2.

Figure 1: 20 most important US cities in terms of GFS

(Source: Google.com, 21 September 2009)

Figure 2: 20 most important US cities in terms of GES

(Source: Google.com, 21 September 2009)

The U.S. cities that were/are most highly ranked in terms of GFS are New York, Washington, Chicago, Los Angeles, Detroit, Boston, and San Francisco. Ranking on GES, we obtain the highest GES scores for New York, Washington, San Francisco, Los Angeles, Chicago, Boston, and Orlando. A casual examination of Figures 1 and 2 suggests that while both have similar patterns, there are some differences in terms of information volumes between the two indices when proceeding down the urban hierarchy. For instance, Las Vegas, St. Louis, and Pittsburgh are in the top-twenty in terms of GFS scores only, while Orlando, Portland, and New Orleans appear in Figure 2. In order to understand these ranking differences, we examine, in contrast to the separate GFS and GES rankings/mappings above, the relationship between both measures (see Figure 3 below). Through an assessment of the differences from the regression line, the cities' positions in terms of GES and GFS scores—that is the relative prominence of environmental and financial Web information—can be illustrated. This so-called regression

residual analysis is a powerful yet simple tool for understanding cities' positions. It can be used readily to identify which cities do not "fit" the generalized model of the relationship between GES and GFS (*GES*=21,195*GFS* + 29099, Pearson r = 0,97), thus indicating the relative position of a city in the two information spaces being represented by the GFS and GES variables. Figure 3 below shows the position of the 51 largest US cities according to both scores.

Figure 3 : position US cities in terms of GES/GFS

(Source: Google.com, 21 September 2009)

This "cloud" of cities can be, heuristically, divided in three main parts. First, there is an absolute domination of New York and Washington in terms of both information topics (not surprising given the many reports, conferences, meetings (e.g. UN data) associated with these cities). Next, at the opposite end of the graph are two lower-ranked 'knowledge' cities, that is, Virginia Beach and Bridgeport (part of the New York metro area). In order to understand the rest of the cities' positions within the central cluster of the "cloud" we look in this regression model at the residuals (vertical distance between a point and the regression line). The largest residual values (absolute value above 1.5) in this model are for Detroit (negative residual, placing the city well below the regression line), Orlando (positive), and New Orleans (positive).

Potential explanations for some of these interesting outliers are rather easier to suggest than others. In the case of Detroit, the higher than "predicted" (by the regression) GFS score is likely based on the plethora of new Web information/commentary relating the financial crisis to slowdowns in the auto industry (Chrysler, GM, Ford), as well as home foreclosures and

unemployment which hit this city particularly hard during the period of this study. New Orleans, by contrast, was ranked "unexpectedly" highly in terms of GES—most likely as a result of the volume of climate/environmental information following the Hurricane Katrina. However, other (large) residuals are less easy to explain which makes meaningful analysis useful, but also difficult. For example, Las Vegas, a city with ongoing and well-document water and resource issues also has a housing market that was hit particularly hard first by the bursting of the real estate "bubble", then the more generalized mortgage crisis (see Table 1).

Table 1: GFS and GES residuals

CITY	**Pos Residuals (more GES)**	**CITY**	**Neg Residuals (more GFS)**
Orlando	3.630	Detroit	-2,900
New Orleans	1.750	St. Louis	-1.238
San Francisco	1.466	Kansas City	-1.197
Portland	1.361	Hartford	-1.172
Seattle	1.220	Indianapolis	-0.873
Sacramento	1.142	San Jose	-0.835
Buffalo	1.136	Atlanta	-0.803
Los Angeles	0.842	Tampa	-0.781
Austin	0.835	Las Vegas	-0.768
San Diego	0.776	Cincinnati	-0.735
Denver	0.682	Jacksonville	-0.732
Baltimore	0.649	Chicago	-0.711
Salt Lake City	0.617	San Antonio	-0.687

Oklahoma City	0.608	Providence	-0.650
Tucson	0.500	Washington	-0.502

(Source: Google.com, 21 September 2009)

Given the relative rankings based on economic and environmental "importance"—particularly as evidenced in Table 1—it seems that a division might usefully be made between the two lists. Rustbelt or Manufacturing Belt cities, where joblessness increased rapidly in 2008 and 2009, appear in general in the right column of Table 1 (exceptions being San Jose, Jacksonville, San Antonio, Tampa, Las Vegas, and Atlanta). The left column, on the other hand, contains predominantly Sunbelt cities (except for Seattle and Buffalo which have, arguably, characteristics of Sunbelt economies). In general, these "higher GES" cities did not suffer as dramatically from the recent global economic upheaval but are facing, because of their geographical locations, particular problems such as water shortages (Woods, 1981). Furthermore, large coastal or port cities are, not surprisingly given the amount of material speculating on climate change, water supply and so forth, ranked more highly for GES than GFS. Future work needs to explore these differences in greater detail. The here-presented preliminary results merely suggest the value of Web information-based research for understanding change as experienced in cities.

