

Investigation role of Information Technology (IT) in urban management transformation

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Abstract: This study investigated the role of information technology in urban management and its transform, construed either as evolutionary or revolutionary, permeates two broad urban research traditions of metropolitan change. It reviews research findings from these two research traditions concerning metropolitan population and employment redistribution. It suggests that synergies between ICT and our car, truck, and airplane society may be a thrust behind well-established urban decentralization and deconcentration trends. Because creating electronic city and electronic municipality that they are result of information technology, causes citizens access to their needed services directly, safe, reliable, quickly and 7-24, and physical offices replace by digital offices and organizations such as municipality, public transportation, regional water organization, etc provide their services virtually and using facilitates such as ICT for citizens. However, such logic poses serious challenges to smart growth's metropolitan agenda. Although both centrifugal and centripetal forces are shaping the form of the information age metropolis, rather than central city renaissance or absolute urban dissolution, the resulting spatially distributed network pattern is polycentric and evolving into a regional constellation of ICT agglomerations interconnected via high-speed transportation and digital networks.

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1. Introduction

In order to develop urban management based on Information Technology (IT), educational institutions, e-entrepreneurs, the information technology (IT) industry, community developers, planners, and urban designers, among others, have come together to reinvent locales as more livable, sustainable and vibrant, world-class, digitally connected communities. Information Technology (IT) The rallying cry of these coalitions is often a denunciation of urban sprawl and its consequences, including central city decline; lack of affordable housing; long commutes; traffic gridlock; fast-disappearing open space; environmental pollution; and automobile-dependent, mass-produced, boring development patterns. This article asks two questions: What conclusions can be gleaned from research about urban form effects associated with information and telecommunication technology (ICT)?

Paradoxically, the literature and research that examine the spatial implications of the information age seem to indicate that the form of cities is spatially looser and fragmented, dynamically becoming more polycentric and complex, and fast dispersing and deconcentrating. Even in some rare instances where regional governance and growth management schemes have been implemented in the United States, such as in the Twin Cities metropolitan region, expansive urban growth has been hard to contain it. This has resulted in the furtherance of urban sprawl, understood as more exurban development, social and

spatial segregation, congested streets, and disappearing open space.

I review research findings from these two research camps in terms of metropolitan population and employment distribution, synergies between ICT and the automobile society, and agglomerations drivers among ICT firms. I conclude with an outline of the challenges that these findings pose to smart growth's metropolitan agenda. ICT's effects on urban form and structure are seldom directly observable and never independent from a host of other factors. They are contingent upon how models of urban structure and attendant theories of urban growth and change conceptualize technology and ICT's role in influencing changes in urban settlement, spatial redistribution of population and employment, and new development patterns.

Thus, ICT-urban form relationships are difficult to tease out not only because of the complexity of urban phenomena and the durability of the built environment but also due to what Henri Lefebvre (2003) called the "blind field"—a blindness resulting from seeing current urban reality through the conceptual lenses and theories shaped by an industrial or agrarian past. Hence, research dominated by classical monocentric urban models, founded on theory derived from early-twentieth century rural market towns, is bound to miss important new metropolitan dynamics associated with our current globalized, tertiarized, quaternized, polycentric, and "informationalized" urban world (Hall 1997). In a seminal review of urban structure research in

economics, Anas, Arnott, and Small (1998) recognized that for more than two centuries, cities have been decentralizing, but that in recent decades, the process has taken a more polycentric and dynamic form, concentrating employment in urban subcenters that rival the central business district (CBD). Although work in the “new economic geography” offers new insights into the formation of economic agglomerations (Krugman 2009; Fujita and Thisse 2002), some researchers have raised questions about its utility in guiding empirical research. This article presents no alternative to this predicament, other than to argue for an interdisciplinary approach in lieu of viewing ICT–urban form relationships exclusively through a single lens.

