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Urban Stud 2010 47: 337 originally published online 5 November 2009
DOI: 10.1177/0042098009349024

Urban Studies
47(2) 337–362, February 2010

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[Paper first received, April 2008; in final form, December 2008]

Abstract

This article is a natural extension of the current discussion on occupational clustering and economic growth. It is argued that, while there has been increased interest in the role of occupations, little has been done from a methodological and empirical approach to discover how the study of occupations can illuminate the study of industry. Prior work in cluster analysis has generally taken an 'either/or' approach towards occupational and industrial analysis. Porter's clustering model has illuminated the cross-fertilising linkages across industries, but this is only half the story. It is argued that what drives these clusters is not only the industry, but also the people and their occupational skills and, therefore, such analysis must be expanded. Using the case of the IT sector in Los Angeles, the industry approach is combined with an 'occupational cluster analysis'. It is concluded that this approach leads to a better understanding of regional competitiveness and growth.

Introduction

In the past 50 years, geographers and economists have come a long way from attributing regional growth to exports and trade (North, 1955; Tiebout, 1956; Thompson, 1965). Much of the work in the past two decades, particularly stemming from Piore and Sabel's (1984) conceptualisation of new industrial districts characterised by 'vertical disintegration' and flexible specialisation of firms, relies on the premise that innovation and human skills drive growth and productivity.

By extension, this thesis argues that, in a post-industrial economy, regional productivity is a function of its concentration of new

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0042-0980 Print/1360-063X Online

DOI: 10.1177/0042098009349024

ideas, innovations and divisions of labour (Piore and Sable, 1984; Lucas, 1988; Saxenian, 1994; Storper, 1997; Scott, 2000; Florida, 2002; Glaeser, 2003). The ability to mobilise these variables relies on the cultivation of an intricate linkage of people and firms. This prescription has become the cornerstone of many contemporary economic development strategies, perhaps most significantly crystallised in Porter's (1998) industrial clustering model, whereby he outlines the dense networking that occurs across industries that generate new products and encourages the exchange of new ideas. The importance of industrial clustering, however, was formalised some 100 years ago by Alfred Marshall (1890/1961) in his conception of 'industrial districts' that possess something 'in the air' sparking perpetual innovation and productivity. As many geographers and planners have argued subsequently, regional growth as understood in the cluster model cannot be attributed to one industry, but to the synergies across different industries that work to create diversified products and innovations within the same geographically based industrial concentration.

Regional employment growth results from increasing both the labour supply and the demand for that labour. Industrial productivity, however, is a function of human capital. Industries need skilled human capital to generate productivity and growth. Hence, more recent productivity measures take into account a region's human capital stock. Florida's (2002) 'creative class' and Glaeser's (2003) 'skilled city' focus on the talent or supply contributions to regional growth. While Porter's earlier industry-based model focuses on the demand curve of the labour market, these more recent contributions highlight the importance of the human capital supply that makes such industrial growth possible. Human beings are the fuel for any industrial cluster. The easiest way to measure human capital stock is through the percentage of those possessing a bachelor's degree or above. Yet this measure poses its own problem. Looking at human capital alone only tells us the demographic characteristics of a population as opposed to the actual value being created by their presence within a regional economy. Educational attributes only measure the available stock but do not tell us what people do with the education they have attained.

Scholars have argued that it is occupations not industrial classifications that are most accurate in their measure of human capital clustering (Barbour and Markusen, 2007; Koo, 2005; Feser, 2003; Markusen, 2004; Florida, 2002). This methodological approach argues that occupations are a better gauge for what people do and where value is being added. This measure counts individuals who may not be captured by educational measures but are contributing significantly to the economy (such as artists, and college dropouts like Bill Gates and Steve Jobs). Further, occupational analysis allows for a more targeted approach in how to construct local economic development for human capital (Markusen, 2004). Occupational analysis also helps to identify the presence of a thick regional labour market in specific applications, which has been identified as an important factor in individual location preference (Florida 2002). While the occupational approach has become a critical part of contemporary development research, Thompson and Thompson's (1985) much earlier work was the first truly to make the case for occupational over industrial analysis. They argued that occupations are a better way to measure a region's skill strengths and point towards other industries that require the skills of the region's occupational advantages.

This article is a natural extension of the current discussion on occupational clustering and economic growth. We argue that, while there has been increased interest in the role of occupations, little has been done from a methodological and empirical approach to find out exactly how occupational analysis plays out on the ground in real places and how the study of occupations can further illuminate the study of industry. Prior work in cluster analysis has generally taken an 'either/or' approach towards occupational and industrial analysis. Porter's (1998) industrial clustering model has illuminated the cross-fertilising linkages across industries, but this is only half the story. We argue that what drives these clusters is not only the industry, but also the people and their skills and occupations and, therefore, such cluster analysis must be expanded. Using the case of the information technology sector in the Los Angeles Metropolitan Statistical Area (MSA), we undertake a two-tier model of industry and occupational analysis. We find that neither approach illuminates the region-specific nuances and that both must be incorporated to capture the region's dynamics. In other words, occupations and industries are both important and simultaneously evaluating them will lead to a better understanding of regional competitiveness and possibilities for development and policy trajectories.

This article uses the case of the information technology sector in Los Angeles to contrast the use of occupational and industrial cluster analysis with only pursuing industry cluster analysis, demonstrating the increasing problems and limitations with using a strictly industry cluster analysis in a post-industrial knowledge-based economy. We incorporate three different datasets and present our two-step analysis in tables and figures throughout. We find that, by combining the previously established industry approach with an 'occupational cluster analysis', we are better able to pin-point the linkages between skills and industries. We conclude that occupations and industries are both important and simultaneously evaluating them will lead to a more comprehensive and nuanced understanding of regional competitiveness and possibilities for growth. We briefly conclude with how our methodology for understanding regional development can contribute to the larger body of work on regional economic analysis and we contemplate how this more nuanced approach may have policy and development implications. Specifically, we speculate that such analysis allows for more fine-tuned and sophisticated place-specific policies, whereby policy-makers focus on their region's skill base and how it relates to the local industrial base. We conjecture that policy aimed at bridging occupational skill sets with industries will fully maximise the potential of both.

Theories and Concepts

Over the past century, social scientists' conception of regional growth has evolved substantially. Of the many angles in which development has been explored, the role of industrial clusters has been one of the more salient lines of research and policy-making. While there have been rebukes towards the effectiveness of the cluster model (see for example, Lundequist and Power, 2002; Martin and Sunley, 2001, 2003; Hervas-Oliver and Albors-Garrigos, 2009), there is a pervasive belief across the social sciences that the geographical clustering of industries and their related human capital and resources is significant to economic growth. Industrial cluster theory posits that significant externalities occur due to co-location of firms and skills. Originally conceived in Marshall's (1890/1961) seminal discussion of 'industrial districts', geographical clustering has been thought to allow for not only efficiency and ease of resource and skill exchange (for example, localisation economies), but also more intangible 'tacit' knowledge (Gertler, 2003) and 'untraded interdependencies' (Storper, 1997) that far outweigh the tangible or formal exchanges among firms and human capital. In other words, firms have to 'be there' physically to attain these benefits. This 'endogenous growth' model (Romer, 1990, 1994) has been documented extensively in studies of high technology, film production, fashion and biotechnology, among others.[1] Saxenian (1994) argued that Silicon Valley trumped Boston's Route 128 because of the more flexible and open environment of exchange across firms, while the latter was steeped in a more 'autarkic' business model that left each firm to its own devices. Piore and Sabel's (1984) ground-breaking look at the new industrial map pointed towards regions steeped in these flexible exchanges of resources, labour pools and ideas across firms and industries. Despite the increasingly advanced technology that enabled people and firms to locate in geographically dispersed regions, it became apparent that, paradoxically, people increasingly tended to agglomerate in the same place due to the intangible benefits of face-to-face contact, exchange of ideas and competition that drove firms to achieve greater innovation (Storper, 1997; Porter, 1998; Glaeser, 2003; Stolarick and Florida, 2006). Regional productivity was a function not just of having the right resources in the right place, but the positive spillovers associated with that agglomeration.