3.2. Web Activity Analysis

In order to grasp the *geographical* and *temporal* dimension of the space of informational flows, we turn from a consideration, in the previous section, of the information *available* about cities to the information sought by Web users *in* cities. These data illustrate the changing urban interest in

these key informational issues *over time*. That is, we seek to merge both the temporality and spatiality of the U.S. cities' Web search activity. In this effort, we take advantage of a relatively recently developed search engine tool: "Google Insights for Search" (http://www.google.com/insights/search). This tool has not been used before by urban scholars looking at global hierarchies or networks. The possibilities of the use of Google Insights for gaining real-time insights into public engagement with key issues have, however, been recognized in the medical field and elsewhere. Google.org—the "part of Google" that aims to make good on the corporation's commitment to donate time and resources towards addressing "some of the world's most urgent problems"—is funding a Web site that tracks worldwide influenza outbreaks in real-time (http://www.google.org/flutrends/) and maps that data. This project, reported in the journal *Nature* (Ginsberg et al., 2009) finds a strong relationship between the geography of "flu"-related search activity, and the underlying geography of flu incidents. The Insights tool analyzes a portion of the worldwide Google web searches from all Google domains and reports the volume of searches for a given term relative to the total number of searches carried out in Google (Google.com, 2009). It should be noted, however, that the reported results only reflect search terms that receive a significant amount of traffic. That is, only search terms that exceed a minimum threshold of search volume are made available within the tool. For our purposes, we investigate the fluctuations of Google search volumes originating within US cities pertaining to the above-mentioned (and sufficiently popular/heavily-trafficked) global issues, i.e. the global financial crisis and global climate change.

Figure 4 presents on a weekly basis the US search trends for the most frequently used 'global financial crisis'-related and 'global warming'-related search terms (i.e. 'the financial crisis' and

'climate change') over the period January 2004 – August 2009.[v] The actual search volumes are normalized in such a way that the maximum search volume for a time slice (a one week window) within the time period in question is fixed at 100. Thus, a search frequency of 60 percent represents a weekly search volume of 60 percent of the peak (long-term) search volume. We also recognize that the peaks and troughs in the search frequency could be correlated in more detail with the ebb and flow of news stories, political campaigns, published scientific data, and stock market fluctuations.

Figure 4: Web search activity (global) of financial and environmental topics over time
(Source: Google Insights for Search, 29 September 2009)

The search volumes during this 300-week period for climate change information fluctuates (and sometimes rather widely) in contrast to financial crisis information. Financial crisis-related queries are relatively insignificant and stable in the years 2004, 2005, 2006 and 2007 (where :Asian financial crisis" and "Asian crisis" account for most of the observed financial crisis-related search activity). The skyrocketing in financial crisis-related search terms occurs in August 2008, and begins to refer explicitly to the onset of the present global crisis. Search volumes for climate change information have fluctuated since 2004, reaching a peak in January 2007,the week that the IPCC (International Panel on Climate Change) report Executive Summary hit the international news media.

In order to understand the *spatiality* of these two sets of indicators—financial and environmental information— we extract from the generalized timeline of overall US search activity (Figure 4) a

spatially disaggregated "snapshot" of where the "hot spots" for search interest in the two sets of terms were located. For the climate change term, we selected the 36 month period from August 2006 through August 2009; for the financial crisis data, we selected the period from August 2008, when financial crisis search activity began to relate explicitly to the global financial crisis, and August 2009. Table 2 shows the cities with the highest Web search activity for the two sets of search terms over the selected periods. Again, the reported results are normalized such that the city with the highest search volume is allocated a score of 100.