They acknowledged that recent changes in the technology of agglomeration, due to advances in ICTs, may profoundly alter the patterns of spatial development, and exhorted urban economists to more seriously concern themselves with understanding the information revolution and its effects on the micro-foundations of agglomerations. In this respect, they assert that an important source of current change in urban structure is the changing economic relationships within and between firms.

elecommunications, information-intensive activities, deregulation and global competition have all contributed to changes in the functions that firms do in-house, and how those functions are spatially organized. Some internal interactions can now be handled via telecommunications with remote offices which already perform routine activities such as accounting. Some vertical interactions are now more advantageously made as external transactions among separate firms, possibly requiring even more frequent face-to-face communications because of the need for contracting . . . firms are developing new interactive modes which are neither market nor hierarchy, but rather constitute . . . a “network” organizational form, characterized by “relationship contracting” and having unknown implications for locational propensities. 1 and (2) what implications can be drawn from this literature regarding smart growth and the new metropolitan agenda? Since research findings are seldom conclusive, particularly on a subject as dynamic and volatile as ICT, answers to these questions must remain tentative.

However, there is a body of heterogeneous research regarding ICT and urban form that raises important issues for smart growth policy. Because causality claims regarding technological change and urban form cannot be divorced from how technology is conceptualized and how urban form and structure are theorized, I first review some concerns raised in the literature about the limitations of classical urban models in capturing new urban realities. Then I

present how ICT, construed as evolutionary and revolutionary, permeates two broad urban research traditions of metropolitan change.

(P. 1427) Echoing a similar concern, Markusen, Hall, and Glasmeir (1986) earlier bemoaned the lack of adequate theory to explain the location of high-tech industry.

Literature review

ICT has been conceptualized and categorized in two major ways: “evolutionary” and “revolutionary”. An evolutionary approach posits a progression of improvements in a specific technological trajectory, such as mobile phones being the latest generation in a long sequence of innovations since Bell’s invention. In this instance, ICT amounts to impressive technological advances in communication, which dramatically reduce communications and transportation costs? Thus, ICT accelerates long-standing urban decentralization trends. The revolutionary approach posits ICT at the core of a socioeconomic paradigm founded on a technical complex of information technologies for the communication, processing, storage, retrieval, manipulation, and organization of digital information. ICT effects are not specific to a sector of the economy, but presumably to all sectors. In this sense, artifacts such as desktop computers, mobile phones, the Internet, and wireless communication devices, together with their corresponding knowledge (software) and physical (e.g., switching centers, optic fiber networks) infrastructures are an integral part of both a technological and organizational revolution transforming all types of organizations, be they corporate, public, or civic. In its most exaggerated and simplistic version, this view was articulated by futurologists of the 1980s, who forecasted the end of cities, presumably as advances in computers and electronic communications would substitute for all form of personal interaction and obviate the need for travel. Not surprisingly, this “death of cities” vision kindled intense popular and academic debate and engaged a vast array of scholarly work from all walks of academia committed to its debunking.

A now classic article by Gaspar and Glaeser discredited the “death of cities” view by empirically showing that the rise in telephone use, a proxy for ICT, was not negatively correlated with urbanization and that “electronic and face-to-face contacts may be complements, not substitutes” (Glaeser). Glaeser (2008) argued that while some face-to-face communications will be replaced by technology, the overall effect of ICT will be a rise in the demand for interaction of all types, including personal and tele-mediated ones. Moreover, referring to his research on high technology industries, Glaeser asserted that ICT-intense industrial agglomerations, such as Silicon

Valley, demonstrate the importance rather than the triviality of geographic proximity among firms. The strength of this approach undoubtedly lies in contributing, along with many others (see Leamer and Storper 2001; Gillespie and Richardson 2000), to putting to rest the ICT–city redundancy myth.

The marriage of ICT and transportation in the form of real-time logistics is deeply transforming production and distribution processes such as just-in-time production—turning trucks and cargo airplanes into mobile warehouses—and scanner-based retail supply chains—scouring the globe for the cheapest goods and the quickest form to bring them to market. The proliferation of Wal-Marts and similar “power centers” (groups of big-box retailers), typically found at the urban edge, are the poster child of ICT-based retail. Contract manufacturing and international outsourcing to lower factor-costs regions and nations—made possible by improved telecommunications and increased bandwidth—abetted the massive overseas relocation of American manufacturing, and increasingly now professional services such as accounting, architectural, and engineering drafting services, help desk and customer services, and more recently, software programming and ICT-intensive producer services.² These are examples of new ICT-enabled cross-national (global) production and distribution systems (Castells 2006). It also reminds us of the significance of ICT-intensive agglomeration economies as sources of urban growth. However, this evolutionary approach sees ICT as basically a step up from telephones and previous communication technologies, whose urban impact reduces to an “economy of presence” (Mitchell 2000), defined by technological substitution or complementary effects on personal interaction. Furthermore, the revolution originates in cities and is bound to transform them into “postindustrial,” “informational,” or “networked” cities. This revolutionary rather than evolutionary view of ICT is embedded in the various sociological and business discourses proclaiming a transition to the Network Society (Castells 1996b), the new E-economy (Cohen, de Long, and Zysman 2001), and other similar notions (Graham and Marvin 2006).

