WHERE ARE THE WEB FACTORIES: THE URBAN BIAS OF E-BUSINESS LOCATION

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ABSTRACT

The Internet has been considered the great equaliser for business, allowing distant locals to compete with large metropolitan regions. Recent research points to a different geography, where domains and connectivity cluster predominantly in large urban areas. The question remains, are new businesses of the Internet economy doing the same or avoiding metropolitan areas? This paper examines the head and branch locations of the top 40 e-business integration firms in the USA. The analysis of the distribution of these locations will provide insight to what regions most benefit from the Internet economy. Further, the data should provide a useful comparison to metropolitan trends for domain and connectivity agglomeration.

Key words: Internet, economic development, e-business, cybergeography

INTRODUCTION

As the world continues to globalise and technology advances in leaps and bounds, the geography of the world is changing. The new interconnectedness and interdependence of the world have changed perceptions of space, place and time. Of these technological advances, the revolution in telecommunications and information technologies (IT) has had perhaps the most profound impact on locations and the discipline of geography. The new technologies of telecommunications and IT are 'inherently spatial' (Falk & Abler 1980; Gillespie & Robins 1989). Communication systems that lie at the heart of telecommunications and IT compress time and space, reducing, if not eliminating, the effects of distance (Atkinson 1998; Brunn & Leinbach 1991; Cairncross 1997; Castells 1989; Negroponte 1995). The 'death of distance' (Cairncross 1997) has led to wide speculation across many disciplines that the IT and telecommunications revolution would be an end to the 'tyranny of geography' (Gillespie & Robins 1989). Communications that once required travel or at least a cable or wire now take place via satellites and wireless telephones, making any place as near as any other.

The end of geography, as an important economic factor, takes a different form in each discipline. Economist Richard Harris postulates that 'the Internet (an advanced telecommunication service) can eliminate the scale disadvantage of small regions' regardless of geographical location (Harris 1998, p. 161). Others have seen the revolution as the 'death of cities' as 'economic functions are made more footloose' because electronic communications make it possible to replace face-to-face activities that formerly had to occur in central locations (Gilder 1995; Harris 1998; Moss 1998; Office of Technology Assessment 1995). In sum, communication technologies have allowed population and economic activity not to be tied to geography and specific locations, but free to decentralise from the core to the periphery and still be connected by telecommunications networks (Abler 1970; Dizard 1982; Gordon & Richardson 1997; Toffler 1981). Further, cities are the 'left over baggage of the industrial era' subject to the 'geographic

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arbitrage' devastating to a 'current configuration of cities'(Gilder 2000). The end of the 'tyranny of geography' argument is based fundamentally on the premise of the ubiquitous availability of telecommunications and IT technology across space. The Internet has been considered the great equaliser for business, allowing distant locals to compete with large metropolitan regions. Recent research points to a different geography, where domains and connectivity cluster predominantly in large urban areas. The question remains are new businesses of the Internet economy doing the same or avoiding metropolitan areas. This paper examines the head and branch locations of the top 40 e-business integration firms in the USA. First, though, the recent literature on the effects of telecommunication technologies on the economy and metropolitan areas will be discussed.

The telecommunications revolution was initiated by deregulation of the telecommunications industry, which turned state-subsidised monopolies into private market competitors. Private firms, even before regulation, had supplied advanced telecommunication services, but deregulation has moved the vast majority of the world's telecommunication networks into private control. Privately operated networks in a competitive environment will respond mainly to market pressures of supply and demand (Gillespie & Robins 1989; Salomon 1996). This means that where demand is greatest, telecommunications will be supplied, resulting in geographic biases. The principal bias is that locations with agglomerations of population and economic activity will be disproportionately supplied telecommunications services and infrastructure (Gasper & Glaesar 1996; Moss 1998; Salomon 1996; Thrift 1996). This suggests that communication innovations propagate a core-periphery effect of IT, where a more refined spatial division of 'information labour' has developed (Hepworth 1987, p. 157). The agglomeration of demand and skilled labour is the basis of the opposing argument: that we will not see communication technologies causing the 'end of geography' and decentralisation of economic activity.

The fundamental question separating the two arguments is whether the core or the periphery will grow and develop as a result of the telecommunications and IT revolution, and at what rate each will grow. To fully understand which areas benefit from new communications technologies it is necessary to look at the broader issues involved. To do so, the information economy, which is being driven by IT and telecommunications, will be examined. Next, core urban areas will be looked at as centres of telecommunication and IT growth and compared with peripheral and rural areas. Finally empirical evidence on e-business locations will be presented and correlated with population, bandwidth and domain agglomerations at the CMSA level. First, though, what has caused a demand for the Internet and, on a larger scale, IT and telecommunications?