By extension, understanding regional growth meant being able to formalise the ways in which industrial agglomerations worked and what types of linkages were most important in the exchange of resources and information. As Piore and Sable (1984) noted, these relationships were marked by vertical disintegration, where firms increasingly outsourced for materials, skills and resources for their production. Thus successful regions possessed dense agglomerations of firms that were able to help each other produce differentiated products, constantly shifting alliances from being collaborators and competitors. Porter (1998) synthesised these dynamics in his discussion of industrial clusters, which he defined as "geographical concentrations of interconnected companies and institutions in a particular field" (p. 78). Affirming previous work, Porter argued that the informal relations outside the firm are most essential to regional productivity. These dynamics reinforce themselves, resulting in a 'lock-in' competitive advantage over other places (Scott, 2000; Castells and Hall, 1994).

While perceived as path-breaking in regional growth models, Porter's model focused primarily on the demand side of regional productivity, not taking into account the people who powered the very clusters necessary to economic growth. More contemporary research revolves around a more nuanced version of clustering—that concentration of people and skills, not firms, is what drives regional growth. From these perspectives, human capital has become the critical factor in dictating regional success (Drucker, 1993; Glaeser, 2003; Lucas, 1988; Florida, 2002, among others). Glaeser (2003) found that cities possessing greater stocks of human capital (as measured by those with a bachelor's degree or above) exhibited greater productivity and growth than those with fewer 'skills'. Further, he found that original stocks of skills predict growth and productivity over time. Similarly, Lucas (1988) and Romer (1986, 1990, 1994) note that knowledge builds upon knowledge, creating what Romer calls 'endogenous' growth. Audretsch and Feldman (1996) found that knowledge-intensive industries tend to exhibit dense clustering of their innovative activities. Many of these more recent explorations tie largely into Schumpeter's (1942) now classic discussion of 'creative destruction', where individuals and firms are able to reconfigure their resources and knowledge to reinvent products and ideas, thus further perpetuating new innovations and divisions of labour. Jacobs (1969), Thompson (1965) and Vernon (1960) have similarly noted the ability for closely concentrated human capital to produce longstanding urban growth, particularly crystallised in Jacobs' discussion of 'new combinations' of human skill sets in generating new industries and jobs. Stolarick and Florida (2006) demonstrate the 'spill-acrosses' created by the interactions among the creative, technical, business and design communities.

Both on a regional and national scale, the human capital-growth connection is well established, as is the ability for skills to beget even more skills. As firms seek out places with dense labour pools, people seek out places that offer thick labour markets, greater possibilities for educational advancement and higher earnings, thus creating uneven concentrations of skills at national and global scales. And while the education measure tells us where general skills are, it does not inform what people are doing with their skills and how these skills are being merged and exchanged within a regional economy. Education only measures base-line skills; it does not give any sense of application or which skills are being used, and which skills are demonstrably more or less important to a region's productivity.

As a result, there has been increasing debate as to *which* skills are important for regional productivity. In other words, scholars have begun to sift through human capital stocks to parcel out which types of skills are most important. The clearest proxy for measuring these dynamics is that of occupations. As Thompson and Thompson (1985) point out, determining which occupational strengths a region possesses determines both local needs and advantage. In other words, occupational strengths can often act as leverage to attract industries seeking out particular skills—not the other way around. Occupational analysis indicates what specific type of human capital a region possesses, thus giving a more place-sensitive analysis of productivity and growth. Further, occupational analysis captures those individuals engaged in economically valuable work who may not have a bachelor's degree or above. This analysis has quickly become the forefront of economic development and economic geographical analysis, as it allows for greater nuance and a deeper understanding of regional growth, and how it differs across geographies.

Several different approaches have been undertaken to get at the occupational dynamics of a region. Markusen (2004) has argued that occupational analysis gives a much clearer picture of local economic dynamics, aiding in more effective economic development policy. Barbour and Markusen (2007) point out that innovative industries cannot be predicted by their industry alone, as occupations (and skills) are more geographically divided, with R&D locating in one part of the country and production in another—a point that Massey (1984) and Nelson (2003) have also argued. Thus, occupations for the same industry can be different for different geographies. Similarly, Feser (2003) has argued for the distinction between "the kinds of work the local economy does [versus] the kinds of products it makes" (p. 1937)—largely a function of the education and skills that a region possesses. Workers may move between jobs and industries within the same region, often without having to attain significant new skills, because "many skills and knowledge-bases are common to multiple occupations" (p. 1940). In his study of the Cleveland metropolitan area, Koo (2005) argues for a three-tier approach in analysing the regional economy, targeting both occupations and industries.

While the earlier work of Thompson and Thompson used a very generic categorisation for occupational clusters, the work of both Feser (2003) and Koo (2005) based their definitions of occupational clusters on the knowledge requirements of approximately 600 occupational categories as defined in the ONET system. In each case, the result was to consolidate the ONET-defined occupational categories into around 20 clusters, which is too few to represent meaningfully occupational labour markets. Rather than using the widely used and recognised framework developed by Porter, Koo uses a model that directly incorporates both occupations and industries. Both approaches fail to account for all BLS occupations. While they offer an additional level of detail that takes advantage of newly available data, their approach falls short in sufficiently justifying the inclusion of these data.[2]

Earlier work by Markusen (2004) provides a potential framework for identifying occupational characteristics, which includes some possible connections to entrepreneurial opportunities, but the actual and potential linkages across industries are not identified. It describes a more prescriptive three-step method that can be used by those in regional economic development for 'occupational targeting'. However, the first step assumes knowledge of existing occupations or occupational clusters within the region that may not be present; a 'step zero' is needed with an approach and specific tools to help those doing economic development to achieve some understanding and insight into their region's current occupational strengths. While targeting specific, high-growth and 'capturable' occupations is desirable, regions need first to understand and build on existing strengths.

Recently, Barbour and Markusen (2007) have investigated the relationship between regional occupational and industry structure. They found that, for some industries, the local occupational mix mirrors the national occupational mix but also showed that, at least in the case of high-tech industries in California, the national occupational structure for an industry is not a good approximation for the regional occupational mix for those same industries. Their result demonstrates that industry is not always sufficient on its own as a way to understand regional economic activity. These results add further support to the argument that both industry and occupational viewpoints are needed.

There is both strong theoretical and empirical evidence that occupational analysis has become an effective method of understanding regional advantage and productivity. Economic development policy can be aided significantly by capitalising on local strengths, best measured through the occupational or skill-mix a region possesses. A solely industrial-based analysis neglects the role of human capital in understanding clustering. External economies, after all, are a function of people and their respective skills and occupations. Rather, industries benefit from these skills and the external economies and spillovers that such concentration of human capital and skills produces.

In this respect, the Porter (1998) model only tells us part of what is going on. It shows the demand side—where the industries are and what they are producing. However, occupational analysis helps to explain firm location choices by highlighting the specific skills industries seek out and that particular regions possess. Occupational analysis informs the supply side of regional productivity and growth, and gives a deeper understanding of what types of work are going on and how these types of work are engaging one another. In other words, occupational analysis gets inside the 'black box' of what types of human capital and skills are more or less important to regional productivity.