This transition is thought to be as momentous as the Industrial Revolution in terms of far and wide effects on society. The growth of local, regional, and global digital grids, and the synergistic marriage of ICT with many other technologies—primarily transportation—are continuously taking advantage of increasing computer power and cheaper and broader communications bandwidth. Notably, the tug of war between centripetal and centrifugal forces on urban form resulting from the “hustle and bustle” of digital exchanges occurring in cities can be traced to four

major influential developments: (1) ICT-based transportation, (2) services and production outsourcing, (3) ICT-induced travel, and (4) ICT-intensive districts.

For instance, retail logistics and outsourcing are known to be bringing about metropolitan\ decentralization,³ regional deconcentration of population and jobs (U.S. Congress, Office of Technology Assessment [OTA]), as well as international deconcentration of employment. However, ICT-intensive producer services, ostensibly spawned by the new management needs of a globally dispersed production and distribution system, not only agglomerate in cities, with greatest concentration in the largest metropolitan economies, that is, the so-called global cities New York and Los Angeles (Sassen 2004), but also in second-tier cities like Seattle, Washington; Atlanta, Georgia; and Orlando, Florida (Beyers 2000). A combination of these two approaches to ICT permeates most research on urban form.

In the *Technological Reshaping of Metropolitan America*, the now defunct Office of Technology Assessment (OTA; 2005, 1) examined the effects of the aforementioned centripetal and centrifugal forces on new patterns of industry and commerce and concluded that a more spatially dispersed and footloose economy would bring about new waves of population and employment redistribution, causing metropolitan areas to be “larger, more dispersed, and less densely populated.” Finally, increased demand for travel resulting from the much touted rise of face-to-face and tele-mediated interaction spawned by digital communications also has the potential to overwhelm transportation networks and to intensify congestion costs for cities (Gillespie and Richardson 2000). On the other hand, agglomerations associated with high-tech regional clusters—such as the Research Triangle, Silicon Valley, and Route 128 and gentrifying districts such as New York’s Silicon Alley made up of clusters of creative new-media companies and small software firms have been, in spite of the “dot.com debacle,” sprouting across the metropolitan landscape. All but the last one of these four major developments relate to centrifugal effects. Firms selectively relocate employment to adjacent nonmetro areas in the urban periphery, down the urban hierarchy to second- and third-tier cities, or internationally to offshore regions. In this tradition, the restructuring of metropolitan economies, involving decentralization and regional deconcentration of jobs and people, has more to do with corporate decisions and industrial deregulation than workers’ residential preferences. Furthermore, capital mobility, internationally liberalized markets, and digital technologies that shrink the costs of

distance have unleashed global cutthroat competition among firms for cross-geographic economies and local races among cities for shares of global capital. Winners, according to Michael Storper (1997), will be those cities and regions that can learn faster and keep innovating or creating knowledge that cannot be readily imitated, commoditized or routinized and relocated to competitor nations and regions. Cities that attract and retain the research and development (R&D) and innovation functions of companies, known as industry shapers, are less prone to incur losses of employment and economic vitality through overseas outsourcing or “geographic arbitrage,” which in international business parlance means “taking advantage of cross-border differentials in labor costs, capital costs, foreign exchange and productivity” (Steinfeld 2001, 1).