Table 2: Web search activity at US cities over time

Web search activity at US cities			
for "Climate Change" in period Aug 2006 - Aug 2009		for "Financial Crisis" in period Aug 2008 - Aug 2009	
City	Search Activity	City	Search Activity
Washington	100	Washington	100
Denver	45	New York	80
Sacramento	43	Boston	56
New York	41	San Francisco	55
Seattle	40	Philadelphia	49
Portland	40	Chicago	47
San Francisco	38	Seattle	46
Reston	37	Reston	46
Boston	35	Pleasanton	44
Pleasanton	34	Los Angeles	42
Minneapolis	29	Miami	42

Chicago	25	Houston	40
San Diego	24	Atlanta	39
Los Angeles	24	Minneapolis	39
Miami	24	Denver	38

(Source: Google Insights for Search, 28 September 2009)

Clearly, different cities populate the rankings on search interest related to the two key issues: note the "popularity" of the "climate change" issue in Denver, Minneapolis, and Seattle in contrast to their rankings on the "financial crisis" topic. Conversely, we see higher rankings for New York, San Francisco, Boston, Miami, and Los Angeles on the latter issue. Distinguishing between coastal versus inland cities and Rustbelt versus Sunbelt cities (see above) suggests that the search activity *within* cities is rather strongly correlated with Web information *about* cities. That is, those cities about which there exists a large quantity of information related to a particular topic tend also to be the cities where Web users are disproportionately interested in that topic. The above-mentioned differences between interest levels in environmental and financial topics are summarized graphically for New York and Denver in Figure 5 below, which presents search volumes for the period 2004-2009. Exploring the small (but important) differences in temporality between search activities in different places presents a complex but exciting avenue for further research.

Figure 5: web activity at Denver/New York

(Source: Google Insights for Search, 13 October 2009)

4. CONCLUSIONS

The work of Saskia Sassen (1991) and Manuel Castells (1996) introduced to urban scholars the idea that cities should primarily be conceived of as centers of knowledge within transnational networks of *information* and *corporeal* flows. While recent research has, to a large extent, heeded these calls by studying the myriad "informational" interactions between major cities across the world, the focus has been predominantly on tangible networks (e.g., corporate geographies, air passenger traffic). The main purpose of this chapter is to suggest why urban researchers should pay attention to the "intangible" space of flows in order to (better) understand the characteristics of and relationships between (world) cities. Specifically, the Web represents an under-utilized database of information that is i) immense and ii) updated in real time, offering a wealth of data that can be used by urban, economic, environmental and social geographers, and others, interested in the spatial and temporal patterns of information surrounding the current economic and environmental crises at regional and international scales. The "cyberspace approach" demonstrated here builds on earlier hyperlink-based studies such as those by Brunn (2003) and Devriendt et al. (2008) by using examining Web information *consumed in* and *produced about* cities, trough time and in relation to issues which are global in scope.

To this end, we illustrated how cyberspace can be interrogated to specify a dynamic classification of the global urban system. Central to this way of thinking is the recognition of the "twin" qualities of cities as *both* lived places with attributes—experiential, economic, representational, infrastructural—*and* nodes in transnational networks of capital, ideas, representations, and information. In section 2 we related the "cyberspace approach" more explicitly with longer-run "world city research". In the empirical section, we showed how the

Google search engine can provide valuable insights (and, indeed, "Insights") into both the production and the consumption of information about key global issues. Specifically, we examined the information availability about, and Web activity in, US cities based on two issues: the global financial crisis, and climate change. What is most striking in the results is that there is no clear population- or economy-size basis to the observed variations in knowledge production and consumption. While cities such as New York and Washington are the most important "knowledge" centers—according to these results—there are important processes and experiences affecting the positions within the information "cloud" (Figure 3) of each city. Furthermore, the Web Activity Analysis demonstrates the fluctuating salience through time of the keywords in and about US cities. In other words, the space of informational flows varies dramatically through time illustrating very clearly the inadequacy of one-time "snapshot"/slice analyses of cities' positions in information networks.

The Google Insights tool offers new and exciting windows onto the geography of information consumption and, as such, is of immense potential use to geographers and other scholars (as well, of course, as commercial interests). In other words, the data and theoretical frameworks of "cyberspace" await further study by geographers and others interested in the positions and experiences of cities in the context and under the aegis of the information-based Knowledge Economy. Popular culture, the diffusion of disease, flows of knowledge and information (and misinformation), new social movements, etc.: all phenomena represented in (and in some cases enabled by) digital communication. All are influencing and (re)producing the relationships between places. All are suggestive of new and creative takes on the global urban system.

