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The Airport City Phenomenon: Evidence from Large US Airports

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Abstract

As air transport for leisure trips, business travel and goods shipment increased rapidly over the past several decades, the emergence of airport cities has been hypothesised. Busy commercial airports may be emerging as central transport nodes in large metropolitan areas, much as ports and rail terminals were in the past, anchoring employment servicing passengers, facilitating frequent travellers and providing a spatial focus for unrelated firms. An analysis of small-area employment data for the areas surrounding 25 major US airports and the related central cities reveals the concentration of employment within 2.5 miles of these airports to be substantial—approximately half that within 2.5 miles of the central point of the corresponding CBDs—and growing. The analysis refocuses a question about the nature of spatial differentiation within metropolitan regions supporting multiple employment nodes.

Commercial aviation in the US and elsewhere has expanded rapidly over the past several decades. Americans and their businesses have become increasingly dependent upon air transport. As shown in Figure 1, revenue passenger miles in the US have more than tripled in the 30 years between 1980 and 2010, despite an uneven path over the past decade (Airlines for America, 2012). Someone in the US steps on a commercial airplane more than 700 million times per year. Flying is more prevalent than reading *Time* and *Newsweek* (Bouvard and Williams, 2004). By 2030 or 2031, 1.25 billion passengers are forecasted to travel through US airports annually (US Department of Transport, 2011a; Table 5). Despite the prospects of rising fuel costs, continuing security concerns, economic uncertainties and worries about global warming, there is little anticipated deviation from an upward trajectory.

Over 80 per cent of American adults have flown at least once. Forty-six per cent of US adults fly in an average year and approximately 11 per cent fly on commercial airlines in a month.[1] Not only do many people fly, but a sizeable minority do so

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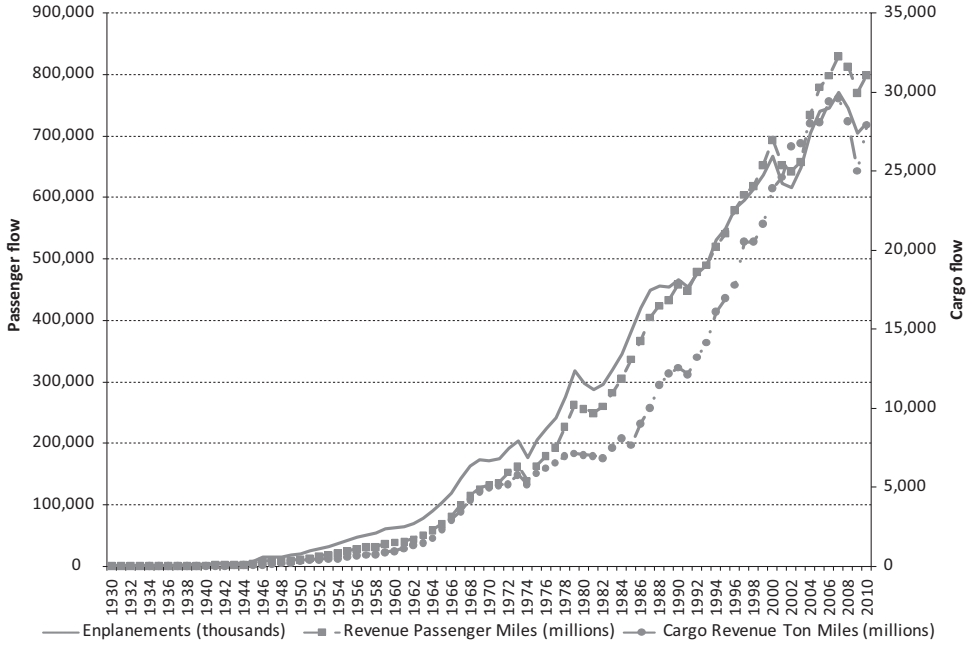

Figure 1. Growth of US air transport, 1928–2010.

very often. In 2007, an estimated 102 million different American adults flew. Forty-one per cent of the air passengers (41.82 million, nationally) flew only once that year, a third (34.68 million) flew two or three times that year and 25 per cent (25.50 million) flew four or more times in that year, the last group accounting for approximately 72 per cent of the flights taken. Among those flying on business, half (16.3 million) fly nine or more times per year, 17 per cent (5.5 million) fly at least every two weeks and 2 per cent (681 000)—more than the entire population of the city of Milwaukee—fly at least once per week.