Research dealing with population and employment redistribution in metropolitan America has a long tradition of privileging telecommunications and transportation interaction as a key explanation of urban change. However, how and why these technologies influence the pattern of metropolitan settlement differ by whether technological change is theorized from within the urban *deconcentration* or regional *restructuring* research traditions (Frey 2003; Elliot 1995; Clark and Kuijpers-Linde 1994; Audirac 2002). The deconcentration perspective—chiefly developed by human ecologists, demographers, urban geographers, and regional scientists, who attempted to explain the unprecedented urban-to-rural migration of the 1970s (also known as the population turnaround)—posits that deep-rooted residential preferences for low-density living combined with rising affluence and advances in ICT and transportation technology vastly increase the range of choice of cities and locales within and outside a metropolitan area. This perspective also posits that as the densest and largest metropolitan areas in the U.S. system of cities mature, they will keep deconcentrating in two ways: first, through a process known as decentralization or “local deconcentration,” which disperses employment and population to the metropolitan edge and into nonmetro counties;⁴ and second, through a process of regional deconcentration characterized by a shift down the urban hierarchy of job and population growth, whereby more people move from larger to smaller places than the other way around.

However, they emphasize the political-economic importance of new regimes of accumulation (e.g., industrial deregulation, private-public alliances), as well as the role that global capital and the international division of labor play in the rapid and flexible reconfiguration of production and distribution sites in a world economy. Regional

restructuring explanations of change in employment distribution stress a new business model based on outsourcing strategies. Empirical analyses of population redistribution in the United States carried out by demographers, geographers, and urban economists show that except for the 1990s, considered an anomalous decade in which large metro areas grew faster than smaller ones; metropolitan decentralization and regional deconcentration of population and employment have been a consistent trend. Comparing intermetropolitan differences early in the 1990s, OTA (2005, 74) concluded that consistent with technological trends, “growth has been fastest in small and medium-sized metros, which gained 2.7 million workers between 1990 and 1994, compared to 1.4 million for large metros.” Elliot’s (2005) demographic study of population migration in 293 metropolitan statistical areas (MSAs) found that decentralization has increased over the past thirty years, and that the U.S. metropolitan system is deconcentrating “outward from older, more established regions” (p. 21).

Furthermore, Elliot contended that his findings consistent with the regional restructuring perspective “are important because they challenge traditional theories of urban agglomeration by demonstrating that local deconcentration was not an anomaly of the 1970s but rather, has become an increasingly common subprocess of metropolitanization during the past thirty years” (p. 21). In an analysis of urban growth, economists Glaeser and Shapiro (2001) reported that in agreement with previous decades, cities in the 1990s continued to sprawl. Low-density cities grew faster than high density cities, and car-oriented cities grew faster than transit-oriented ones. Using county business pattern data from 1951 to 1996, Carlino (2000) found that jobs have spread out faster than population in the postwar era and that jobs grew faster in less dense and smaller metropolitan areas. Moreover, deconcentration of population and employment, characterized by slower growth of jobs and population in dense MSAs, was common to both the frost belt and sunbelt regions. Finally, after investigating the decentralization of industry in America, Glaeser and Kahn (2001) asserted that by 1996, the average metro area was highly decentralized, arguably in response to the residential preferences of workers. The median employee works eight miles from the city center, while the median resident lives nine miles away—save for New York, where the median job distance is three miles from the center.

In contrast, the regional restructuring perspective draws from a variety of theoretical traditions, which include world systems theory (Timberlake 1985); world city formation (Sassen

1991); the various post-Fordist formulations from the French Regulation School (see Amin 1994) to flexible specialization à la Storper and Scott (1992) and Scott (1988); and informationalism/network society (Castells 1985, 1989, 1996b). These perspectives, which emerged in the 1980s to explain American and European deindustrialization, embrace the revolutionary approach to ICT discussed above. However, they emphasize the political-economic importance of new regimes of accumulation (e.g., industrial deregulation, private-public alliances), as well as the role that global capital and the international division of labor play in the rapid and flexible reconfiguration of production and distribution. In contrast, the regional restructuring perspective draws from a variety of theoretical traditions, which include world systems theory (Timberlake 1995); world city formation (Sassen 1991); the various post-Fordist formulations from the French Regulation School (see Amin 1994) to flexible specialization à la Storper and Scott (2002) and Scott (1998); and informationalism/network society (Castells, 2006). These perspectives, which emerged in the 1980s to explain American and European deindustrialization, embrace the revolutionary approach to ICT discussed above.