5. REFERENCES

Abler, R. (1974). The geography of communications. In M. E. Hurst (Ed.), *Transportation Geography* (327-346). New York: McGraw Hill.

Adams, P. (1997). Cyberspace and Virtual Places. *Geographical Review, 87*, 155–171.

Beaverstock, J., Smith, R., Taylor, P., Walker, D. & Lorimer, H. (2000). Globalization and world cities: some measurement methodologies. *Applied Geography, 20*(1), 43-63.

Brunn, S. & Williams, J. (2005). Cybercities of Asia: measuring globalization using hyperlinks. *Asian Geographer, 23*(1/2), 121-147.

Brunn, S. (2003). A note on the hyperlinks of major Eurasian cities. *Eurasian Geography and Economics, 44*(4), 321-324.

Brunn, S. (2004). An e-classification of the world's capital cities: URL references to websites. In H. Kehal (Ed.), *Digital Economy: Impacts, Influences and Challenges* (200-216). Hershey, PA: Idea Group, Inc.

Castells, M. (1996). *The Rise of the Network Society*. Oxford: Blackwell.

Castells, M. (2000). *The Rise of the Network Society*. Second Edition. Oxford: Blackwell.

Cicognani, A. (1998). On the linguistic nature of cyberspace and virtual communities. *Virtual Reality, 3*, 16-24.

Crutcher, M. & Zook, M. (2009). Placemarks and waterlines: racialized cyberscapes in post-Katrina Google Earth. *Geoforum*, in press.

Davis, K. (1959). *The World's Metropolitan Areas*. Berkeley, University of California Press.

Demographia (2008). *Largest Urban Areas in the World*. Retrieved October 4, 2009, from http://www.demographia.com/db-wlargestua.pdf

Denstadli, J. & Gripsrund, M. (2010). Face-to-face by travel or picture: the relationship between travelling and video communication in business settings. In J. Beaverstock, B. Derudder, J. Faulconbridge & F. Witlox (Eds.), *International Business Travel and the Global Economy* (in press). London: Ashgate.

Derudder, B. (2006). On conceptual confusion in empirical analyses of a transnational urban network. *Urban Studies, 43*(11), 2027-2046.

Derudder, B., Devriendt, L., & Witlox, F. (2007). Flying where you don't want to go: an empirical analysis of hubs in the global airline network. *Tijdschrift voor Economische en Sociale Geografie, 98*(3), 307-324.

Devriendt, L., Boulton, A., Brunn, S., Derudder, B. & Witlox, F. (2009). Major cities in the Information World: monitoring cyberspace in real-time. *GaWC Research Bulletin 308*. Retrieved June 23, 2009 from http://www.lboro.ac.uk/gawc/rb/rb308.html.

Devriendt, L., Derudder, B. & Witlox, F. (2008). Cyberplace and Cyberspace: two approaches to analyzing digital intercity linkages. *Journal of Urban Technology, 15*(2), 5-32.

Friedmann, J. (1986). The world city hypothesis. *Development and Change, 17*, 63-83.

Ginsberg, J., Mohebbi, M., Patel, R., Brammer, M., & Brilliant, L. (2009). Letter: Detecting influenza epidemics using search query data. *Nature, 457*, 1012-1014.

Goldsmith, J., & Wu, T. (2006). *Who Controls the Internet? Illusions of a Borderless World*. Oxford: Oxford University Press

Gorman, S., & Malecki, J. (2000). The networks of the Internet: an analysis of provider networks in the USA. *Telecommunications Policy, 24*(2), 113-134

Hall, P. (1966). *The World Cities*. New York: McGraw-Hill.

Hoskote, R. (2008). Versions of a postcolonial metropolis: competing discourses on Bombay's image. In K. Segbers (Ed.) (pp. 258-287), *The Making of Global City Regions: Johannesburg, Mumbai/Bombay, Sao Paulo, and Shanghai*. Baltimore: JHU Press.

Hudson-Smith, A., Milton, R. Dearden, J. & Batty, M. (2007). Virtual cities: digital mirrors into a recursive world. *UCL Working Papers Series, 125*(December 2007), 1-24.

Jefferson, M. (1939). The law of the primate city. *Geographical Review, 29*, 226-232.