Current occupational research partially accounts for these dynamics, but occupational and industrial analysis is not an either/or approach. Occupational analysis only tells us part of the story. To be useful, any model of occupational clusters needs to be much more finely grained and the industry side of the equation should be addressed by those methods that are already generally accepted and most widely used. Using the case of information technology in Los Angeles, we argue that both industrial analysis and occupational analysis are essential in providing a deeper understanding of the role of human capital and skills in industrial clustering. We will now turn to our methodological approach for accomplishing this task.

Data Sources and Methods

The data employed to investigate these relationships are divided into three different categories. All data used are from 2000. The first category is specific data on occupations. For the occupational analysis, the data taken are from two sources: US Bureau of the Census and the Bureau of Labor Statistics Occupational Employment Statistics (OES). The Standard Occupation Classification (SOC) forms the basis for the OES. Occupational data are reported on individuals currently working in the specified occupation.

The second category is industry data, which were taken from the Census Bureau's County Business Patterns. Industry data are reported at the firm or establishment level and are reported for firms that have employees or sales. The final category is data on individuals that include both occupation and industry information: the 5 per cent Census Public Use Microdata Sample (PUMS). While the previous two sources report separate information on occupations or industries, this final source allows for reporting of occupations *within* an industry or for the reporting of all industries for a given occupation.[3]

The analysis in this paper will consider the implications of analysing separately and jointly both occupations and industries for the US overall. For tractability, we will restrict analysis to specific industries, specific occupations, specific geographies or a combination of specific industries and specific occupations in a specific geography. However, there is nothing about the analysis completed here that is limited by the industry, occupation or geography selected. This same analysis would be appropriate across numerous domains. The industry and occupation will be restricted to the information systems/information technology (IS/IT) domain. This high-growth field continues to garner much attention and is the focus of many regional economic development efforts and industry cluster analyses. While not intended to be representative of all industries and occupations, as it is a mix of high human capital, manufacturing and service-based activities, it is representative of the current knowledge or creative economy (Bell, 1973; Drucker, 1993; Florida, 2002) that is readily accepted as the dominant economic paradigm.

We also focus our analysis geographically by looking at the IS/IT cluster in the Los Angeles metropolitan area. Specifically, analysis will focus on the Los Angeles PMSA, which is limited to the City of Los Angeles and Los Angeles County only. Although the obvious home to the entertainment industry, Los Angeles is also one of the country's largest centres of garment and apparel manufacturing, in addition to a wide variety of both professional and personal service industries. It is precisely because Los Angeles is not known for any particular strengths in the IS/IT domain that it makes for an excellent 'test case' for this analysis. Analysing the IS/IT industry and occupations in Austin or San Jose or Seattle, while informative in their own right, would lead to results that are not easily applicable to other areas less concentrated in high technology. Looking at the IS/IT domain in Los Angeles is more likely to generate results that are meaningful and applicable to, for example, Kansas City, Dallas, Chicago and Pittsburgh.

We will first look at the general results from the analyses of these various datasets, then we will focus on particular industrial domains and geography. We conclude with the implications of these results and discussion of future research in occupational cluster analysis.

Results

Understanding Occupations through SOC Data

First, information from the individual occupation titles and the SOC is considered. Previous attempts at analysing information at the occupational level have started by attempting to cluster, group or summarise the current 800 occupations. We will show that the SOC occupations already reflect significant grouping and summarisation of the underlying employment. Attempts to summarise even further have resulted in confusing and not particularly helpful analysis. Understanding local occupational strengths and weaknesses requires an appreciation of the actual labour market conditions that an individual would be facing. Oversummarised results remove this individual understandability and eliminate the ability to judge the true occupational competitive advantage created by a 'thick' labour market.

The 2000 US census collected information on 30 646 individual occupational titles. From those titles, Census Bureau processing created the SOC which, for 2000, produced 797 individual occupation codes. Table 1 shows the average number of individual occupational titles for each of the levels in the SOC.

As can be seen in Table 1, each level of the SOC represents a substantial number of individual occupation titles. Previous analyses that have attempted to cluster occupations using various methods have failed to consider that the 'base' occupation from which they started was already a cluster of numerous individual occupations. Their resulting groupings with only 20–30 unique occupational clusters has resulted, on average, with over 1000 individual occupational titles in each cluster. Recent work discussing the importance of regional competitive advantage that can be gained through occupational mix has identified the role of thick labour markets in being able to attract individuals to a region (Florida, 2002). People are attracted to regions where they have many opportunities to use their skill set. However, being able to identify regional competitive advantage using this approach means that a much more finely grained analysis is required. An occupational cluster that includes over 1000 different job titles is not one from which a thick labour market can be meaningfully identified.

Table 1. Occupation groups and titles

Number of groups	*SOC level*	*Average titles per group*
797	Occupation	38.5
444	Broad occupation	69
93	Minor group	329
22	Major group	1 393

We also identify the specific occupations from the SOC that could be classified as being information systems or information technology occupations. (Please see the Appendix, Tables A1 and A2, for the complete list.) Figure 1 shows employment totals for the five largest occupations for the entire US and for Los Angeles. At 3.4 million, IS/IT occupations are 2.8 per cent of total US employment with the highest employment in *Computer programmers* and *Computer support specialists*. For Los Angeles, approximately 98 000 IS/IT workers make up 2.7 per cent of the workforce with highest employment again in *Computer programmers* and *Computer support specialists*. Although most IS/IT employment in Los Angeles is distributed across the occupations in a similar fashion to the entire country, Los Angeles does have a higher percentage of its employment in *Network and computer systems administrators* and *Computer operators* and a lower percentage in *Computer science teachers, post-secondary*. Also, no *Semiconductor processors* are reported for Los Angeles

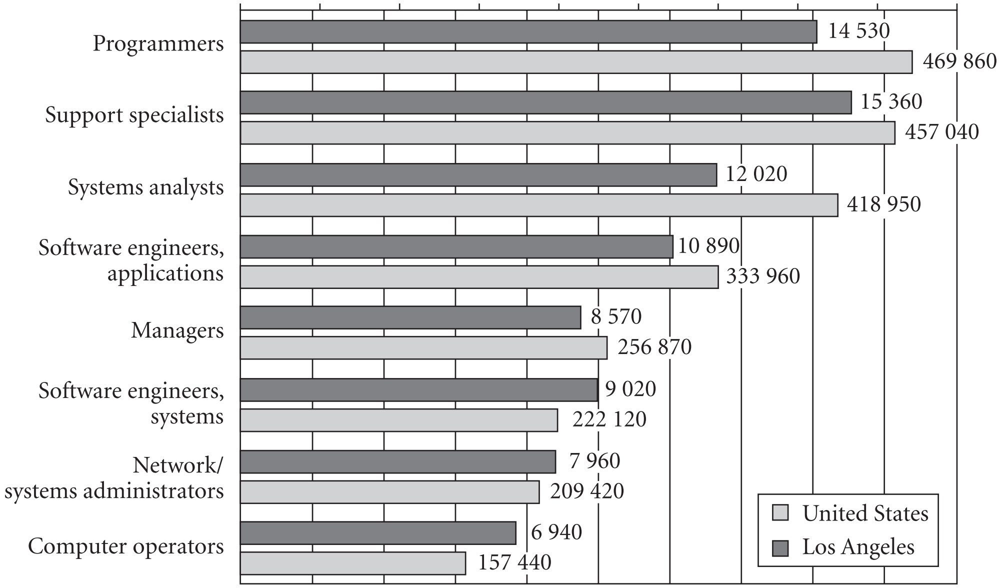

Figure 1. US and Los Angeles IS/IT occupations, five largest, 2000

but do comprise almost 2 per cent of the IS/IT workforce nationally.