These authors also found that manufacturing has decentralized the most, while “idea-intensive” industries remain centralized. However, other studies show some departure from this finding. Hackler (2000) reported both intrametropolitan and intermetropolitan decentralization of high ICT-intensive manufacturing. These firms are locating in peripheral counties and in second-tier cities, while their numbers in large city counties, like Los Angeles and New York, are declining. Even producer services, known to cluster in CBDs and edge cities (Coffey 2000), are following a similar trend. As ICT infrastructures spread throughout the urban hierarchy, producer-service activities are also deconcentrating to second-tier metropolitan areas, which have fewer large-city transactions costs and diseconomies such as crime, traffic congestion, long commutes, and environmental pollution. Moreover, Beyers (2000) has shown that producer services are locating in nonmetro counties as well. The author believed that these establishments locate themselves mainly to be near their deconcentrating clients, who are also driven by the new ICT based business models.

In sum, whether informed by a deconcentration or regional restructuring perspective, research examining population and employment redistribution across the national metropolitan landscape provides a consistent account of increased metropolitan decentralization and deconcentration. This is also beginning to be the case of ICT-intensive

manufacturing and producer services, once thought to be less likely to decentralize. How much of this empirical regularity is directly attributable to ICT effects is anyone’s guess. Furthermore, whether the driver behind decentralizing settlement pattern is (1) congestion costs exacerbated by ICT and travel complementarities overwhelming agglomeration benefits, (2) changing residential preferences of a more footloose population reflecting new demographic realities (Champion 2001), (3) global restructuring of production, (4) greater socioeconomic polarization between information haves and have-nots, or (5) a perverse set of policy incentives (OTA 1995) will most likely depend on one’s theoretical proclivities.

Alternatively, a combination of all of the above points clearly to Hall’s (1997, 311) observation that we are in the midst of postindustrial urban reality in which cities are: “globalized (connected to other cities in global networks); tertiarized and even quaternarized (dependent almost entirely for their economic existence on advanced services); and polycentric (dispersing residences and decentralizing employment into multiple centers or ‘edge cities’).” The latter observation is fundamental in understanding that the observed process of decentralization and deconcentration is simultaneously an agglomerative process, no longer dominated.

However, one key factor thought to contribute to further urban expansion and regional deconcentration in the information age is the synergistic interaction between ICT and the automobile society, which begets increased demand for intermodal connectivity and faster mobility. This is not only due to the ICT-induced rise in interaction and concomitant demand for travel, but also to the disaggregation of labor and the emergence of new e-business activity. Skeptics may argue that the ultimate driver of American decentralization is the car and the truck (Glaeser and Kahn 2003). However, even Glaeser and Kahn (2003, 22) submitted that “technological innovations have enabled trucks to replace boats and trains” and that together with the car, trucks made possible the emergence of edge cities (for an alternative economic view, see Brueckner 2000). They noted in their national study of urban sprawl that a 10-percentage-point increase in job sprawl increases metropolitan-per-capita income by 2.7 percent. Thus, they announced that metropolitan decentralization is not antithetical to agglomeration, that edge cities are economically more relevant agglomerations than CBDs, and that they are the natural urban offspring of a car-based society (p. 41).

If high-tech and intensely networked knowledge firms are indispensable to the viability of cities and regions (Malecki and Veldhoen 2003; Storper 2007; Florida 2000) and to the geographic centrality of economic activity, what is known about the location, nature, and duration of these agglomerations in the so-called new economy? A wide range of theories and debates regarding industrial clusters, including “Marshallian,” “flexible specialization,” “innovation milieu,” “new industrial districts,” “untraded interdependencies,” and so on, surround this question.

According to restructuring analysts, the shedding of manufacturing jobs and the emergence of a new business model that relies on a flexible workforce that can contract and expand according to the firm’s needs has giveaway to the actualization of work. This is manifested in the rise in self-employed, flextime, part-time, and temp workforces (Castells; Giuliano 2008), who may commute more than once a day to different jobs in different urban locations. Together with mobile telephony, which has spawned the “mobile office,” a casualized workforce may deepen the demand for road travel. Also, the rise of e-commerce including business-to business (B2B) activity such as supply chains and just-in-time freight logistics, which make use of GPS (global positioning satellite), EDI (electronic data interchange), and the Internet, as well as business-to-customer (B2C) services such as online shopping, and other intelligent routing and tracking technology for home and door-to-door delivery, have greatly increased the demand for freight mobility.

