LONDON: DIGITAL CITY ON THE RISE

DR. MICHAEL MANDEL
SOUTH MOUNTAIN ECONOMICS

DR. JONATHAN LIEBENAU
LONDON SCHOOL OF ECONOMICS

JUNE 2014

EXECUTIVE SUMMARY

London has always been one of the leading knowledge cities in the world. Its streets and offices are filled with skilled and accomplished academics, consultants, lawyers, engineers, editors, designers, marketing and advertising experts, producers, and writers.

But in recent years, something new has been happening in London. As more and more knowledge becomes digital, the city's deep base of professional expertise has helped fuel a thriving urban tech scene in the East End, Soho, and areas across the city. Increasing numbers of tech start-ups are receiving national and international attention, and tech giants such as Google and Facebook have been bolstering their presence in London.

London's rise as a major tech hub is an example of the broader global phenomenon of digital cities. While the high technology and programming sector had previously been located in sprawling suburban office parks and corporate campuses, start-ups and established tech firms alike are now being drawn to urban cores. This pattern has been demonstrated strongly in San Francisco and New York—where tech firms benefited from proximity to existing industry clusters, talent streams, and venture capital—and a similar pattern has been unfolding in London.[1]

Good policy has helped as well: Since taking office in 2008, the local and national governments have used a variety of policy measures to attract existing tech businesses and encourage start-ups, building on London's world-class strengths in finance, advertising, and media. The latest initiatives aim to expand the existing areas of tech growth eastward and north, based in part on long-term investments in transportation. In March 2014, Mayor Boris Johnson of London outlined a bold vision: to make London the tech capital of the world. For a city founded more than 2000 years ago, that's a striking goal.[2]

To reach that goal, London will have to address issues—many of which are found in other digital cities. These include the availability of capital, the sustainability of the talent pipeline, the rising cost of real estate, and the presence of affordable, flexible, and scalable infrastructure needed to support the growth of start-ups. If these challenges are met, London's tech sector can become a powerful engine for broader and more robust economic growth in London, the United Kingdom, and the rest of Europe—creating large, multinational tech companies as well as hundreds of other enterprises.

In this study, we develop a unique framework to study the impact of London's tech/information (tech/info) sector on the city's economy, and to benchmark London's performance against other global digital cities such as New York and San Francisco. As in previous studies, we use the term "tech/info" rather than simply "tech" to emphasize the changing nature of the tech industry. It used to be that tech, telecom, and content companies were effectively in separate industries. Today, convergence rules, and these industries share a common tech-savvy workforce and often overlapping goals.

London's tech/info sector is exceedingly diverse, drawing companies and workers from across the globe. The tech/info sector includes tech start-ups such as Swiftkey; WorldRemit, an online money transfer service that recently received $40 million in venture capital funding; and WireWax, a video tagging company which has its headquarters in London and an office in New York City. It includes established tech companies such as Google and Facebook; a large number of computer consultants and app developer firms such as Milo and The App Business; and media companies such as Reuters, Economist Group, Pearson, and News Corporation.

In this study, we also examine a wider set of industries that interact closely with the tech/info sector. This includes the knowledge industries that provide the environment for London's success as a tech mecca, ranging from consulting to advertising, accounting, and scientific research. This is referred to as the "expanded tech/info sector."

Some key findings:

→ There are 382,000 workers in London's tech/info sector—an increase of 11 percent since 2009.

→ The growth of London's tech/info sector from 2009 to 2013 was more than triple the previous four years.

→ London's expanded tech/info sector—including tech, information, professional, and scientific industries—has increased by 15 percent since 2009, compared to an increase of only 8 percent for the rest of the London economy.

→ Overall, the expanded tech/info sector has accounted for 30 percent of total London job gains since 2009.

→ Collectively, the tech/info sector in London plus the East and Southeast regions, including Oxford and Cambridge, has roughly 744,000 tech/info workers, up by 76,000 since 2009. That's slightly larger than California's tech/info sector (692,000). What's more, the tech/info sector in the combined London-East-Southeast region is growing faster than California, even taking into account the rapid growth of San Francisco.