NAICS and Industry Analysis

The second and more widely taken approach to analysing regional competitive advantage is to use the North American Industry Classification System (NAICS) categories in order to form industry clusters.[4] Using NAICS, Table 2 shows the five largest industries by employment for the entire US for 2000, the specific industries, their employment and the total number of establishments for the IS/IT industry cluster. According to the industry cluster, the US IS/IT cluster was approximately 2.0 million employees or about 1.8 per cent of total employment. Compare this with the occupation number that showed 3.4 million and over 2.8 per cent. The largest employers in the IS/IT cluster are in the *Custom computer programming services*, *Computer system design services* and *Semiconductor and related device manufacturing* industries.

Specific industry data are not available for Los Angeles at this level of detail. The most detailed information that is publicly available is only at the three-digit NAICS code level. Tables 3 and 4 show the summary data for the US and Los Angeles at the three-digit level. At this level, each industry group includes more than just the IS/IT industry cluster. For the overall US, almost 17 per cent of total employment is included in these nine industry groups. The largest employment is in the *Professional, scientific, and technical services* and *Whole trade, durable goods* industries. For the Los Angeles area, the nine industry groups account for over 22 per cent of total regional employment. Although Los Angeles has a higher concentration of employment in the *Professional, scientific and technical services* industry and a lower concentration in *Machinery manufacturing*, the distribution of employment across all nine industries is similar between Los Angeles and the entire US. Surprisingly, while *Publishing* makes up over 5.5 per cent of the total employment across these nine industry groups for the entire US, less than 3 per cent of the total employment in the Los Angeles area is in *Publishing*.

Table 2. US IS/IT industries, five largest, detailed level, 2000

NAICS	*Description*	*Total employment*	*Percentage IT*	*Percentage of total*	*Total establishments*
		114 064 976			7 070 048
All IT		2 070 438		1.82	
541512	Computer systems design services	521 454	25.19	0.46	36 400
541511	Custom computer programming services	490 319	23.68	0.43	42 352
334413	Semiconductor and related device manufacturing	207 211	10.01	0.18	1 190
334418	Printed circuit assembly (electronic assembly) manufacturing	101 263	4.89	0.09	708
541519	Other computer related services	96 620	4.67	0.08	19 783

However, Los Angeles does have a higher share of employment in *Information services and data processing services* when compared with the nation as a whole.

While the industry-level data are most widely used for regional competitive analysis, sufficiently detailed data are not generally publicly available.[5] Moreover, as a simple comparison between the occupational and industry results shows, there are significant differences in understanding at both the national and regional levels. One obvious chasm between the data is which industries do the IT occupations identified in the SOC data fall within? This gap in the data is a function of the fact that the two data sources are independent of each other and only provide an 'either/or' level of analysis. We next turn our attention to developing a deeper understanding of those differences by using census data that simultaneously capture both occupation and industry for a sample of the entire US population.

Census PUMs as a Link between Industry and Occupation

The 2000 Public Use Micro Sample (PUMS) from the US Census provides both industry and occupation detail for individuals from a 5 per cent sample of all US households. Although not exactly the same occupation and industry definitions are reported in the PUMS, the census does provide a 'cross-walk' or bridge that generally links census occupation codes to SOC occupation codes and another bridge that links census industry codes to NAICS industry codes (see the Appendix).

Using these occupation and industry codes, all individuals working in either the IS/IT industry and/or in an IS/IT occupation were extracted. The results are summarised in Table 5 for both the US overall and Los Angeles. For the entire US, 2.8 per cent of the PUMS sample of employed individuals worked in either the IS/IT industry or in an IS/IT occupation. Over half were people working in an IS/IT occupation but *not* in the IS/IT industry. Over 25 per cent worked in an IS/IT industry but *not* in an IS/IT occupation. Finally, at the national level, just under a quarter of those working in an IS/IT occupation or in an IS/IT industry are actually in *both* an IS/IT occupation and the IS/IT industry. The results for Los Angeles reveal a similar pattern. The majority of those doing IS/IT work do not work in an IS/IT industry nor do the majority of those working in

Table 3. US IS/IT industries, three-digit level, 2000

NAICS	*Description*	*Total employment*	*Percentage of groups*	*Percentage of total*	*Total establishments*
		114 064 976			7 070 048
All IT		19 259 416		16.88	1 459 765
541///	Professional, scientific and technical services	6 816 216	35.39	5.98	722 698
421///	Wholesale trade, durable goods	3 624 617	18.82	3.18	288 584
611///	Educational services	2 532 324	13.15	2.22	68 014
334///	Computer and electronic product manufacturing	1 557 087	8.08	1.37	17 148
333///	Machinery manufacturing	1 377 950	7.15	1.21	29 442
811///	Repair and maintenance	1 334 206	6.93	1.17	232 567
511///	Publishing industries	1 080 664	5.61	0.95	32 545
514///	Information services and data processing services	529 031	2.75	0.46	23 175
443///	Electronics and appliance stores	407 321	2.11	0.36	45 592

Table 4. Los Angeles IS/IT industries, three-digit level, 2000

NAICS	*Description*	*Total employment*	*Percentage of groups*	*Percentage of total*	*Total establishments*
		3 863 871			226 282
All IT		866 775		22.43	
541///	Professional, scientific, and technical services	406 503	46.90	10.52	25 391
421///	Wholesale trade, durable goods	154 338	17.81	3.99	12 710
611///	Educational services	105 017	12.12	2.72	2 583
334///	Computer and electronic product manufacturing	58 467	6.75	1.51	816
811///	Repair and maintenance	43 717	5.04	1.13	7 079
514///	Information services and data processing services	32 030	3.70	0.83	903
333///	Machinery manufacturing	27 458	3.17	0.71	903
511///	Publishing industries	24 943	2.88	0.65	1 064
443///	Electronics and appliance stores	14 302	1.65	0.37	1 367

an IS/IT industry actually work in an IS/IT occupation.

Tables 6 and 7 show the breakdown for the IS/IT industry and IS/IT occupations (US overall and Los Angeles). The industry breakdown (Table 6) shows a similar distribution between the overall US and Los Angeles. Most individuals are employed in the *Computer systems design and related services* industry. The entire country has

Table 5. US IS/IT industry and/or IS/IT occupation (PUMS), US and Los Angeles

IT occupation?	*IT industry?*	*Percentage of IT (either)*	*Percentage of total sample*
US			
N	Y	25.65	0.72
Y	N	50.23	1.41
Y	Y	24.12	0.68
Los Angeles			
N	Y	29.16	0.82
Y	N	47.71	1.33
Y	Y	23.13	0.65

Table 6. IS/IT industry, US and Los Angeles (PUMS)

	US	*Los Angeles*		
PUMS industry	*Percentage of total*	*Percentage of total*	*NAICS code*	*Industry description*
000	1.39	1.46		IT industry workers
738	0.77	0.75	5415	Computer systems design and related services
336	0.29	0.24	3341	Computer and peripheral equipment manufacturing
678	0.16	0.32	5141 exc. 51412	Other information services
679	0.13	0.12	5142	Data processing services
649	0.04	0.04	5112	Software publishing

Table 7. IS/IT occupations, US and Los Angeles (PUMS)

	US	*Los Angeles*		
PUMS occupation	*Percentage of total*	*Percentage of total*	*SOC occupation*	*Occupation description*
000	2.08	1.98		IT occupation workers
102	0.38	0.29	15-1030	Computer software engineers
101	0.36	0.36	15-1021	Computer programmers
100	0.35	0.35	15-10XX	Computer scientists and systems analysts
104	0.19	0.17	15-1041	Computer support specialists
111	0.17	0.20	15-1081	Network systems and data communications analysts
011	0.16	0.14	11-3021	Computer and information systems managers
701	0.16	0.17	49-2011	Computer, automated teller, and office machine repairers
580	0.15	0.14	43-9011	Computer operators
110	0.09	0.08	15-1071	Network and computer systems administrators
106	0.04	0.04	15-1061	Database administrators
140	0.04	0.04	17-2061	Computer hardware engineers

slightly higher employment in *Computer and peripheral equipment manufacturing*, while Los Angeles has a higher percentage of employment in the *Other information services* industry, which includes broadcasting. At the occupational level (Table 7) again the occupational distribution between the US and Los Angeles is similar with higher percentages in the same occupations as was seen using the OES occupational data. However, Los Angeles has a much lower share of employment in *Computer software engineers* and a slightly higher share in *Network systems and data communications analysts*.