The surge in passenger and freight travel demand stemming from the shift to postindustrial economy prompted the U.S. Department of Transportation/Federal Highway Administration (FDOT-FHWA) to note that the current deficit in road system capacity threatens the quality of life and economic viability of regions and to warn that the resulting congestion could have a devastating effect on the speed and reliability of the production system. Between 1980 and 2000, total vehicle miles traveled (VMT) increased 80 percent while road capacity increased only 2 percent. In the same period, the growth in truck VMT exceeded the growth of passenger VMT (see Figure 1). Furthermore, between 1998 and 2020, total VMT is projected to increase on average by more than 2.5 percent per year, while truck VMT increases by more than 3 percent. With no slowdown in travel and freight transportation in sight, FDOT-FHWA (2002) reported that while in 1998 10 percent of the national urban highway system was congested, by 2020 congestion will reach 29 percent and that during peak periods this figure will reach 42 percent.

Moreover, “Urban Interstates are and will continue to be the most traveled segments, with congestion reaching 53 percent in 2020” (p. 1). Other freight modes are as well suffering congestion and capacity problems. Air cargo capacity is being overwhelmed by shippers “increasingly relying on air cargo services to meet just in-time deliveries and lower inventories” (p. 1). U.S. container ports and the maritime industry are also experiencing congestions related to increases in international traffic, and the rail industry is challenged by an aging infrastructure.

At a regional level, places with null or unreliable Internet backbone access are destined to become superfluous to the new economy. At the intrametropolitan level, this lack of access intensifies the central city–suburban spatial mismatch characteristic of the automobile society (see Shen 1999; OTA 1995). Hence, one of the distinguishable traits of the informational/network society is the rise in demand for swift intermodalism (air, sea, truck, and rail cargo) and fast mobility and digital connectivity (Castells 1996a; Graham and Marvin 1996). The resulting increases in freight and car travel are likely to give way to new surges in exurban expansion in the form of increasingly dispersed working sites and residences pushed outward by traffic gridlock. Moreover, despite the potential yet marginal substitution effects of telecommuting for travel (Handy and Mokhtarian 1995; Mokhtarian 1998), rising levels of traffic congestion and overburdened network capacity are a manifest effect of the new information economy on transportation infrastructure, and ultimately on urban form (Hepworth and Ducatel 1992; Graham and Marvin 1996). In sum, as the transition from “industrial” to “postindustrial” increasingly connotes pervasive socioeconomic transformations, the form of the information age metropolis emerges as (1) polycentric and intensely extranet worked by land, air, water, and digital means to global and regional urban systems; and (2) deeply digitally and multimodally intranet worked, albeit all the more socioeconomically segregated, physically overextended, and stuck in traffic (Audirac 2002).

Here the emphasis is on urban spatial relationships; thus, the following discussion selectively focuses on “localization” of economic activity (Storper 2007) and “informational” city ideas (Castells 2006), which have been influential in shaping the current discourse on the New Economy (e.g., Florida’s [2002] “The Rise of the Creative Class” and Atkinson and Gottlieb’s [2001] *The Metropolitan New Economy Index*).

Regional restructuring scholars of the informational development variety see new emerging urban and regional agglomerations shaped by three

interrelated factors that influence the location decisions of newest-intensive firms: (1) access to the cities and places networked into the digital global economy, (2) the technological infrastructure (e.g., Internet backbone, airports, container ports, highways) that form the digital and fast communications lattice connecting these cities and places (very much like railways defined economic regions in the industrial era), and (3) the places valued by the information age elite (e.g., knowledge workers, and the new economy's managerial and high-tech elite). Alternatively, Storper (2007) stressed firms' "untraded interdependencies,"—that is, place-bound cultural, institutional, and other relational assets that are not tradable or easily substitutable and that militate against spatial dispersion. One such asset is tacit knowledge. Tacit knowledge spillovers are key in the generation of economic agglomerations that are resistant to decentralization. Tacit knowledge cannot be routinized and transferred across distance and typically requires face-to-face interaction. Thus, highly innovative firms building on tacit knowledge tend to cluster and to remain spatially concentrated rather than dispersed.