THE INFORMATION ECONOMY

As the world economy shifted from the fourth Kondratieff wave of Fordist mass production to the fifth wave of information networks, a fundamental change occurred. Inputs for economic activity were no longer simply labour, capital and energy, but also information. The globalisation of the economy that encompasses the mobility of production and importance of services has made information the linchpin of operations. These operations in turn are dependent on the flow of information over great distances made possible by technology. The predominance of information has resulted in the generalisation of a new 'information society' or, more directly, to the development of an 'information economy' (Hepworth 1990; Porat 1970). Mark Hepworth sees the advanced industrialised nations developing in the midst of an 'information revolution' that will determine the future of cities, regions and countries (Hepworth 1990). This information revolution has made globalisation and the export of services possible by compressing space and time to make the friction of distance less constraining.

Telecommunications in day-to-day business is a necessity in today's economy, as seen in the need to communicate with customers, suppliers and internal management, especially when spatially separated. Does this essentiality at a micro level carry over to a necessity at the macro level? The extent of the importance of telecommunications in economic growth and development is still a largely unanswered question. The role of communications and technology in the development of regions has received some attention. Examinations of the role of communications and technology in the development of Singapore, Israel, New Zealand, Latin America, and the Pacific Rim were compiled in a volume edited by Brunn and Leinbach (1991) (see also Corey 1991; Howenstine 1991; Forer & Parrott 1991; Kellerman 1991; Lewis & Mukaida 1991). The general conclusion of the various regional case studies found that communications and technology played a vital role in recent economic growth and development. Telecommunications is important not only in the growth of separate regions, but in connecting regions in an increasingly interdependent economy. It is this interconnection of regions that makes telecommunications an important facilitator of economic growth. Interconnection through technology and communication has allowed many developments, including international transactions in information services, a global restructuring of capital markets, and the globalisation of flexible production (Hepworth 1990; Langdale 1989). The effects of telecommunications have been global, from Australia to Zanzibar, and at the same time universal in application, from agriculture to services to manufacturing. If information can be transmitted globally by telecommunications and used universally throughout the economy, then does the *location* of production and services matter?

In air travel, passengers are restricted to locations that are connected to the airline network they are flying. In the same way, information transmission is limited to locations connected to a telecommunications network. This creates a disparity in locations according to differences in their connectivity to telecommunications networks. If information cannot be transmitted to a locale, its involvement in a globalised 'information economy' is severely hampered. Location in relation to the availability of telecommunications is an issue in economic development and growth. The question of whether the level of telecommunications connectivity results from economic growth or is required for growth to occur is debatable. In the case of airlines it was found that connectivity affects, and is simultaneously affected by, economic (employment) growth (or decline) (Ivy *et al.* 1995).

There is a curious absence of research in geographic literature on networks and communications that are by their nature geographically distributed. Hillis states: 'As a field of geographic inquiry, communications and its technologies have been the subject of fitful attention on the part of human geography.' (Hillis 1998, p. 543). He believes that communication has often been 'conflated' with transportation without regard for its implications for people and places (p. 543). It is true that communication is too often lumped with transportation as just another network and infrastructure factored into economic growth and development. In a sense, transportation networks and communication networks share the commonality that they are networks – composed of nodes and links that can be analysed as such. Outside of the mathematical commonality of pure network analysis, communication networks operate and function very differently from transportation networks and should not be considered in common. In order to 'rethink communications geography', as Hillis (1998, p. 558) suggests, geographers must understand how communication networks operate and how information that is carried on them differs from the movements of tangible goods on more familiar transportation networks. Perhaps the greatest challenge in rethinking a geography of communications is consideration of the Internet, the network of networks. As the Internet infiltrates the literature of geography it is important not to make the same mistakes Hillis alludes to in the geography of communications. Despite the dearth of geography literature on communications, some of the 'fitful attention' it has received needs to be considered, specifically in the context of the information society.

NETWORKS, WORLD CITIES AND THE URBAN HIERARCHY

Originally, pundits proclaimed that the new economic landscape would collapse time and space, making location irrelevant. In a search for lower cost areas to conduct business, economic activity would diffuse and cities would no longer serve as important agglomerations of activities, information, services and human resources (Sassen 1994). This was the view of globalisation, through an information economy, implemented by a telecommunication revolution. While the world was globalising and economic activity was dispersing, however, command and control were becoming increasingly vital to keep order and direction. In order to control the myriad of operations and information entailed in a global economy, business had to have central locations that were equipped with the communication and service infrastructure to facilitate these functions. Business was demanding an ever-increasing mass of facilities, services, physical infrastructure, and connectivity to compete in the globalised information economy. Only in the largest urban areas were these agglomerations of infrastructure and resources available for business to meet their new needs and functions. Far from being replaced, cities had evolved to a new order of importance, constituting the central nervous system of a globalised world.