Table 8 shows the breakdown by occupation for those working in the IS/IT industry cluster. These tables allow *all* occupations to be included. For clarity, we have only shown the top 10 occupations with the largest percentages of the IS/IT industry employment share. For the overall US, the IS/IT industry employs people working in 337 different occupations. (The PUMS reports 509 unique occupations.) In the Los Angeles area, the IS/IT industry employs people working in 157 different occupations. Not surprisingly, the highest concentration of employment is among those in IS/IT occupations, but under 30 per cent of the national IS/IT employment is in the top three occupations. For Los Angeles, the top three occupations account for fewer than 26 per cent of total industry employment. A substantial number of those working in the IS/IT industry are working in decidedly non-IS/IT specific occupations like general management, sales, accounting, clerical and human resources. The table also shows the differences between IS/IT employment in the overall US and Los Angeles. While Los Angeles has a lower share of *Computer software engineers* and *Computer scientists and systems analysts*, it has a higher share of employment in *Network systems and data communications analysts* and various *'general' management* occupations and *Designers*. This table shows the difference in occupational mix between Los Angeles and general US IS/IT industry employment. Even in just this example, we can see that Los Angeles has remarkably different occupational and industrial linkages than the US as a whole.

Table 9 shows the breakdown by industry for those working in an IS/IT occupation.

Table 8. Top ten occupations (any) for those working in IS/IT, US and Los Angeles (PUMS)

PUMS occupational code	*US*	*Los Angeles*	*SOC occupational code*	*Occupation description*
	Percentage of total	*Percentage of total*		
102	**11.92**	8.09	15-1030	Computer software engineers
101	9.46	9.56	15-1021	Computer programmers
100	**8.41**	7.93	15-10XX	Computer scientists and systems analysts
111	4.80	**6.83**	15-1081	Network systems and data communications analysts
043	**4.15**	3.20	11-9199	Managers, all other
104	**4.09**	3.10	15-1041	Computer support specialists
005	3.12	3.07	11-2020	Marketing and sales managers
011	2.95	2.41	11-3021	Computer and information systems managers
484	2.86	**3.31**	41-3099	Sales representatives, services, all other
001	2.47	**3.18**	11-1011	Chief executives

This table allows *all* industries to be included. Only the top 10 industries with the largest percentages of the IS/IT occupation employment share are shown. For the overall US, those working in IS/IT occupations work in 243 different industries. (The PUMS reports 266 individual industries.) In the Los Angeles area, the IS/IT occupations are present in 186 different industries. Not surprisingly, the highest concentration of employment is in the *Computer systems design and related services* industry, but that accounts for less than 23 per cent of total employment in IS/IT occupations in both the overall US and within Los Angeles. A substantial number of those working in IS/IT occupations are working in categorically non-IS/IT industries like insurance, banking, aerospace and education.

Table 9 shows that the real strength of Los Angeles' IS/IT cluster is not really in the IS/IT industry. Rather, it is imbedded in other industries like *On-line information services*, *aerospace*, *broadcasting* and *Motion pictures*. And, in industries where Los Angeles underperforms compared with the national average, like the various *Finance* industries, *IT manufacturing*, and *telecommunications*, other regions' IS/IT clusters would be based around those industries.

Conclusions

The lexicon of economic development must be expanded to include occupational cluster analysis as a meaningful complement to current industry cluster analysis. Current regional economic development analysis provides an incomplete picture. Understanding a regional economy only from an industry perspective or only from an occupational perspective does not provide a comprehensive analysis of local economic dynamics. Using the information technology 'cluster'

Table 9. Top ten industries (any) for those working in IS/IT occupation, US and Los Angeles (PUMS)

	US	*Los Angeles*		
PUMS industry	*Percentage of total*	*Percentage of total*	*NAICS*	*Industry description*
738	22.78	22.01	5415	Computer systems design and related services
479	5.13	4.36	443112, 44312	Radio, TV, and computer stores
699	4.16	3.51	524	Insurance carriers and related activities
336	3.97	2.85	3341	Computer and peripheral equipment manufacturing
668	3.27	1.78	51331	Wired telecommunications carriers
687	3.12	2.61	521, 52211, 52219	Banking and related activities
739	3.03	2.27	5416	Management, scientific and technical consulting services
678	2.72	5.21	5141 exc. 51412	Other information services
339	2.69	1.74	3344, 3346	Electronic component and product manufacturing, NEC
679	2.22	1.99	5142	Data processing services

(both industrial and occupational) as an example, we demonstrate the significant differences between the industry IT cluster and the occupational IT cluster and show that the appropriate level of analysis for occupations is the SOC (Standard Occupation Classification) 'occupation' which, on average, represents over 38 individual occupational titles. We next consider the specific case of the IS/IT cluster in the Los Angeles region and show that there are significant differences between the industrial and occupational composition of the IT cluster for Los Angeles and the overall US. This analysis, which jointly considers the distribution of occupations within industry and industries across occupations, provides deeper insight into the regional economy of Los Angeles, with possibilities for how such results could aid in more nuanced place- and skill-specific development and industrial policy.

Standard occupational 'cluster' definitions put forward in earlier research are too generic to be truly useful. The Census/BLS standard occupation definition is a much more appropriate level of analysis for understanding a regional economy. Look at the two graphs (Figures 2 and 3). Both are standard bubble charts that show average US growth (horizontal); location quotient[6] for Los Angeles (vertical); total employment (bubble size). The first, Figure 2, although only showing five occupational clusters, is at the level of the typical occupational clusters that have been recommended by previous research. The second, Figure 3, actually shows the individual IS/IT occupations for Los Angeles. Figure 3 is notably superior in the information conveyed, as it gives a much better idea of what is happening within the region and more clearly articulates the strengths and weaknesses of the region. While the first might be helpful from an overview perspective, it does not offer any assistance or direction beyond providing an overview. Clearly, occupational cluster analysis needs to be at the detailed occupation level to be useful.

Across the US in 2000, the information technology *industry* accounted for approximately 2.0 million full-time employees, which is approximately 1.8 per cent of the total workforce. However, simultaneously, information technology *occupations* accounted for 3.4 million full-time employees, or 2.8 per cent of the total workforce. The occupational number was actually even higher since the industry count includes the self-employed while the occupational data exclude the self-employed. Clearly, the IT *industry* and the IT *occupations* are not the same thing. The latter provides a broad skill base to multiple industries. Using census PUMS data which include both industry and occupation for individuals, we find that over 50 per cent of those working in an IT *occupation* are *not* working in the IT *industry*. And, over 25 per cent of those working in the IT *industry* are *not* working in an IT *occupation*. Not quite one-in-four people working in either the IT *industry* or an IT *occupation* actually are in an IT *occupation* at a company that is in the IT *industry*.