Automobiles predominate for local travel but air transport accounts for 42 per cent of the person-trips of 250 miles (one way) or more and 68 per cent of the person-miles on such trips (Bureau of Transport Statistics, 2003). A substantial number of people depend heavily on using air transport for their livelihoods. Accordingly, they tend to congregate in the regions with the best air service. Forty-three per cent of frequent fliers reside in the 10 largest metropolitan areas; less than 35 per cent of all air travellers and less than 22 per cent of all Americans do.

Declining real costs of air travel have allowed many to lay claim to membership of the recreational 'jet set.' Approximately 30 per cent of all US air travel is for vacationing with numerous resorts heavily dependent upon aviation to deliver their guests. Las Vegas, Miami and Orlando, to mention just three of the areas examined later, could not exist, as we know them, without mass air travel. New patterns of migration also lead to greater use of air travel. Nearly 30 per cent of air travel is to visit family and friends or to take care of family business. As parents retire to different states, children attend distant universities and adult siblings take jobs in far-off cities, family visits often entail air travel. Several of the areas we examine below

are favoured migration destinations for either retirees or their children.

The declining costs of air travel have also helped to expand the market areas of many businesses, creating an increasingly competitive business environment, resulting in both an increased specialisation of function and a need for greater speed of interaction which have reinforced each other to make flying an essential part of doing business.[2] Forty per cent of US air travel is for business. Contemporary knowledge-based firms—particularly those engaged in producer services and in advanced manufacturing, with a broad spatial reach but narrow market niches—have replaced local spatial (near) monopolies with broad functional ranges to produce larger, interpenetrating market areas of specialised firms. Specialisation requires frequent contact across long distances. The trends towards increased business travel are likely to continue as long as the productivity gains from specialisation outweigh the additional costs of travel.

Air transport is equally critical to the movement of goods in national and global supply and distribution chains. Goods shipped by air tend to share three characteristics: they have a high value-to-weight ratio; they are highly perishable; and they are time-critical components of complex supply or distribution chains. New economy products such as microelectronics, pharmaceuticals, aerospace components, medical devices and other high value-to-weight products account for more than 80 per cent of international air cargo. In 2010, the US exported $393 billion by air comprising 31 per cent of all US exports by value while importing $444 billion via air (23 per cent of all US imports and 39 per cent of non-energy imports).[3]

Figure 1 also shows that air cargo revenue ton-miles have increased nearly fourfold over the past 30 years. Accordingly, airports are among the nation's top ports. Air transport's increased speed, still generally declining real costs and greater capability in overcoming physical barriers have resulted in the substitution of rapid-response logistics and fast transport for warehousing (Bowersox *et al.*, 2002). The use of air transport, therefore, continues to rise more rapidly than output, although perhaps not as rapidly as in the late 20th century. The contemporary economy is clearly air-dependent.

These are the basic facts of contemporary American air transport. Some of the urban implications of commercial aviation have been investigated. The literature on the geography of air travel has documented the relationship between air travel and position in the international city system (Smith and Timberlake, 2001) and its role in rearranging global spatial structure (Fröbel *et al.*, 1980; Graham, 1995). The role of air travel in accelerating regional economic growth has also been measured (for example, Brueckner, 2003; Chi, 2012; Neal, 2012). The presence of a large airport can affect choice of metropolitan area in business location decisions (for example, Malecki, 1997).

Although planners discussed possibilities as early as the late 1920s (Le Corbusier, 1929; Hubbard *et al.*, 1930; Neutra, 1930) and social scientists (Ogburn, 1946; Taafe, 1952) revisited the issues a few decades later, much less attention has been devoted to the intrametropolitan spatial—land use and employment—impacts of commercial aviation. More recently, the emergence of airport cities which are centred on the passenger and cargo terminals of major airports, but which may extend beyond the airport fence, have been hypothesised (Conway and Liston, 1976; Conway, 1980, 1993; Güller and Güller, 2001; Kasarda and Lindsay, 2011; van Wijk, 2007). The intrametropolitan spatial impacts are more often asserted than measured, however, and they are not always rooted in theory.