→ London is a major hub for big data. There are an estimated 54,000 big data workers within 25 miles of London, compared to 57,000 for New York City and 98,000 for San Francisco-Silicon Valley.

→ London is the world leader in financial technology (fintech). There are an estimated 44,000 fintech workers within 25 miles of London, compared to 43,000 for New York and only 11,000 for San Francisco-Silicon Valley.

→ London's share of the combined US-UK tech/info sector has been rising over time, from 5.8 percent in 2000 to 6.8 percent in 2013.

→ Taken together, London, New York City, and San Francisco accounted for 41 percent of the job growth in the combined US-UK tech info sector between 2009 and 2013.

INTRODUCTION

As one of the great financial centers of the world, London was significantly affected by the financial crisis, with the financial services industry losing 8 percent of its jobs in only 12 months. Three years later, the London labor market has generated an almost 9 percent increase in employment in 2012 and 2013, far outperforming the less than 1 percent gain forecast in 2012 for that period.

Driving this has been London's rise as a major tech hub, which in turn, is an example of a broader global phenomenon of "digital cities." While the high technology and programming sector had previously been located in sprawling suburban office parks and corporate campuses, start-ups and established tech firms alike are now being drawn to urban cores. This pattern has been demonstrated strongly in San Francisco and New York—where tech firms benefited from proximity to existing industry clusters, talent streams, and venture capital—and a similar pattern has been unfolding in London. Moreover, London has built on its long-time strength as a globally-connected trading city, with a very strong higher-education and creative base.

Good policy has helped as well. While finance is still a major economic driver in London, tech is gaining ground. This is in part because of imaginative policies adopted by the national government and the London Mayor's office, such as the 2010 Tech City initiative from Prime Minister David Cameron and Mayor Johnson. Other initiatives include a program to boost computer science teaching in the London schools and support for businesses taking on technology apprenticeships. A long-term infrastructure investment plan aims to expand the existing areas of tech growth eastward and north, based in part on long-term investments in transportation, including the upgrading of London Overground and CrossRail, in conjunction with an Act of Parliament.

These policies have been remarkably effective in maintaining the spotlight on London tech businesses and bolstering the feeling of excitement, creativity and productivity that characterizes the community. While estimates of the number of foreign tech workers in London are unreliable, the presence of many German, French, Italian and other European technologists and entrepreneurs is evident, drawn by the relative ease of creating and building innovative businesses.

Still, there is a lot more room for London's tech sector to grow. London has yet to produce a home-grown, multinational tech giant on the scale of Yahoo or Twitter. In addition, London still attracts less venture capital than New York or San Francisco, and while 'Tech City London' has gotten some attention, London's tech sector has yet to fully build its global identity and brand.

To help chart its future, it is important to note what has been accomplished, and the London tech sector has become an important part of the regional and national economy. The purpose of this study is to measure London's tech/info sector and tech workforce in a global context with a specific focus on the jobs it creates. First, this study will examine the impact of the tech/info sector on London's overall job growth. We will show how London is getting a growing share of the tech/info jobs in the combined Anglo-American economy, and compare London's tech/info sector to that of two U.S digital cities, New York City and San Francisco. We will drill down and analyse two important parts of London's tech boom: fintech and big data. Finally, we will outline and compare the policies that have helped London thrive as a global digital city.

UNDERSTANDING LONDON'S TECH/INFO SECTOR

Over the past 40 years, the way that people define "tech" has repeatedly changed. In the mid-1970s, tech was about manufacturing: the pre-eminent global tech company was IBM, then mainly a computer manufacturer, and the UK tech sector was primarily comprised of an army of electronics manufacturers employing almost 400,000 workers. With the advent of the personal computer, the definition of tech expanded in the 1980s to include software and semiconductors. The pre-eminent global tech companies were Microsoft and Intel, and computer programmers became an essential part of the UK workforce.

In the 1990s and the 2000s, the definition of tech broadened again to include Internet companies such as AOL and Yahoo, and later Google. Electronics manufacturing continued to shrink in importance in the UK, while employment in new professions such as web developer and network technician soared.