While only a single industry and occupation cluster within one region (Los Angeles versus the US) was specifically addressed by this analysis, this example is demonstrative of several broader implications. First, this particular industry and occupation combination is one that has been the continued focus of much economic development activity. Secondly, across the entire US, the IT *industry* employs people in 337 (of 509 unique) occupational code groups. In just Los Angeles, the IT *industry* has 157 occupations. Moreover, for the US, IT *occupations* show up in 243 (of 266 unique) industry code groups. Just in Los Angeles, IT *occupations* are in 186 different industries. While only a 'single' cluster, it is clear from these results that with only 11 IT *occupations* and 5 IT *industries*, 326 non-IT occupations and 238 non-IT

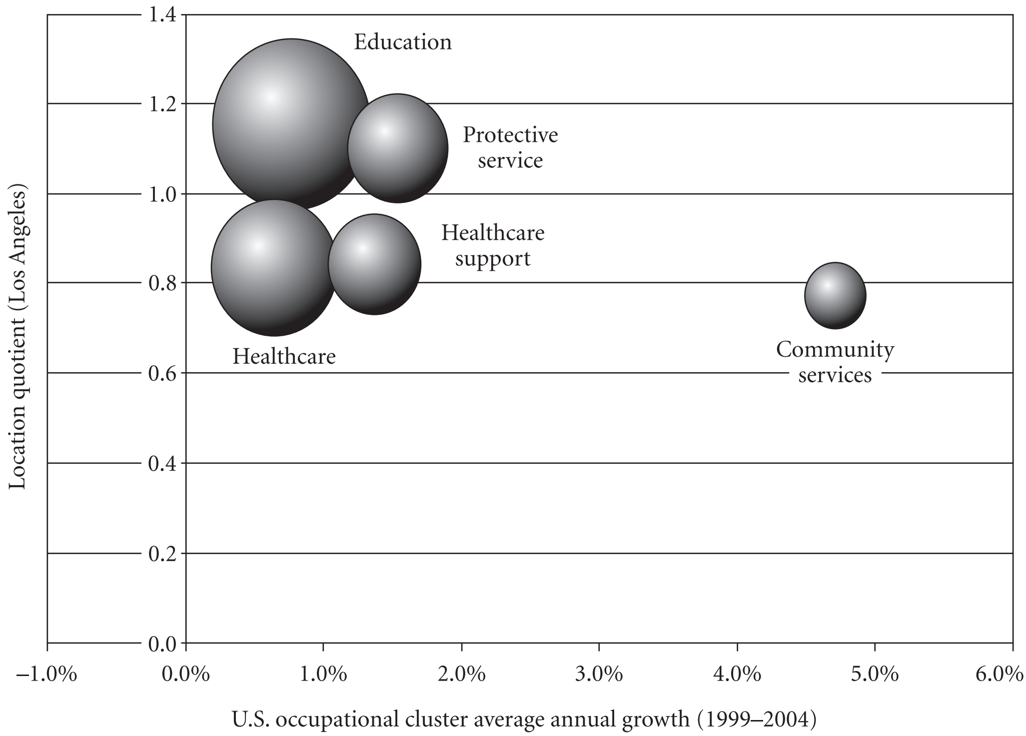

Figure 2. 'High-level' occupational clusters (all clusters are visible)

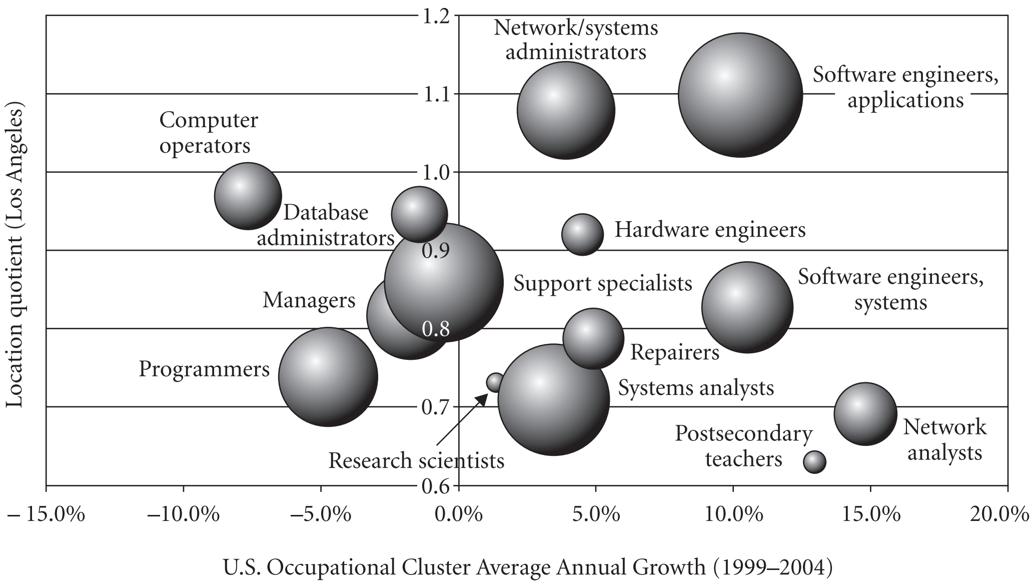

Figure 3. Specific occupations (all clusters except 'Semiconductor processors' are visible)

industries cross-fertilise in some capacity with IT, using IT skills in non-IT industries. Yet this nuance would not be picked up by employing either occupational or industrial analysis alone. While our example is limited to one occupational and industrial cluster, the techniques developed in this paper could easily be used to understand numerous other industry and occupational clusters.

Our analysis is a contribution to the larger body of research seeking to establish the best measures to gauge the economic composition of a region. By linking occupation and industry, this analysis helps to develop an understanding that is especially important in today's global economy. It is no longer sufficient to evaluate a region's manufacturing base and potential for outsourcing, offshoring or global competition solely on the basis of industry. The occupational mix must also be taken into consideration. For example, Los Angeles has significant employment in the automotive industry. However, no one who understands that industry in Los Angeles would argue that it is the same as Flint, Michigan, or Oshawa, Ontario. By also looking at the occupational mix, it becomes clear that many of Los Angeles's 'auto workers' are designers and programmers—not assembly-line workers. In the same way, much of Detroit's automotive employment has shifted from significant shares in manufacturing occupations to people working in management, accounting, marketing, etc. The transition from manufacturing employment that is still based on people actually assembling products to advanced manufacturing or manufacturing employment based mostly on 'home office' activities can only be discovered and understood by looking at the occupational mix within the specific manufacturing industries. If the actual manufacturing activities have already been moved to lower-cost labour markets, the remaining 'manufacturing industry' employment is more likely to be the higher-value, more highly paid occupations that are less likely to move and are more difficult to transition out of the region simply based on lower labour costs. Just evaluating on employment within the industry without taking into consideration the mix of occupations will not reveal a meaningful picture of the situation. These distinctions are enormous when formulating policy targeting a particular industry. Car manufacturing tax breaks would no more help Los Angeles than art and design school subsidies would help Flint, Michigan. And yet, from a macro perspective, both regions would be prime targets for auto production industrial policy. The geographical distinctions in the production process and their vast implications for growth have been seminally documented by Massey (1984).

This analysis points to another important component of current economic development strategy. Because firms go where skills are, being aware of both the industries and the skills that drive regional development presents possibilities for other types of industry growth—particularly when the tides of globalisation and innovation can change competitive advantage at a rapid pace. Skill strengths allow a region to seek out new opportunities and industry attraction outside their primary cluster, a point that Jacobs (1969) made long ago. We speculate that our results may contribute to job training and educational attainment policies aimed at creating a local skill base that can be used in a variety of different industries.

This paper set forth to combine traditional industry cluster analysis with the less frequently considered occupational cluster analysis, arguing that the view from only one of these lenses does not highlight the true strengths, weakness and opportunities that are present within a regional economy. Using the case of the IT industry and occupations in Los Angeles, we demonstrate how such mismatches (and chasms in information) occur.