We raise three questions about the implications of the heavy dependence upon air transport for urban form. First, in what ways could we theoretically expect the growing reliance on air transport to affect the intrametropolitan spatial pattern of employment? The mix of transport modes and the historically varying necessity for nodes of interchange among them have long been recognised as having an influence on urban structure (Borchert, 1967; Muller, 2004; Taaffe *et al.*, 1996). Our discussion will be in terms of general expectations because several causal arguments rooted in economics, semiotics and politics can result in similar spatial outcomes. Indeed, the motivations of firms making location decisions are often a mix of operational efficiency, corporate symbolism and political awareness.

Secondly, how is the location of employment actually being affected by the use of air transport? Less than 22 per cent of metropolitan employment is within three miles of the centre city of major metropolitan areas (Glaeser *et al.*, 2001); airports may be influencing the development of the many edge (Garreau, 1991) and edgeless (Lang, 2003a) cities. The backbone of our evidence comes from employment data regularly collected for small areas on a national (US) basis. We cross-validate our systematic quantitative data with supplemental evidence and the results of available single-city studies of local employment patterns.

Finally, how might the growing use of air travel affect urban spatial structure more generally? Polycentric regions may develop different patterns of internal specialisation and differentiation. With an estimated $52.2 billion in airport infrastructure improvement needs in the first half of this decade (US Department of Transport, 2011b) and with infrastructure investment on the political agenda along with population and employment continuing to increase outside major central cities, now may be a fitting time to develop an urban vision to improve the likelihood that such spending creates communities that are economically efficient, environmentally sustainable and aesthetically pleasing by integrating the implications of air transport more fully into land use and ground transport planning.

Transport and Urban Development Expectations

The basic model of urban form is a monocentric city anchored by a long-distance transport interchange (O'Sullivan, 2007). Cooley (1894), in his seminal work on transport over a century ago, laid the groundwork for considering the impact of transport nodes on urban form. Pre-dating the automobile and the airplane, his predictions are not merely abstractions based on recent facts

> Population and wealth tend to collect wherever there is a break in transportation. … By a break is meant an interruption of the movement at least sufficient to cause a transfer of goods and their temporary storage. If this physical interruption of the movement is all that takes place we have what I may call a mechanical break; but if on account of the close relation between transportation and exchange … the physical interruption causes a change in the ownership of the transported goods, we have a commercial break (Cooley, 1894, p. 91).

The need for a common intermodal infrastructure creates a geographical focus for employment and residences. Mechanical breaks (physical interruptions) in the movement of goods require buildings for storage and persons to care for them and for the goods they contain. Logistics functions locate in and around these structures. The persons loading, unloading, and providing local and longer-distance distribution

require supporting retail, restaurants and other services. Equally important, commercial breaks (changes in ownership) tend to occur where mechanical breaks are located. Changes in ownership require financial, legal, and other types of commercial support giving rise to professional service employment. Central transport breaks also make for a convenient base for those who need to travel frequently.

Interruptions in the movement of goods and people require some support activities, provide the favourable pre-conditions for the location of other activities and may also attract yet other activities with a range of causal factors operating. Historically, efficient locations for mechanical breaks have determined the location of transfer points and have provided a nucleus for city formation (Vance, 1970). For example, throughout Chicago's history, the immediate points of passenger and cargo transfer between transport modes and routes rapidly became trading, financial and hospitality centres (Cronon, 1991).

The geographical extent of interaction is limited by the costs of carrying out interactions and the anticipated rewards from completing the interaction (Hawley, 1950; Powell, 2001). Thus, the spatial texture of social organisation is determined by the combination of temporal rhythms and transport technology, which influence the spatial extent of social interaction. When Cooley (1894) wrote, the combination between train, horse-drawn vehicle and foot traffic helped to determine the location of major settlements and articulated the spatial structure of most cities and towns (Borchert, 1967; Muller, 2004; Taaffe *et al.*, 1996). As average commuting time tends towards a constant whatever the transport technology used (Shafer and Victor, 2000), automobiles, like street cars, and bicycles before them, reduced the time of travel even as they enlarged cities (Forer, 1978). The automobile's influence on urban form was already apparent in the 1930s when only a minority of urban dwellers had access to an automobile (McKenzie, 1933). Today, 88 per cent of all US trips are made by automobile (Pucher and Renne, 2003; Pisarski, 2006).