Finally, in recent years, the definition of tech has morphed again to become tech/info.[3] Tech companies now focus on content and interconnectivity, which after all are the great strengths of dense and well-connected global cities such as London and New York. In this world, the key to success becomes the combination of tech skills with deep knowledge of complementary sectors in which technology is being used; these areas include: fashion, design, finance, advertising, entertainment, media, education, and health.

This study's focus is the "tech/info" sector in order to capture the convergence between tech, content, and interconnectivity. As defined in this study, the tech/info sector includes such companies as: software, computer programming, app developers, telecom companies, companies providing Internet services, big data companies, firms that are building technology platforms for financial services, and video and music start-ups.

Specifically, the term encompasses companies such as Workshare, a London-headquartered firm that will securely store and share corporate documents and as of early June 2014 had job openings for sales, developers, and customer support; Hyperoptic, a company installing fiber optic networks in the UK; Shazam, which makes an app that identifies music and TV; Metapack, a company that does "delivery intelligence;" and NewVoiceMedia, which offers cloud contact ser-

vices. The tech/info sector also includes the London offices of Skype, Google and Facebook; the headquarters of BT (British Telecom), a major broadband provider; and the London offices of the BBC and the *Financial Times*, media companies rapidly utilizing new technologies and being disrupted by them.

SIZING LONDON'S TECH/INFO SECTOR

In 2013, London's tech/info sector employed 382,000 workers, an increase of 11 percent since 2009. Measuring by employment, the single largest industry in London's tech/info sector is computer programming and consultancy, with almost 130,000 workers in 2012, including website designers, app developers, and most employees at big data start-ups. Moreover, the tech/info sector created three times as many jobs from 2009 to 2013 as it did from 2005 to 2009 (Figure 1).

FIGURE 1

LONDON: ACCELERATING TECH/INFO GROWTH
(CHANGE IN TECH/INFO JOBS, THOUSANDS)
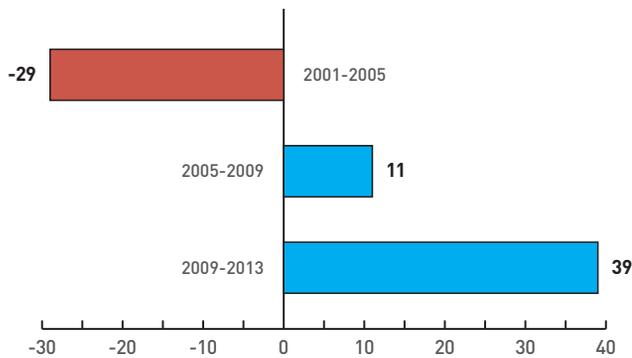
Data: Office for National Statistics, South Mountain Economics LLC

These findings in London mirror with what we found in New York and San Francisco: that the growing tech/info sectors were a lifeline to these three cities during the massive economic downturn of 2009.

HOW LONDON COMPARES TO OTHER DIGITAL CITIES

In a global economy, it's not sufficient to measure how a city like London compares with the rest of the United Kingdom. Another good indicator is the strength of London against the combined tech/info sector of the United Kingdom and the acknowledged global leader in tech, the United States. Figure 2 shows that London accounts for a steadily rising share of the combined Anglo-American tech/info employment, going from 5.8 percent in 2000 to 6.8 percent in 2013. In other words, London is performing well on the global stage.

FIGURE 2

GLOBAL DIGITAL CITY: LONDON GAINS GROUND
(LONDON TECH/INFO JOBS AS SHARE OF COMBINED US-UK TECH/INFO JOBS*)

*Tech/info employment as defined in appendix. Includes self-employed
Data: Office for National Statistics, Bureau of Labor statistics,
South Mountain Economics LLC

Taken together, London, New York, and San Francisco account for an amazing share of total tech/info growth. From 2009 to 2013, London, New York City, and San Francisco added 89, 000 tech/info jobs, collectively adding up to about 42 percent of tech/info job creation in the U.S. and the U.K.