Thus, although this does not portend a radical decentralization of Internet infrastructure, or a solution to the digital divide (Sanyal 2000), it nonetheless points to increasingly fewer places left out of the digital grid. This also augments the potential for large and smaller cities and towns to grow their own ICT intensive businesses, and ultimately abet the aforementioned employment deconcentration trends. Both new ICT-based business models, spreading throughout an industry, and the greater freedom in location that Beyers (1996, 2000) observed, split producer-service establishments' locational preference into urban and exurban sites. However, untraded interdependencies are not static. Audretsch and Feldman's (2000) research suggests that as an industry matures, the spatial agglomerating influence of innovative knowledge spillover wanes as the industry nears the end of its life cycle. This in turn triggers a congestion effect and a tendency for innovative firms in that industry to spatially disperse (p. 190). For instance, biotechnology firms that relocated out of Silicon Valley between 1990 and 2001 tended to be older ones (Zhang 2003). Thus, the propensity for knowledge-intensive and innovative activity to remain spatially concentrated is industry specific and hinges on the stage of the industry's life cycle. This is important in understanding the new dynamics of decentralization and deconcentration of ICT businesses, whose increasingly compressed life cycles are an upshot of extremely high-paced rates of technological and organizational innovation.

Some sociologists and planners argue that the spatial polarization of opportunity between information haves and have-nots is not only a sign of the digital divide but also a telling indication of the deepening of socioeconomic inequalities in the information age and the ensuing rise of dual cities characterized by a shrinking middle class and a growing income gap between rich and poor. This gives way to increased spatial segregation as wealthy communities increasingly isolate and physically distance themselves from poor ones (Castells 2006).

Regarding Internet access, research by Moss and Townsend (2000) reported seven metropolitan areas⁸ dominating Internet backbone networks. However, backbone capacity has started to deconcentrate to secondary hubs. Similarly, O'Kelly and Grubestic (2002) found that the top seven metropolitan areas, which are also important multimodal nodes in the national transportation network, have retained market and geographic dominance of Internet backbone. However, in spite of this, second- and third-tier cities from among the top thirty most digitally networked cities are emerging as important players. Furthermore, rural municipalities are starting to partner with wireless Internet service providers (WISP) for deploying fixed wireless commercial and residential connection to the metropolitan Internet backbone (Blackwell 2002).

Conclusion

The purpose of this study is to explain the role of information technology in urban management and stable development. Current study findings showed that information and communication technology play a major role in management and stable development of cities. Under the conditions of postindustrial urban growth examined in this article, questions arise regarding the utility of traditional urban models to understand the forces and processes shaping contemporary urban form. Viewing ICT's societal effects as revolutionary rather than evolutionary reveals that key processes influencing urban form include ICT-based transportation logistics, regional and international outsourcing, ICT-induced travel, and ICT-intensive agglomerations. Two research traditions that have examined the population and employment redistribution of the past thirty years consistently show national metropolitan settlement patterns to be decentralizing and deconcentrating. One possible explanation of this empirical regularity may be the increased synergies between ICT and our automobile society, which result in greater travel demand for people and freight in all motorized modes. In addition to domestic and international supply and production-chain outsourcing, congested transportation networks may be one important factor

pushing employment and population to the metropolitan periphery and down the metropolitan hierarchy.

In terms of theory and research explaining ICT-agglomerative activities, this article examined the notion of untraded interdependencies, access to ICT infrastructure and locational preferences of ICT firms and elite workers. Research suggests that tacit-knowledge spillovers, considered the territorial “glue” of ICT-intensive districts, are dynamic and changing and dependent on the stage of the industry’s life cycle. Near-end-life-cycle ICT industries tend to disperse, and this, along with the diffusion of Internet backbone, may explain the appeal of second-tier cities to relocating ICT firms. In sum, this article concludes that the form of the information age metropolis emerges as (1) polycentric and intensely extranet worked by land, air, water, and digital means to global and regional urban systems; and deeply digitally and multimodally intranetworked, albeit all the more socioeconomically segregated, physically overextended, and stuck in traffic. This condition stresses the spatial form and tempo of the postindustrial city, which translates into time-sensitive rather than distancesensitive development patterns—what called the dominance of the “space of flows” over the “space of places.” All in all, the above trends suggest that in the absence of effective models of regional governance and a revamped smart growth agenda (Katz 2002), the information age’s shaping of the American metropolis may severely defy smart growth’s attempts to curb urban sprawl, understood as more exurban development and loss of farmland and open space, social and spatial segregation, and traffic gridlock.

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