The concept of this new urban hierarchy of global cities is encapsulated in the ideas of the *world cities system* first proposed by Friedman (1986). World cities theory gained acceptance and expanded, with new ideas being added to the paradigm, analysing different aspects that contributed to the formation and dynamic evolution of world cities (Knox & Taylor 1995). One constant throughout research and writing about the world cities system is the accumulation of telecommunications in metropolitan areas to link them as command and control centres. It is the fundamental need of business to have a command and control centre from which to communicate and direct that has made global cities so important. According to world cities theory, the primary forces involved in this scenario were correct, but the effect on the geography of space and place was not (Friedman 1986; Moss 1998; Sassen 1994). Cities did not vanish, but rose in primacy, developing into a new global urban hierarchy.

Telecommunications and IT have also allowed for a more profound spatial division of labour, allowing cities to be directly connected to branch and subsidiary locations in other regions (Atkinson 1998; Moss 1998; Pollard & Storper 1996). In the spatial division of labour, low-order economic activities have increasingly been exported to peripheral regions, but high-order economic activities increasingly concentrate in urban areas and especially global cities (Atkinson 1998; Howland 1993; Moss 1998; Pollard & Storper 1996; Richardson & Gillespie 1996; Wilson 1994). High-order activities have stayed in urban agglomerations to take advantage of the productivity benefits afforded by high density (Ciccione & Hall 1996). The same correlation between density and productivity can be extended to telecommunications and IT: the higher the telecommunications and information technology density, the more productive the agglomeration. This results in a cumulative causation cycle in which agglomeration increases productivity, inducing growth, which increases density, further increasing productivity.

Fundamentally, telecommunications is an infrastructure, much the same way as roads and highways, both being vital to commerce. Telecommunications forms a network by which information is transmitted. But the telecommunications network is not a fully connected network; certain locations are connected to the network and others are not. Further, of the locations connected to the network, some are better connected with faster and larger links than others. When the only facet of telecommunications was voice communication by telephones, these differences in size, speed and capacity made little difference. Today, with the information and technology revolution sparking the advent of fax transmissions, the Internet, e-mail and audio and video transmissions, the level of telecommunications connectivity in a place has a profound impact on the type and level of business that can be carried out.

An important aspect of 'concentrating information – intensive activities' is the need for access to high-capacity bandwidth (Moss 1998, p. 113). In many regards bandwidth is the link that makes communications – and specifically Internet protocol (IP) – networks different from transport networks. The limiting factor of IP networks is not distance, but the capacity of the bandwidth available on the network from one location to another. The amount of bandwidth available to locations (nodes) connected to communications networks is not equal, and there are resulting different (uneven) levels of service available to locations across space (Moss 1998). Mitchell illustrates the point well:

> low baud-rate (bandwidth) connection puts you in the boonies, where the flow of information reduces to a trickle, where you cannot make so many connections, and where interactions are less intense ... Since the high cost of bandwidth cable connections grows with distance, information hotspots often develop around high-capacity data sources. Much as oases grow up around wells (Mitchell 1995, p 131).

This point has not been without contention. Atkinson (1998) maintains that global cities appear to have few or no advantages with respect to advanced telecommunications when compared with other metropolitan areas. Further, the US Office of Technology Assessment described advanced telecommunications infrastructure as rapidly diffusing across the country, minimising competitive differences based on infrastructure alone (OTA 1995). Koltkin (2000) goes even further, stating that recent experience and the technological revolution make such assumptions dubious (the growth of global cities). Indeed, throughout the 1990s employment in high-end producer services, particularly finance, continued to shift towards the periphery. This case is not completely without empirical backing, by the early 1990s economic growth in the periphery was outpacing major metro areas almost two to one and from 1989–91 rural population increased 1.75 million (Huber 1994). Further, since the mid 1960s 15 of the largest 25 cities have lost four million people while the total US population has increased 60 million (Rybczynski & Linneman 1997). Whether this growth of the periphery is a result of technology or has driven technologically-based economic development in these areas remains to be seen.

There had been a dearth of empirical studies that measure the agglomeration or ubiquity of advanced telecommunication services and infrastructure in metropolitan areas. The lack of research has led to statements, such as that by Atkinson (1998, p. 140), that information technology activity on networks does not take place at the nodes, 'which are (only) passive switching stations', but that interaction occurs at the 'extremities among dispersed users'. Not only is this statement inaccurate from a technical perspective but also from a theoretical standpoint. Nodes are vital, not passive, technical aspects of networks, but more importantly are the centres around which IT and telecommunication-based economic activity have grown. In recent years several empirical studies have examined the agglomeration of advanced telecommunication services and infrastructure (measured in bandwidth and switches) in metropolitan areas. These studies reveal that communications infrastructure has disproportionately agglomerated in the largest metropolitan regions (Moss & Townsend 1997; Wheeler & O'Kelly 1999; Malecki & Gorman 2001). Further, the bandwidth gap between the largest metro areas and peripheral regions is only increasing (Malecki 2002; Moss & Townsend 2000). The agglomeration of bandwidth in metropolitan areas is also reinforced by the concentration of domains in these same large areas (Moss & Townsend 1997; Kolko 2000; Zook 2000a, 2000b). Zook (2000a) found a strong correlation with the agglomeration of domains with information intensive industries and Kolko (1999) discovered that even after controlling for other variables that domain density is higher in larger cities. Both findings by Zook (2000a) and Kolko (2000) found these relationships strengthening over time. The top 20 metropolitan areas for bandwidth have a 0.9275 positive correlation at a 0.01 level of significance with the top 20 metropolitan areas ranked for domains.