THE EXPANDED TECH/INFO SECTOR

The December 2013 Tech City third anniversary report included a wide variety of professional and technical industries in their statistical estimates of the London tech economy, such as architecture, engineering, public relations, market research, advertising and design firms.[4] Following their lead, this section examines what we call the "expanded tech/info sector," which includes the tech/info sector plus the city's professional, scientific, and technical industries.

This grouping acknowledges that the boundaries between tech and other knowledge-based industries are increasingly porous. Indeed, London's tech start-ups draw on a deep pool of local expertise from knowledge-based industries such as consulting, accounting, scientific research, and advertising. As knowledge increasingly becomes digital, professionals find themselves spending more and more time online, and their firms are increasingly investing in developing tech expertise. For example, the big accounting firms in London are always hiring large numbers of tech workers, with firms such as Deloitte boasting about their UK strength in data analytics.

By this measure, the expanded tech/info sector grew by 15 percent between 2009 and 2013 (Figure 3). By comparison, all other industries in London, including the public sector only grew by 8 percent over this period. As a result, the expanded tech/info sector has accounted for 30 percent of total London job gains since 2009.

FIGURE 3

WHAT'S DRIVING LONDON'S GROWTH?

	Number of jobs, 2013 (thousands)	Number of new jobs created, 2009-2013 (thousands)	Share of total new jobs in London, 2009-2013
Expanded tech/info	1088	143	30
Other industries	4228	330	70

Note: Expanded tech info includes tech/info, as noted in appendix
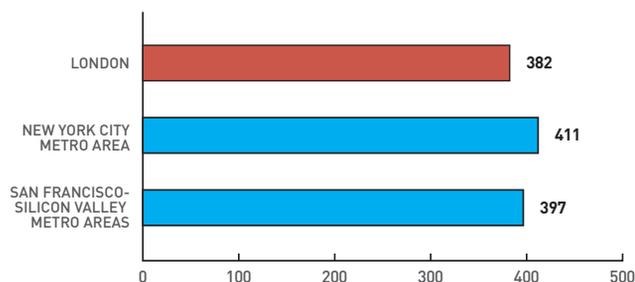Data: Office for National Statistics, South Mountain Economics LLC

DIGITAL REGIONS

The statistical agencies of the United Kingdom treat London as both a city and a region. In order to compare London to the leading tech regions in the US, New York and the San Francisco Bay Area, it is first necessary to make sure that the geographies match up on key criteria. The size of London—32 boroughs and the City of London—makes it more analogous to the 25 counties of the New York City metro area than to the five counties/boroughs of New York City proper. Similarly, London is far larger than the city of San Francisco (population 825,000; one-tenth that of London), so the most instructive comparison is to the combination of the San Francisco and San Jose metro regions, which we will call San Francisco-Silicon Valley.

When compared to these broader regions, London's tech/info sector rivals in size the tech sector in New York and San Francisco-Silicon Valley. The New York metro area had 411,000 tech/info sector workers in 2013. San Francisco-Silicon Valley has 397,000 tech/info workers, including computer and electronic manufacturing. London's tech/info employment level of 382,000 clearly places the city within the top echelon of global tech regions today (Figure 4). Moreover, the sector is growing rapidly. Since 2009, London's tech/info sector has grown by 11.2 percent, compared to 7.7 percent for the New York metro area, and outstripping national percentage increases for Great Britain and the U.S as well. Only the San Francisco-Silicon Valley region has surged ahead at a faster pace.

Collectively the tech/info sector in London plus the East and Southeast regions, including Oxford and Cambridge, has roughly 744,000 tech/info workers, up by 76,000 since 2009. That's slightly larger than California's tech/info sector (692,000). What's more, the tech/info sector in the combined London-East-Southeast region is growing faster than California, even with the rapid growth of San Francisco.