There are multiple avenues by which such economic analysis may inform policy-making and development, particularly in honing-in on the place-specific linkages between occupation and industry. Inherent in our methodological contribution is the fact that regions exhibit localised advantages and industrial relationships that cannot be explained by just one form of analysis. And thus, our approach offers the tool kit which will shed light on the type of policy and development approaches that may be needed on a place-by-place basis. We hope to have evidenced the need and importance of considering *both* the industrial and occupational mix when studying a regional economy. Each can, and should, be evaluated separately as each presents a useful, even if only partial, perspective on the regional economy. However, this analysis points to the limitations of such an approach. We demonstrate how evaluating occupations and industries simultaneously can lead to a better understanding of and policy approach towards regional competitiveness and possibilities for growth. Future research avenues may seek to unearth why skills concentrate in some places over others, subsequently bringing the wealth of firms, innovation and resources that drive regional growth.

Notes

1. While the cluster and endogenous growth models have been widely discussed and applied to regional development schemes, it should be noted that there are some critiques of this model, particularly Martin and Sunley (2003) challenging the benefits that emerge from industrial agglomeration. They argue that, while clusters do exhibit some benefits, they are not a panacea and do not produce all of the endogenous growth qualities that are attributed to them. As Martin and Sunley put it, caution should be urged and a 'public policy health warning' when such development approaches are applied.
2. Unfortunately, this approach resulted in lost data since the ONET occupations do not completely map to the OES occupational codes. Further, the results end up being consolidated at such a high level that, while perhaps interesting, they are eventually meaningless for developing a more profound and useful understanding of a regional labour market. Koo first exacerbates this problem by creating an even more generalised 'metropolitan knowledge index' that does not really lead anywhere but then seems to point out and try to address the intractability of the identified occupational clusters by analysing some specific occupations in the Cleveland area. He continues by trying to incorporate a kind of industry analysis into the formulation.
3. Occupational data from two sources are used. The first is the standard list of occupation titles (30 646) that were reported in the 2000 Census as part of the *demographic* census 'industry and occupation' reporting. These data were collected from the one-in-five households that completed the census 'long' form. The job titles on this list are the ones reported by individuals working in those jobs or reported by a person in the household for that person. Under the heading of 'Occupation', the form specifically asked "What kind of work was this person doing? (For example: registered nurse, personnel manager, supervisor of order department, auto mechanic, accountant)." This was followed by a clarification question on job duties. The responses provided on these questions formed the basis of the Standard Occupation Classification (SOC) System that is used by both the Bureau of the Census (Census) and the Bureau of Labor Statistics (BLS). In analysing these responses, Census also used information on job duties, industry, education levels, company worked for and other data to assign an individual to a specific occupation. The SOC forms the basis for the second occupational data source – the Occupational Employment Statistics (OES) programme from the BLS.

   The OES programme collects information from employers (the self-employed are not included in this survey) at the regional level (previously known as the metropolitan statistical area, MSA; now the core-based statistical area, CBSA). Data on number of employees and wages paid are collected and summarised. BLS reports at the broad metropolitan and state levels on the number of employees, average salary, hourly wage, which, when reported, is always annual salary divided by 2,080 (52 × 40) and wage distribution characteristics for approximately 800 occupations. The 2005 survey reports on 820 individual occupations which BLS reports as being summarised as follows.

> All workers are classified into one of over 820 occupations according to their occupational definition. To facilitate classification, occupations are combined to form 23 major groups, 96 minor groups, and 449 broad occupations. Each broad occupation includes detailed occupation(s) requiring similar job duties, skills, education, or experience (http://www.bls.gov/soc/home.htm).

The 2000 results, which are used here, include 797 occupations which are summarised into 444 broad occupations, 93 minor groups and 22 major groups.

Industry-level data are obtained from the Census Bureau's County Business Patterns (CBP) dataset. The CBP reports by year for each state and county, the total number of employees and the total number of establishments by industry. The North American Industry Classification System (NAICS) is used to identify specific industries. NAICS is a multilevel classification system with a higher number of digits (starting with 2 and going up to 6) used for greater and greater levels of detail. At the national level, 5- and 6-digit reporting is provided, but at finer geographies, less detailed information is provided to avoid disclosure problems.

The final set of data used in this analysis is the 2000 Public Use Micro Sample (PUMS) from the US Bureau of the Census. The 5 per cent PUMS sample has been used. (A smaller 1per cent sample is also available.) The PUMS includes data for a random sample of households and their respective individuals that complete the long form. Some data values are top-coded to prevent disclosure and all location information is removed and replaced with a Public Use Micro Sample Area (PUMA) code. PUMA are uniquely defined for the PUMS from census tracts, remain within state but not county or MSA boundaries, and encompass approximately 100 000 residents. The PUMS provides data on a random sample of those residents. For this analysis, in addition to location information, only three specific pieces of information were used: occupation, industry and worker class. Only information on those who were currently working was retained. This results in specific information on occupation and industry for a random sample of the entire US working population.

4. Please see the Appendix for specific industries that should be included in the information systems/information technology industry cluster. The Appendix contains a full industry list that shows the two-, three-, four- and five-digit industries listed are the higher-level industries, which may include other industries that are not part of this cluster. The industry codes listed are NAICS codes from the 1997 standard.
5. More detailed data are available through various subscription sources, but much of this purchased data is intended for marketing rather than analytical purposes and is not subjected to the same data quality regimes as publicly available government data. More specific data on industries are available from the US Census, but are generally limited to higher geographical levels. More detailed data are also available for Economic Census years (ending in xxx2 or xxx7). Census has also made some more detailed data available for purchase. All analysis has been limited to what can be completed with publicly available data.
6. A location quotient is a measure of the relative concentration of a particular occupation or industry in one locale as compared with a larger geographical area (in this case, Los Angeles compared with the US as a whole).

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Appendix

Table A1 lists the specific occupations, SOC code, total employment and employment shares for the 'IS/IT' occupations included in this report for the entire US and Los Angeles. Table A2 lists the specific industries and Table A3 the occupations identified as being in the 'IS/IT' sector. Table A4 provides detailed information by industry code, but only for the US since data at this level of detail were not readily available for Los Angeles. Table A5 lists the specific industries included in the 'IS/IT' industry cluster at the 5- and 6-digit NAICS code level. Table A6 lists the corresponding occupation and industry census codes for the SOC (Standard Occupation Classification) and NAICS (North American Industrial Classification System) codes used in this analysis for the 'IS/IT' sector.

Table A1. IS/IT occupations, 2000

		Entire US		*Los Angeles*	
Occupation code	*Occupation title*	*Percentage of IT*	*Percentage of total*	*Percentage of IT*	*Percentage of total*
11-3021	Computer and information systems managers	8.30	0.23	8.75	0.24
15-1011	Computer and information scientists, research	0.76	0.02	0.52	0.01
15-1021	Computer programmers	15.55	0.44	14.84	0.41
15-1031	Computer software engineers, applications	10.97	0.31	11.12	0.30
15-1032	Computer software engineers, systems software	7.75	0.22	9.21	0.25
15-1041	Computer support specialists	15.31	0.43	15.69	0.43
15-1051	Computer systems analysts	13.57	0.38	12.28	0.34
15-1061	Database administrators	3.16	0.09	3.20	0.09
15-1071	Network and computer systems administrators	6.86	0.19	8.13	0.22
15-1081	Network systems and data communications analysts	3.49	0.10	3.43	0.09
17-2061	Computer hardware engineers	1.87	0.05	1.36	0.04
25-1021	Computer science teachers, post-secondary	0.81	0.02	0.48	0.01
43-9011	Computer operators	5.46	0.15	7.09	0.19

(*Continued*)