The mounting number of empirical studies points to an agglomeration effect for bandwidth and domains that further reinforces the core-periphery urban hierarchy. The question that remains is what effect, if any, has this agglomeration had on economic growth in the affected metropolitan areas. The literature on the role of technology in economic development points to a positive correlation (Malecki 1997). What has been lacking are empirical studies examining the growth of new economy sectors and their correlation to the agglomeration of bandwidth and domains.

E-BUSINESS PROFESSIONAL SERVICES AS ECONOMIC ENGINES?

While the Internet has garnered wide public attention as the driver of the 'new economy', and recently as the impetus of stock market declines, few empirical studies measuring the Internet economy exist. An exception is recent reports from the University of Texas Center for Research in Electronic Commerce. The centre's January 2001 report finds that, 'the Internet economy has become a more integral part of the (overall) US economy than ever before, creating jobs and increasing productivity across the economy' (CREC 2001, p. 1). Specifically, the report found that the Internet economy directly supports 3.088 million workers, producing \$830 bn in revenue for the year 2000, a 58% increase from 1999 and a 156% increase from 1998 (CREC 2001).

In its Internet economy measurements efforts the University of Texas centre established a measurement methodology that structures the Internet economy into four layers:

Layer 1 – The Internet infrastructure layer
Layer 2 – The Internet applications layer
Layer 3 – The Internet intermediary layer
Layer 4 – The Internet commerce layer
(Barrau *et al.* 1999, p. 4)

Layer 1 includes companies with products and services that help create an Internet protocol (IP)-based network infrastructure, a necessity for electronic commerce. Layer 2 consists of the applications and services built above the IP infrastructure that makes it technologically feasible to perform business activities online. The Internet intermediaries of Layer 3 increases the efficiency of electronic markets by facilitating the meeting of buyers and sellers over the Internet. Finally, Layer 4 involves the sale of products and services to consumers or businesses over the Internet.

This paper examines the e-business professional services market that resides at Layer 2 of the Internet economy. The most basic and obvious product of e-business professional service firms is the website. From a more comprehensive viewpoint the better firms provide Internet related business consulting, IT consulting, interactive marketing, custom software development, system and network integration, IT outsourcing and training that allow e-businesses to operate (Gartner 2000). In 2000 these professional services accounted for a \$17 bn market (2.1% of the total Internet economy), and are forecasted to reach \$100 bn by 2003. These e-business firms are not only producing services for the volatile dot-coms, but also have vested themselves in the Internet operations at every level including healthcare, local government, manufacturing, utilities, finance, communications and retail sectors.

Demand for e-business services skyrocketed in the late 1990s triggering very rapid expansion and growth of e-business firms. As customers demanded increasing levels and types of service, e-business service firms responded by developing new business areas through acquisition, merger and internal development and hiring. This growth pushed firms from solely web production into new areas such as business consulting, software development and network integration. At the same time it attracted several 'old economy' firms into the e-business services game. Large consultancies such as KPMG, Andersen Consulting, Deloitte & Touche and Arthur Andersen all developed e-business services groups, integrating their traditional services with Internet specialties. At the same time software and network integration firms like IBM and Computer Associates developed e-business services of their own, leveraging their network software and hardware expertise. Even 'new economy' firms such as Dell expanded their services from personal computer (PC) and server manufacturing to include e-business services. Forrester (2000) reported that e-business service firms come from diverse backgrounds like strategy consulting, legacy systems integration, and web design, yet each seeks to offer services in one another's area of strength.

This flurry of growth in the e-business sector resulted in several mergers and acquisitions among firms. A common method for spreading a firm's geographic reach was to acquire another smaller firm in the new target market and convert it into the new regional office. This same tactic was often employed when a firm needed to add new services and skills. If firm 'x' needed a software development group to fill a market or customer demand they would often acquire firm 'y', a specialist software firm, to do so. Often these acquisitions took the form of a swap for stock, and the acquired firm's president becoming either the new department or new regional office's head.

The result of this high level of merger and acquisition are several very large firms that are vertically integrated to deliver e-business projects from start to finish, called end-to-end solution providers. One firm provides: the consulting to best deliver a client's business model to the Internet; the market research and focus groups to test it; construction of the site's architecture and user interface; development of custom software to run the client's application; integration of the system with the client's legacy technology; marketing and advertising of the new website or technology; and maintenance and operation of the system. The new e-business service firms are structurally reminiscent of the automobile industry during the mid twentieth century. These were large vertical agglomerations that owned and operated all the inputs to automobile production from the rubber plants in Brazil to the assembly lines in Detroit. The merger and acquisition strategy of the e-business service firms has lead to widespread criticism of bloated and unco-ordinated organisations with poor quality control (Gartner 2000; Forrester 2000). A recent Forrester survey reported a flurry of negative headlines in a report on the e-business professional service market:

- End-to-end solution providers? Not in this pack!
- Many eCIs (e-commerce integrators) don't realize their own shortcomings
- Horror stories abound for first-time implementations
- Good fundamentals have not permeated most eCI organizations
- It's a failure of leadership

(Forrester 2000)

In fact, of the 40 firms surveyed and rated by Forrester the top firm only garnered 70% of the 50 maximum points and the average firm's score was below 50%.