FIGURE 4

GLOBAL DIGITAL REGIONS: WHERE LONDON STANDS

TECH/INFO SECTOR JOBS, 2013* (THOUSANDS)

Region	Jobs
LONDON	382
NEW YORK CITY METRO AREA	411
SAN FRANCISCO-SILICON VALLEY METRO AREAS	397

*Tech/info employment as defined in the appendix. Includes self–employed. San Francisco-Silicon Valley includes computer and electronics manufacturing Data: Office for National Statistics, Bureau of Labor Statistics, South Mountain Economics LLC

FINTECH AND BIG DATA JOBS IN LONDON

Fintech and big data firms are essential parts of London's tech ecosystem. In this section, we estimate the size of these key sectors using the "want-ad" methodology described in the Appendix.

Fintech start-ups run the gamut from financial planning platforms to risk analysis to new ways of providing employee payments. Much like the role that biotech start-ups serve for the pharmaceutical industry, fintech start-ups are creating and nurturing financial innovations that may eventually find their way into mainstream financial firms. There are also numerous fintech firms that have been spun off from mainstream firms, either as part of a nurturing strategy or in response to the perceived moribund character of incumbents. Indeed, an accelerator for fintech start-ups, Level 39, was set up in Canada Square at Canary Wharf.

Because financial services is such an integrated industry, fintech start-ups need to be close to the existing financial firms who may be competitors, suppliers, customers, or sources of talent. Additionally, as regulatory scrutiny increases, fintech start-ups benefit from being able to integrate culturally and geographically with the mainline financial sector.

Based on our methodology, we determined London has an estimated 44,000 IT workers involved in fintech as of May 2014 (Figure 5). That number is roughly comparable to the 43,000 fintech workers in New York, and far ahead of the 11,000 in San Francisco-Silicon Valley. It's important to note that because of data limitations, the results are based on distance from the urban center, rather than being arranged by historic political boundaries.

One of the most rapidly expanding sub-fields within tech/info today is "big data" or data analytics.[5] London is a hub for big data start-ups serving a range of key London industries. Businesses in advertising, fashion, entertainment, and media need to learn how to extract valuable conclusions from the overwhelming stream of data generated by business transactions. In addition, the UK central government is both a big producer of data and a big user of data analytics.

As with other analyses, London again performs strongly when compared to other cities. At the top of the list is San Francisco-Silicon Valley, home of Google, Facebook, and other big data pioneers. London ranks next on the list, followed by New York and Washington, DC, with the latter reflecting once again the influence of the U.S. federal government. Both Cambridge and Oxford are comparatively weak in big data jobs, which could lend support to the premise that data analytics is heavily dependent upon proximity to commercial or government customers.

FIGURE 5

RANKING LONDON: FINTECH AND BIG DATA WORKERS
ESTIMATED JOBS, THOUSANDS, MAY 2014

	Fintech occupations	Big data occupations
London (50 miles)	51	68
London (25 miles)	44	54
New York City (50 miles)	48	66
New York City (25 miles)	43	57
San Francisco-Silicon Valley (50 miles)	13	118
San Francisco-Silicon Valley (25 miles)	11	98
Cambridge	1	7
Edinburgh	3	2
Manchester	3	3
Oxford	2	4
Boston	10	38
Seattle	3	29
Washington DC	7	53
United Kingdom total	82	102
United States total	200	588

Note: All jobs within 25-mile radius except as shown.
San Francisco-Silicon Valley is centered at San Mateo, CA
Estimates are based on the want-ad methodology described in appendix,
Big data estimates are benchmarked to U.S. big data estimate from Mandel (2014), adjusted to account for computer and information systems managers
Data: Office for National Statistics, Bureau of Labor Statistics, Indeed.com, South Mountain Economics LLC

# LESSONS FROM LONDON AND OTHER GLOBAL DIGITAL CITIES

This study of the London tech/info economy follows previous South Mountain Economics studies on the tech/info economies in New York and San Francisco. In all three cities, the tech/info economy grew much more than had been expected by earlier economic projections and, as a result, it helped drive economic growth in the middle of the greatest global economic crisis in generations.

As with San Francisco and New York, London's tech/info boom came about for several reasons. Part of it was organic—driven by the presence of educated workers (many coming from the major universities clustered there), talented programmers and designers (media and large, older tech companies), customers (media, arts, advertising, public sector), and complementary industries (finance, media, fashion) with which tech companies could share talent, ideas, and products. The tech boom was also partly facilitated by infrastructure: the East End and the area that eventually became named Silicon Roundabout had available, affordable office space that was close to transit and appealing to tech workers.