Kaba, S. (1996). Building the future: an architectural manifesto for the next Millennium. *Web Architecture Magazine, April*.

Kellerman, A. (2002). *The Internet on Earth. A Geography of Information*. West Sussex, England: John Wiley & Sons Ltd.

Knox, P. (1994). *Urbanization: An Introduction to Urban Geography*. Englewood Wliffs, NJ: Prentice Hall.

Lai, K. (2009). Global Cities in Competition? A Qualitative Analysis of Shanghai, Beijing and Hong Kong as Financial Centres'. *GaWC Research Bulletin* 313. Retrieved October 4, 2009 from http://www.lboro.ac.uk/gawc/rb/rb313.html.

Malecki, E. & Wei, H (2009). A wired world: the evolving geography of submarine cables and the shift to Asia. *Annals of the Association of American Geographers, 99*(2), 360-382.

Moss, M. & Townsend, A. (2000). The Internet backbone and the American metropolis. *Information Society, 16*(1), 35-47.

O'Brien, R. (1992). *Global Financial Integration: the End of Geography*. London: Pinter.

Pred, A. (1980). *Urban Growth and City Systems in the United States, 1840-1860.* Hutchinson: London.

Rutherford, J., Gillespie, A. & Richardson, R. (2004). The territoriality of Pan-European telecommunications backbone networks. *Journal of Urban Technology, 11*(3), 1-34.

Sassen, S. (1991). *The Global City: New York, London, Tokyo*. Princeton: Princeton University Press.

Sheller, M. & Urry, J. (2006). The new mobilities paradigm. *Environment and Planning A, 38*(2), 207-226.

Short, J., Kim, Y., Kuss, M. and H. Wells (1996). The dirty little secret of word city research. *International Journal of Regional and Urban Research, 20*, 697-717.

Taylor, P. (2001). Specification of the world city network. *Geographical Analysis, 33*, 181-194.

Taylor, P. (2004). *World City Network: A Global Urban Analysis*. London: Routledge

Taylor, P. (2008). World Cities in Globalization. *GaWC Research Bulletin 263*. Retrieved April 28, 2008 from http://www.lboro.ac.uk/gawc/rb/rb263.html.

Taylor, P. (2009). Urban Economics in thrall to Christaller: A Misguided Search for City Hierarchies in External Urban Relations. *GaWC Research Bulletin 311*. Retrieved June 30, 2009 from http://www.lboro.ac.uk/gawc/rb/rb311.html.

Taylor, P., Derudder, B. & Witlox, F. (2007). Comparing airline passenger destinations with global service connectivities: a worldwide empirical study of 214 cities. *Urban Geography, 28*(3), 232-248.

Thompson, G. F. (2003). *Between hierarchies and markets*. Oxford: Oxford University Press.

Woods, M. (1981). Desert-like conditions hurt Sun Belt. *The Blade (Toledo, OH)*, 18 January 1981.

Zook, M. & Brunn, S. (2005). Regions, hierarchies and legacies: European Cities and global air travel. *Journal of Contemporary European Studies*, *13*(2), 203-220.

Zook, M. & Brunn, S. (2006). From podes to antipodes: positionalities and global airline geographies. *Annals of the Association of American Geographers, 96*(3), 471-490.

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[ii] Based in the geography department at the University of Loughborough, UK, the Globalization and World City (GaWC) Research Network was established as a central place for scholars studying the relations between cities.

[iii] GaWC-researchers have developed a methodology for studying transnational urban networks based on the assumption that advanced producer service firms 'interlock' cities through their intra-firm communications of information, knowledge, plans, directions, advice, etc. to create a network of global service centres (Beaverstock et al. 2000).

[iv] Another shortcoming of previous hyperlink studies is that there is not any critical reflection or discussion on the merits of using search engine data: while there are clearly great advantages to using the Google Search Engine—especially size (over one trillion unique URLs trawled), and timeliness (the index is continuously updated by its distributed network of "spiders")— cautions are required. For example, searching via Google.com (the US/international version of Google), and the spelling of search terms and city names in English limits our analysis to the English language Web. This and other "problems" with these methods are discussed, and how these are addressed in the subsequent analysis, in Devriendt et al. (2009). We refer readers to this publication for a more detailed discussion of these methodological challenges.

[v] In each case, we used the Google Insights service to identify the two most frequently searched keyword terms related to each topic.