LOCATION OF E-BUSINESS PROFESSIONAL SERVICES FIRMS

Industry problems and criticism aside, the e-business service firms provide a good indicator of the growth of the Internet economy as a whole. Often called the 'arms dealers' of the Internet, e-business service firm's rapid domestic expansion provides an interesting indicator of regional Internet economic growth. The 2000 Forrester survey identified the top 40 e-business professional service firms, called e-commerce integrators (eCI) by Forrester, using the following requirements:

- E-business revenue – To ensure that the eCI has an important presence in the market, the survey looked for firms generating at least $15 m in revenue from Internet related projects.
- Skills distribution – The survey identified service providers with significant capacity in strategy, user experience and technical disciplines by evaluating their resource allocation. Companies that cleared this requirement met two out of three criteria: 1. more than 15% of all staff or 50 people in strategy; 2. more that 15% or 50 people in user experience; and 3. more than 50% or 150 people in technical services.

In short this meant firms needed over $15 m in revenue and at least 300 employees. Many firms, such as marchFIRST easily exceed these figures with some 8,900 employees and $365 m of revenue in a single quarter (Johnson 2000). The primary benefit of using the Forrester list of firms is the ability to identify firms that are making a sizeable economic impact on a region with their presence. The majority of jobs with all these firms are high paying and the collaborative nature of the business requires multiple local partnerships. This leads to an increased economic multiplier effect (Forrester 2000). From Forrester's rankings the office locations for each firm were identified and entered into a database. Firms such as Andersen Consulting, Deloitte Consulting and KPMG were excluded since offices that provided e-business and traditional professional services could not be distinguished in the data. From the office locations a matrix was constructed to rank consolidated metropolitan statistical areas (CMSA) by the number of firms located in each region.

Locating the office locations for each e-business service firm from their websites, phone interviews and corporate publications revealed some interesting trends outside of the statistical analysis. The majority of firms were located in the downtown and central business district areas of each metro region, a facet covered up by aggregating the data to CMSAs for standardisation. Many firms felt that a downtown location attracted younger and single employees with the Internet background and willingness to work longer hours. Further downtown areas typically had concentrations of similar firms to partner and contract with and the technical services required for business operations. The availability of unique office space and plenty of bandwidth were also frequently sited. Kotkin (2000) reveals similar findings in his examination of how the digital revolution is reshaping the US landscape:

> As a result, some of the largest concentrations of Internet companies – and the greatest concentrations of Internet hosts – are not in suburban areas but in heavily urban areas, such as the South of Market section of San Francisco, which by 1997 had become home to some two hundred multimedia companies. Contrary to notions such as those exposed in the 1960s by the French sociologist Alan Touraine, who saw an inevitable 'lessening' in social relationships as a result of post-industrial society, the new digital industries are largely sustained by interaction between specific groups who seek out and find one another uniquely in the urban milieu (p. 20).

Table 1. *Number of firms per CMSA.*

City	Web firms
New York	39
San Francisco	33
Boston	23
Los Angeles	20
Chicago	19
Washington DC	15
Dallas	13
Atlanta	12
Denver	10
Detroit	8
Seattle	6
Houston	5
Minneapolis-St Paul	5
Philadelphia	4
Austin	4
Portland	3
Phoenix	3
Miami	3
Charlotte	3
Cleveland	2