It is also important to note the parallels between local government policy in London and New York, and to a lesser extent San Francisco. In London, like New York, the local government undertook a series of low-cost policy catalysts to encourage the growth of the tech/information sector. These include the conscious effort to create a tech community in the city, including the formation of such organizations as Tech City UK along with related promotional and educational activities. These efforts helped created a virtuous circle in which policy helped create a clear guidepost for attracting start-ups to the city, which in turn generated even more excitement, energy, and economic growth.

These factors underlying the London tech/info boom complement each other, and in some sense cannot be separated out. But without support from the local government, we might be looking at a story of a city with some good tech companies and some interesting start-ups—the London of 10 years ago—rather than studying it alongside San Francisco and New York as a leading digital city.

In sum, all these cities have challenges to continued growth and job creation in the tech sector. However, looking to the future, the London tech sector is poised to become a major driver of economic growth for the city and for the UK generally.
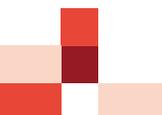
APPENDIX: METHODOLOGY

This study is the third in a series on global digital cities. The September 2013 report on the New York City economy developed a new definition of the "tech/information" sector reflecting the realities of the convergence between technology and content. The April 2014 report on San Francisco extended and refined that definition in order to get a better understanding of how global digital cities grow.

The main purposes of this study are to measure the size and growth of the London tech/info economy, and understand how it compares to the New York area and the San Francisco-Silicon Valley cluster. Two different approaches are used. The first approach is industry-based, using official government industry data from the Office for National Statistics to identify tech/info jobs.

Additional perspective is provided by analyzing counts of online want ads or advertisements for jobs. This "want-ad" approach allows us to track the prevalence of fintech and big data occupations. Moreover, it allows us to estimate employment in narrower categories, such as big data occupations and fintech occupations. This approach builds on a methodology developed by South Mountain Economics over the past several years.

Both the industry-based approach and the want-ad approach are used to make international comparisons of London with New York and the San Francisco-Silicon Valley region. The methodology for making such comparisons are discussed below.

INDUSTRY-BASED APPROACH

For this study, the data for the industry-based approach comes from the Office for National Statistics. There are two important questions. First, which London industries belong in what this study calls the tech/info sector? Second, how can the London tech/info sector be defined in a way that best aligns with international comparability?

To answer these questions, consider that in the age of convergence, many traditional media companies have extensive online operations, and many Internet companies are extensive producers of content. Moreover,

it's clear that publishing and media companies are part of the same ecosystem as smaller digital media, social networking, and e-commerce start-ups.

In particular, virtually all of the major London news, publishing, and media organizations — such as the BBC and the *Financial Times* — are pouring major resources into their online and mobile operations. Moreover, Internet- and mobile-savvy workers move back and forth between the large companies and small start-ups. That's the mark of a well-functioning ecosystem. Indeed, the large publishing and media companies serve much the same anchor function in London as the large tech companies do in Silicon Valley.

At a minimum, the tech/info sector in London should include all of the Information and Communications broad industry group, as defined by government statistical agencies (Figure 6). This group (SIC codes 58 through 63) includes everything from web portals to wireless telecom to traditional newspaper and broadcast companies to computer programming, and computer consultancies. That means large companies such as Google and Facebook, and small start-ups such as CityMapper, maker of a transport app, should, all fall into this broad category.

The next decision is whether to include other industries in the definition of the tech/info sector as well. The New York and San Francisco studies do include several other industries, such as "scientific research and development services." The Tech City study of London makes the case for broadening the definition of the tech/media/digital sector to include industries such as "public relations and communications," "architectural activities," and "advertising agencies."

In this study, we present results for both the tech/info sector and the expanded tech/info sector, which includes professional, scientific, and technical industries. Figure 6 shows the industry categories for the U.K. and for the comparable sectors in the U.S.