(**Table A1** *Continued*)

Occupation code	*Occupation title*	*Entire US*		*Los Angeles*	
		Percentage of IT	*Percentage of total*	*Percentage of IT*	*Percentage of total*
49-2011	Computer, automated teller and office machine repairers	4.17	0.12	3.90	0.11
51-9141	Semiconductor processors	1.96	0.06	N/A	
	Total employment, IT occupations	3 413 690	2.82	97 910	2.73
	Total employment, all occupations		121 021 750		3 583 920

Table A2. Full list of IS/IT industries

NAICS code 1997	*US NAICS description*
31-33	Manufacturing
333	Machinery manufacturing
3332	Industrial machinery manufacturing
333295	**Semiconductor machinery manufacturing**
334	Computer and electronic product manufacturing
3341	Computer and peripheral equipment manufacturing
33411	Computer and peripheral equipment manufacturing
334111	**Electronic computer manufacturing**
334112	**Computer storage device manufacturing**
334113	**Computer terminal manufacturing**
334119	**Other computer peripheral equipment manufacturing**
3344	Semiconductor and other electronic component manufacturing
33441	Semiconductor and other electronic component manufacturing
334411	**Electron tube manufacturing**
334412	**Bare printed circuit board manufacturing**
334413	**Semiconductor and related device manufacturing**
334414	**Electronic capacitor manufacturing**
334415	**Electronic resistor manufacturing**
334416	**Electronic coil, transformer and other inductor manufacturing**
334417	**Electronic connector manufacturing**
334418	**Printed circuit assembly (electronic assembly) manufacturing**
334419	**Other electronic component manufacturing**
3346	Manufacturing and reproducing magnetic and optical media
33461	Manufacturing and reproducing magnetic and optical media
334611	**Software reproducing**
334613	**Magnetic and optical recording media manufacturing**
42	Wholesale trade
421	Wholesale trade, durable goods
4214	Professional and commercial equipment and supplies wholesalers
42143	**Computer and computer peripheral equipment and software wholesalers**
42144	**Other commercial equipment wholesalers**
44-45	Retail trade
443	Electronics and appliance stores
4431	Electronics and appliance stores

(*Continued*)

(**Table A2** *Continued*)

NAICS code 1997	*US NAICS description*
44312	**Computer and software stores**
51	Information
511	Publishing industries
5112	Software publishers
51121	**Software publishers**
514	Information services and data processing services
5142	Data processing services
51421	**Data processing services**
54	Professional, scientific and technical services
541	Professional, scientific and technical services
5415	Computer systems design and related services
54151	Computer systems design and related services
541511	**Custom computer programming services**
541512	**Computer systems design services**
541513	**Computer facilities management services**
541519	**Other computer related services**
61	Educational services
611	Educational services
6114	Business schools and computer and management training
61142	**Computer training**
81	Other services (except public administration)
811	Repair and maintenance
8112	Electronic and precision equipment repair and maintenance
81121	Electronic and precision equipment repair and maintenance
811212	**Computer and office machine repair and maintenance**

Note: analysed industries are shown in bold.

Table A3. IS/IT occupations (occupations analysed)

Occupation code	*Occupation title*
11-3021	Computer and information systems managers
15-1011	Computer and information scientists, research
15-1021	Computer programmers
15-1031	Computer software engineers, applications
15-1032	Computer software engineers, systems software
15-1041	Computer support specialists
15-1051	Computer systems analysts
15-1061	Database administrators
15-1071	Network and computer systems administrators
15-1081	Network systems and data communications analysts
17-2061	Computer hardware engineers
25-1021	Computer science teachers, post-secondary
43-9011	Computer operators
49-2011	Computer, automated teller and office machine repairers
51-9141	Semiconductor processors

Table A4. US IS/IT industries, detailed level, 2000

NAICS	*Description*	*Percentage of IT employment*	*Percentage of total employment*	*Percentage of IT establishments*	*Percentage of total establishments*
333295	Semiconductor machinery manufacturing	1.93	0.04	0.22	0.0037
334111	Electronic computer manufacturing	3.57	0.06	0.53	0.0087
334112	Computer storage device manufacturing	1.68	0.03	0.17	0.0029
334113	Computer terminal manufacturing	0.17	0.00	0.11	0.0019
334119	Other computer peripheral equipment manufacturing	3.95	0.07	0.97	0.0159
334411	Electron tube manufacturing	0.82	0.01	0.13	0.0021
334412	Bare printed circuit board manufacturing	3.74	0.07	1.18	0.0193
334413	Semiconductor and related device manufacturing	10.01	0.18	1.03	0.0168
334414	Electronic capacitor manufacturing	0.82	0.01	0.10	0.0017
334415	Electronic resistor manufacturing	0.48	0.01	0.09	0.0014
334416	Electronic coil, transformer and other inductor manufacturing	0.87	0.02	0.38	0.0062
334417	Electronic connector manufacturing	1.65	0.03	0.28	0.0046
334418	Printed circuit assembly (electronic assembly) manufacturing	4.89	0.09	0.61	0.0100
334419	Other electronic component manufacturing	4.32	0.08	1.48	0.0243
334611	Software reproducing	0.17	0.00	0.08	0.0014
334613	Magnetic and optical recording media manufacturing	0.69	0.01	0.22	0.0036
541511	Custom computer programming services	23.68	0.43	36.65	0.5990
541512	Computer systems design services	25.19	0.46	31.50	0.5148
541513	Computer facilities management services	3.04	0.06	1.39	0.0228
541519	Other computer related services	4.67	0.08	17.12	0.2798
811212	Computer and office machine repair and maintenance	3.68	0.07	5.73	0.0937
	Total, IT industries	2 070 438	1.82	115 561	1.63
	Total, all industries		114 064 976		7 070 048

Table A5. IS/IT industries

NAICS code 1997	*US NAICS description*
333295	Semiconductor machinery manufacturing
334111	Electronic computer manufacturing
334112	Computer storage device manufacturing
334113	Computer terminal manufacturing
334119	Other computer peripheral equipment manufacturing
334411	Electron tube manufacturing
334412	Bare printed circuit board manufacturing
334413	Semiconductor and related device manufacturing
334414	Electronic capacitor manufacturing
334415	Electronic resistor manufacturing
334416	Electronic coil, transformer and other inductor manufacturing
334417	Electronic connector manufacturing
334418	Printed circuit assembly (electronic assembly) manufacturing
334419	Other electronic component manufacturing
334611	Software reproducing
334613	Magnetic and optical recording media manufacturing
42143	Computer and computer peripheral equipment and software wholesalers
42144	Other commercial equipment wholesalers
44312	Computer and software stores
51121	Software publishers
51421	Data processing services
541511	Custom computer programming services
541512	Computer systems design services
541513	Computer facilities management services
541519	Other computer related services
61142	Computer training
811212	Computer and office machine repair and maintenance

Table A6. IS/IT occupations and industries (census)

Census occupation code	*Occupation code*	*Occupation description*
011	11-3021	Computer and information systems managers
100	15-10XX	Computer scientists and systems analysts
101	15-1021	Computer programmers
102	15-1030	Computer software engineers
104	15-1041	Computer support specialists
106	15-1061	Database administrators
110	15-1071	Network and computer systems administrators
111	15-1081	Network systems and data communications analysts
140	17-2061	Computer hardware engineers
580	43-9011	Computer operators
701	49-2011	Computer, automated teller and office machine repairers

(*Continued*)

(**Table A6** *Continued*)

Census industry code	*NAICS*	*Industry description*
336	3341	Computer and peripheral equipment manufacturing
649	5112	Software publishing
678	5141 exc. 51412	Other information services
679	5142	Data processing services
738	5415	Computer systems design and related services