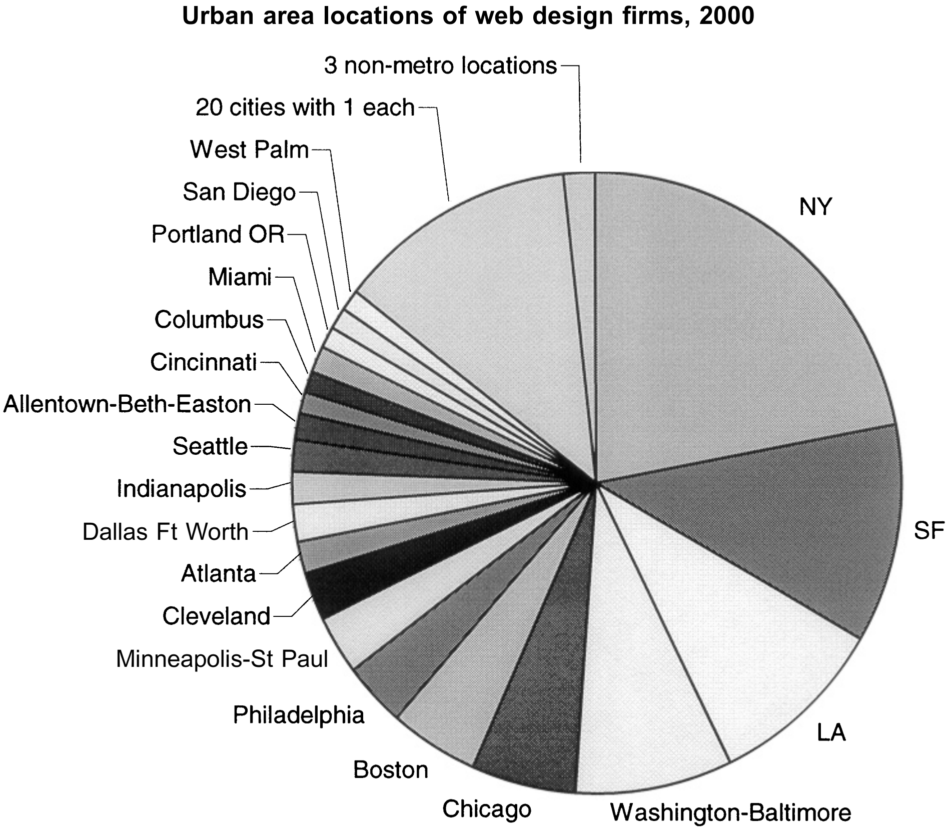
Source: Forrester 2000.

As seen in Table 1 the location of the top e-business professional service firms follow the same trend predicted by Kotkin. The top five locations are New York, San Francisco, Boston, Los Angeles and Chicago, all large populous metropolitan areas concentrated in downtown areas. Malecki (2002) compiled data on 157 web development firms by CMSA (Figure 1), finding the top five to be San Francisco, New York, Los Angeles, Boston and Washington DC (sixth in Table 1), further supporting the trend of e-business location in large metropolitan areas.

Studies have examined the qualitative reasons, such as quality of life, sociological and community for Internet and e-business firm location patterns, but few have endeavoured to look at quantitative factors. Several studies have found agglomeration of domains (Zook 2000a, 2000b; Kolko 2000; Moss & Townsend 1997), bandwidth (Moss & Townsend 2000; Malecki & Gorman 2001) and bandwidth driven by population (Malecki 2002), but none have looked for correlation between these agglomerations and e-business firm location patterns. For these purposes each CMSA from the firm location data was ranked by population, number of domains, connected bandwidth, domain per establishment, firm per million population, domains per firm and domain per Mbps (megabits per second).

Population – from US Census Bureau (2001) for consolidated metropolitan statistical areas (Table 2).

Domains – the registered addresses of internet destinations (i.e. www.amazon.com). When each address is registered with Internic a contact address is given and this is the location that is representative in the data. Domain counts courtesy of Matthew Zook and *The Internet Geography Project* (www.zooknic.com) (Table 3).[1]



Source: *Internet World*
Source: Malecki 2002.

Figure 1. *Locations of 167 web design fiirms*

Bandwidth – the amount of IP backbone bandwidth connected to a region, from *The Boardwatch Directory of Internet Service Providers* and compiled courtesy of Malecki and National Science Foundation grant BCS-9911222 and the University of Florida's Center for International Business Education and Research (Table 4).[1]

Domain per establishment – domain counts weighted per 1,000 establishments at the CMSA level from Dun and Bradstreet (1998), courtesy of Matthew Zook and *The Internet Geography Project* (www.zooknic.com). Provides an indicator of the ratio of general establishments with some variety of Internet presence. The higher level could indicate a greater need for e-business professional services (Table 5).

Firm per million population – firm per CMSA weighted by population of the region. Provides insight to the population served per firm (Table 6).

Domains per firm – the number of domains per firm. This provides a measure of possible demand for e-business services in a region (Table 7).

Domain per Mbps – the number of domains divided by the amount of bandwidth (Mbps) in a region. This provides a measure of the possible demand for connectivity services in a region (Table 8).

Table 2. *Population per CMSA.*

CMSA	Population
New York	20,196,649
Los Angeles	16,036,587
Chicago	8,885,919
Washington, DC	7,359,044
San Francisco	6,873,645
Philadelphia	5,999,034
Boston	5,667,225
Detroit	5,469,312
Dallas	4,909,523
Houston	4,493,741
Atlanta	3,857,097
Miami	3,711,102
Seattle	3,465,760
Phoenix	3,013,696
Cleveland	2,910,616
Minneapolis-St Paul	2,872,109
Denver	2,417,908
Portland	2,180,996
Charlotte	1,417,217
Austin	1,146,050

Source: US Census Bureau (2001).