FIGURE 6

DEFINING THE TECH/INFO SECTOR

TECH/INFO SECTOR
UNITED KINGDOM
→ Information and Communications sector (SIC J):
  Publishing
  Software publishing (Including games)
  Motion picture, video, sound recording and
   television programme production
  Radio and television broadcasting
  Telecommunications (wired and wireless)
  Computer programming and software development
  Computer consultancy
  Data processing and hosting
  Web portals
  News agencies and other information service activities

UNITED STATES
→ Information (NAICS 51)
  Publishing
  Software publishing
  Motion picture and sound recording
  Radio, television, and cable broadcasting
  Telecommunications (wired and wireless)
  Data processing and hosting
  Internet Publishing and Broadcasting and Web Search Portals
  News Syndicates and other information services
→ Computer Systems Design and Related Services (NAICS 5415)
  Custom Computer Programming Services
  Computer Systems Design Services
  Computer Facilities Management Services

EXPANDED TECH/INFO SECTOR
UNITED KINGDOM
→ Information and Communications sector (SIC J)
→ Professional, scientific and technical activities (SIC M)

UNITED STATES
→ Information (NAICS 51)
→ Professional, Scientific, and Technical Services (NAICS 54)
→ Management of Companies and Enterprises (NAICS 55)

Data: Office for National Statistics, U.S. Census Bureau,
South Mountain Economics LLC

WANT-AD APPROACH
The industry approach gives us a consistent set of official job numbers that can be tracked over time. However, the industry approach by itself is not enough. In particular, neither finance nor health/education nor professional services are part of our definition of the tech/info sector. That's disturbing, because, some

of the biggest employers of tech workers in London are the financial firms, such as HSBC and Barclays. Indeed, these companies in many ways are engaged in a technological arms race.

The other problem with the industry approach is that the official statistics are not fine-grained enough to identify particular areas such as "big data" or "fintech." To put it another way, the official industry statistics are both too narrow and not narrow enough.

However, to deal with these problems, we utilize an alternative measure of "tech" for London that relies on a want-ad approach. This methodology was originally developed by South Mountain Economics for tracking App Economy jobs in the United States. More recently, the want-ad methodology was further developed and applied to the United Kingdom.

An advertisement for a job, by definition, must contain sufficient information about the skills needed for the position and the location of the job to attract the right potential jobseekers. Moreover, want ad activity has increasingly moved online, where ads are collected and de-duplicated by want-ad aggregators such as Indeed.co.uk in the United Kingdom, and Indeed.com and The Conference Board in the United States.

In this study, we use the advanced search function of Indeed.co.uk and Indeed.com to generate counts of want ads fitting certain location and skill criteria. That enables us to estimate employment in areas such as big data and fintech jobs. With some attention to detail, these comparisons can be made consistently across national borders as well.

An essential step in the want-ad analysis is to develop a link between the number of want ads and the overall number of jobs in an occupation. The intuition is that the more workers in a particular occupation, the more ads that employers will have to place to fill vacancies created through normal attrition and turnover. This intuition is explored and empirically justified in Mandel and Scherer (2014, forthcoming).[6]

This link, expressed as the job/ad multiplier, is occupation-specific and country-specific, as well as being

dependent on the particular want-ad aggregator being used. Our analysis shows that using Indeed.com as the want-ad aggregator gives us a job/ad multiplier of 9.0 for the UK IT occupations, and 12.6 for US IT occupations Note that the multiplier is lower for the UK than the US, implying that UK employers are generating more ads per job on average.

Keyword lists were generated for big data jobs and fintech jobs. These keyword lists were used to generate Figure 5 in the study. The job/ad multipliers were used to directly generate the estimates for fintech jobs. In the case of the big data jobs, the U.S. aggregate number was benchmarked to another recent study of U.S. big data jobs adjusted to account for computer and information systems managers.[7] Then the want ad data was used to generate the estimates of big data jobs for London and other cities.