Table 4. *Bandwidth per CMSA.*

CMSA	Bandwidth (Mbps)
New York	234258
Chicago	221738
Washington, DC	208159
San Francisco	201772
Dallas	183571
Atlanta	149200
Los Angeles	140649
Seattle	109510
Denver	97545
Houston	80483
Boston	75044
Philadelphia	74167
Portland	68174
Cleveland	61671
Phoenix	45868
Detroit	45868
Miami	42138
Charlotte	35441
Austin	32884
Minneapolis-St Paul	29734

Source: See Note 2.

Table 3. *Number of domains per CMSA.*

CMSA	Domains
New York	1,241,871
Los Angeles	1,116,142
San Francisco	788,599
Washington, DC	480,309
Chicago	344,356
Boston	332,502
Miami	242,108
Philadelphia	229,323
Dallas	229,253
Seattle	226,061
Atlanta	199,166
Houston	180,063
Phoenix	148,213
Denver	142,933
Minneapolis-St Paul	136,071
Detroit	134,866
Portland	100,443
Austin	83,949
Cleveland	78,936
Charlotte	42,744

Source: Matthew Zook and *The Internet Geography Project.*[1]

Table 5. *Number of domains per 100 establishments at the CMSA level.*

CMSA	Domain-EST
San Francisco	2,617
Los Angeles	1,855
Austin	1,733
Washington, DC	1,610
Phoenix	1,488
Seattle	1,431
New York	1,400
Miami	1,399
Boston	1,381
Denver	1,255
Atlanta	1,254
Minneapolis-St Paul	1,186
Dallas	1,111
Chicago	1,110
Portland	1,032
Houston	992
Philadelphia	962
Charlotte	741
Cleveland	727
Detroit	677

Source: Dun & Bradstreet 1998; Zook 2000a, 2000b.

Table 6. *Number of firms per million population at the CMSA level.*

CMSA	Firm-mil
San Francisco	4.800946223
Denver	4.135806656
Boston	4.058423655
Austin	3.490249117
Atlanta	3.111148099
Dallas	2.647915083
Chicago	2.138214404
Charlotte	2.116824735
Washington, DC	2.038308237
New York	1.931013407
Minneapolis-St Paul	1.740881004
Seattle	1.731222012
Detroit	1.462706827
Portland	1.375518341
Los Angeles	1.247148162
Houston	1.112658696
Phoenix	0.995455414
Miami	0.808385218
Cleveland	0.687139767
Philadelphia	0.666774017

Source: Dun & Bradstreet 1998; Zook 2000a, 2000b.

Table 7. *Number of domains per firm at the CMSA level.*

CMSA	Domains per web firm
Miami	80,703
Philadelphia	57,331
Los Angeles	55,807
Phoenix	49,404
Cleveland	39,468
Seattle	37,677
Houston	36,013
Portland	33,481
Washington, DC	32,021
New York	31,843
Minneapolis-St Paul	27,214
San Francisco	23,897
Austin	20,987
Chicago	18,124
Dallas	17,635
Detroit	16,858
Atlanta	16,597
Boston	14,457
Denver	14,293
Charlotte	14,248

Source: Dun & Bradstreet 1998; Zook 2000a, 2000b.

Table 8. *Number of domains per connected Mbps at the CMSA level.*

CMSA	Domains per Mbps
Los Angeles	7.94
Miami	5.75
New York	5.30
Minneapolis-St Paul	4.58
Boston	4.43
San Francisco	3.91
Phoenix	3.23
Philadelphia	3.09
Detroit	2.94
Austin	2.55
Washington, DC	2.31
Houston	2.24
Seattle	2.06
Chicago	1.55
Portland	1.47
Denver	1.47
Atlanta	1.33
Cleveland	1.28
Dallas	1.25
Charlotte	1.21

Source: see note 2; Zook 2000a, 2000b.

Each of these variables was then correlated to the number of firms per CMSA using spearman rank correlations to find which variable most influenced the e-business service firm's location. The results of the spearman rank correlations in Table 9 reveal some interesting trends. Domains, bandwidth and population all were significantly higher (all above 0.930) than any of the other variables (all below 0.878). The domain, bandwidth and population numbers are agglomeration indicators where as domain per establishment, firms per million population, domains per web firm and domain per Mbps are all demand indicators. Agglomeration means they are raw numbers of sheer quantity of the variable in a location, and demand means the agglomeration number has been divided to give an indication of demand by discounting pure size or amount. When the correlations for agglomeration factors and demand factors were averaged (Table 10) agglomeration resulted in a 0.933 correlation and 0.780 correlation for demand factors. This would seem to indicate that

Table 9. *Spearman rank correlations for firm location.*

Variable	Correlation (0.01 level of significance)
Domains	0.935
Bandwidth	0.933
Population	0.930
Firms per million population	0.879
Domains per 1000 establishments	0.839
Domains per Mbps	0.795
Domains per firm	0.606

Source: Author's research.

Table 10. *Spearman rank correlation for agglomeration and demand variables.*

Variable	Correlation (0.01 level of significance)
Domains Bandwidth Population	Agglomeration variables = 0.933
Firms per million population Domains per 1000 establishments Domains per Mbps Domains per firm	Demand variables = 0.780

Source: Author's research.

Table 11. *Spearman rank correlation for firm location weighted by population and demand factors*

Variable	Correlation (0.01 level of significance)
Domains per 1000 establishments	0.805
Domains per Mbps	0.644
Domains per Firm	0.462

Source: Author's research.

e-business professional services are following agglomerations of economic activity and not necessarily market opportunity. There is also the possibility that since the firm location number is based on sheer size and is not weighted at all this could have influenced the rank correlations. To try to account for this the demand factors were correlated with firm location weighted by population. As seen in Table 11 the values of 0.462 and 0.644 for domains per firm and domains per Mbps would seem to exclude these variables as good indicators of firm location. The 0.805 correlation for domains per 1,000 establishments in conjunction with its 0.835 to unweighted firm agglomeration would seem to indicate it as a reasonable indicator for firm location. This could be in part due to the larger Dun & Bradstreet data set that domains per 1,000 establishments provide as an indicator. Further this could mean that the sample dataset of firms provided by the Forrester report was too small for adequate statistical significance.

NEW MARKETS AND DOMINANT REGIONS

Looking at individual indicators gives further insight into supply and demand factors that could be affecting both the e-business service sector and the Internet economy as a whole. Domains per web firm gives an interesting indicator of possible demand in a region for e-business services. While many of these domains could be family websites and other smaller entities below the scope of e-business service needs, the raw indicator does give a measure of the amount of possible work available in a region. With the exception of Los Angeles the top five provide an unusual group of locations not commonly seen in top Internet indicators, including Miami, Philadelphia, Los Angeles, Phoenix and Cleveland. Miami is well ahead of the pack with some 80,703 domains served per firm. One possible reason for this large number could be Miami's role as an information technology gateway to Latin America. Similar trends have already been noted in bandwidth connectivity and collocation with Miami serving as a major network access point to Latin America. New Internet infrastructure firms and exchange points have been establishing presences in Miami with the goal of becoming the Internet equivalent of Miami International Airport, which serves as a hub for the entire Latin American region (Malecki & Gorman 2001). Whether e-business services follow on the heels of bandwidth remains to be seen, but the trends seen in the correlation between bandwidth and firm location would seem to point in that direction.

Further pursuing the connection between bandwidth and Internet related economic growth the 'domain per Mbps' provides some useful insight. While the indicator scored poorly as a measure of current e-business service firm location it provides a plausible clue to the regions that are growing in demand faster than bandwidth can be provided. Leading the list are Los Angeles, Miami, New York, Minneapolis, Boston and San Francisco. Even though New York and San Francisco lead the country in bandwidth connectivity it still does not appear to be enough. These two leading Internet and technology regions continue to leverage their agglomerations to spawn productivity and growth as would be expected in the application of Ciccione and Hall's (1996) economic theories; a fact further reinforced by New York and San Francisco's ranking as the top two e-business service firm locations with 39 and 33 firms respectively. The next closest region is Boston with only 23. In fact if you look at New York and San Francisco's rankings for all the agglomeration indicators, New York is number one in all four and San Francisco averages a 3.5 followed closely by Los Angeles at 3.65. No other region comes close to these three and they will most likely continue to be the sure-fire regions of continued Internet growth. Whether the demand indicators in Miami and to a lesser extent Minneapolis, Phoenix and Philadelphia will lead to e-business service growth remains to be seen.

CONCLUSION

This paper is only a precursory look at how the 'digital economy' is impacting regions. Much further research, including larger data sets, more sophisticated quantitative analysis and more refined indicators will be required to get a true picture of how the Internet is making an economic impact on metropolitan regions in the USA. What can be surmised from this initial inquiry is that growth has not been even, but skewed and perhaps even dominated by New York and San Francisco. These findings seem to point to agglomeration as the key indicator that has been spurning increases in economic growth and productivity in these regions. The combination of domains, bandwidth and population appear to be the most influential drivers of regional Internet economic growth. While the largest metropolitan areas are relatively dominant, many smaller regions, such as Miami, pose new market opportunities for e-business services growth.

Overall the most obvious outcome of this research is that the Internet is not acting as the great geographic equaliser that was predicted by many pundits. Instead it is increasingly falling into a more distinct urban hierarchy noted by several researchers and reinforced by this study. If anything, e-business professional service firms have shown a distinctly urban bias for downtown and central business district areas in the largest metropolitan areas. The regional economic impacts of the Internet and its spatial biases requires further study, but these initial findings provide some new insight into an evolving urban hierarchy of Internet growth.

Notes

1. Domain data loaned by Dr Matthew Zook and *The Internet Geography Project.*
2. Data loaned by Dr Ed Malecki and Angela McIntee from their Internet infrastructure research – National Science Foundation grant BCS-9911222 and the University of Florida's Center for International Business Education and Research.

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