For the larger tech hubs of London, New York, and San Francisco-Silicon Valley, the figures show employment within both 25- and 50-mile radius. The 25-mile radius for London reaches substantially beyond the city's political borders, while the 50-mile radius gets out to Cambridge, Oxford, and Reading. The 25-mile radius around New York City include the whole city and parts of Long Island, New Jersey, and Westchester, while the 50-mile radius reaches out to the headquarters of IBM and GE, and Bell Laboratories in New Jersey. The study uses San Mateo (California) as the center of the Bay Area, so a 25-mile radius includes San Francisco and Berkeley to the north and San Jose to the south, while a 50-mile radius includes most of the broader Bay Area. For the smaller hubs such as Oxford (UK) and Seattle (US), the tables report employment with a 25-mile radius.
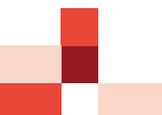
AUTHORS

Dr. Michael Mandel is president and founder of South Mountain Economics LLC (SME), which provides global expertise on emerging occupations and emerging industries. SME is widely cited for its September 2013 report "Building A Digital City: The Growth And Impact of New York City's Tech/info Sector," and for its April 2104 report, "San Francisco and the Tech/Info Boom: Making the Transition to a Balanced and Growing Economy."

SME recently completed a project tracking innovative job creation in the United Kingdom. SME studies on the App Economy were quoted in publications such as the *Financial Times*, the *New York Times*, *Bloomberg*, the *Atlantic*, *Time*, and *Forbes*.

Mandel is also chief economic strategist at the Progressive Policy Institute in Washington (DC), where he supervises PPI's research and policy work across such topics as the data-driven economy, the impact of regulation on innovation, and policies to improve production, investment and job growth. Mandel argues that innovation can be a force for creating jobs and opportunity for the broad population. Recent studies include "Can the Internet of Everything Bring Back the High-Growth Economy?" and "Where are the Big Data Jobs?".

Mandel, who received a PhD in economics from Harvard University, is senior fellow at Wharton's Mack Institute for Innovation Management at the University of Pennsylvania. He is the author of four books including *Rational Exuberance: Silencing the Enemies of Growth and Why the Future Is Better Than You Think*.

Dr. Jonathan Liebenau is an Associate Professor (Reader) in Technology Management in the Department of Management at the London School of Economics. Liebenau leads LSE Tech, a research group at LSE's Department of Management active in the area of Internet and Communications Economics, Policy and Strategy. He specialises in two areas: fundamental concepts of information, and the problems and prospects of information and communication technology in economic development. He has previously worked in academic administration, technology policy, and the economic history of science-based industry. He is the author or editor of several books and over 70 other major publications and has provided consultancy services to leading companies and strategic government agencies, including: Dell, BT, IBM, Microsoft, Tata Consultancy Services, Nortel, EDS, Lloyd Thompson; and in the UK Government, the Office of Science and Innovation, the Department of Trade and Industry and the Home Office. He also has worked with the Royal Society for the Arts and DigitalEurope, and is on the advisory boards of Istanbul Bilgi University and American University in Cairo, School of Business.

ENDNOTES

1   Michael Mandel. "Building a Digital City: The Growth And Impact of New York City'sTech/information Sector," South Mountain Economics, September 2013. Michael Mandel, "San Francisco and the Tech/Info Boom," South Mountain Economics, April 2014.

2   "Mayor outlines vision to make London the tech capital of the world," press release, London & Partners, March 2014.

3   The tech/info sector was originally named in our 2013 report on New York City. (Michael Mandel. "Building a Digital City: The Growth And Impact of New York City's Tech/information Sector," South Mountain Economics, September 2013.)

4   "Tech Powers the London Economy: The Tech City 3rd Anniversary Report," Tech City, December 2013

5   For big data job in the U.S., see Michael Mandel, "Where Are the Big Data Jobs?" Progressive Policy Institute, May 2014

6   Michael Mandel and Scherer, Judith. "Using Want-Ad Data for Mapping of Jobs and Economic Activity Related to Innovative Technologies," NESTA working paper, 2014, forthcoming. See also: Michael Mandel and Scherer, Judith. "The Geography of the App Economy," South Mountain Economics, October 2012

7   Michael Mandel, "Where Are the Big Data Jobs?" Progressive Policy Institute, May 2014