The flexibility of automobiles and trucks, combined with a developed road network, not only enlarged the spatial reach of daily movement but removed many of the common points of transport break, blurring urban form. Consequently, downtowns, most of which formed within sight of the original mechanical breaks in transport between water and land or between railroad and local transport, lost much of their accessibility advantage while the urban centrality due to the intersection of intraurban rail lines declined. The anchors lost their hold.

If the combination of long-distance and local modes of transport shaped urban space in earlier time-periods—even when only a minority used those modes on a frequent basis—the infrastructure shared by the combination of air transport and automobile/truck transport may offer an important urbanisation economy (Mills, 1972) and central symbol (Lynch, 1960) today. Airports may influence firm location decisions just as the common port facilities and 'union' railway stations did in an earlier era. Our basic expectation is that, as air travel becomes more prevalent, airports will increasingly serve as functional urban anchors and as symbolic points of orientation even though the large majority of metropolitan residents are not intense users of air transport.

Extensive land needs, noise considerations exacerbated by early jet engines and the marginal role of air travel in daily living in earlier decades pushed airports progressively further from city centres. Today, air travel is neither tangential to business and

recreation, as the travel patterns already outlined show, nor peripheral to many cities. However, with the addition of new residences and new employment at the urban fringe, many once-distant airport sites (for example, Washington Dulles) are no longer remote. Large cities have been expanding outwards and they may be moving towards airports.

Airports and Intrametropolitan Spatial Form: Empirical Evidence

Given our theoretical expectations, we examined employment patterns surrounding the 25 busiest US passenger airports using data from the Zip Business Patterns, Bureau of Transport Statistics, airport reports and other sources. Large numbers of Americans live and work near and travel through the airports shown in Table 1. This is a diverse set offering direct connections to a large number of domestic and international destinations. Some of these airports are airline hubs (for example, ATL, ORD), some serve popular tourist spots (for example, LAS, MCO), others are popular migration destinations (e.g., CLT, PHX) and others are important business centres (for example, JFK, LAX). All three types of travel discussed earlier (vacationing, visiting family and friends, and business) are important to this set of airports. Collectively, these airports were responsible for almost two-thirds (65 per cent) of all US passenger traffic in 2010. (Passenger data are based on the Bureau of Transport Statistics T-100 series.)

As already noted, several of the airports listed are also important international cargo gateways. New York's Kennedy Airport, for example, was the third most important port in the US by value of imports and exports in 2009, after the Los Angeles and New York seaports. Seven other airports also figured prominently in the set of top 20 ports (Bureau of Transport Statistics, 2010; Table 1-51).

Airport terminals may be the busiest public spaces in many metropolitan areas. The volumes of people and products passing through these airports alone imply that they serve as urban centres. Atlanta's Hartsfield-Jackson Airport, the world's busiest, processed 86 734 000 total (43 367 000 departing) passengers in 2010, representing nearly 6 per cent of national air traffic. The *daily* number—many of whom are just transferring—travelling through Atlanta approached 238 000. That daily transient population was larger than the total residential (2010) populations of approximately 180 of the 366 US metropolitan statistical areas and was nearly 30 per cent of the (2010) US population. Approximately one-third of those daily passengers either began or ended their air travel in Atlanta which means that the origins and destinations of 79 000 air travellers daily must be accessible to the airport (estimate based on Bureau of Transport Statistics data). Of these, 31 500 were flying on business and therefore possibly headed towards or coming from a place of business. Chicago's O'Hare was not far behind Atlanta while Los Angeles, Dallas-Fort Worth and Denver airports also processed over 50 million passengers annually.

Employment directly servicing that travel can reach into the tens of thousands at the largest airports. Over 55 000 were employed on-site at Atlanta's Hartsfield-Jackson Airport, exceeding the US Census definition of a metropolitan area central city. Employment at the 25 airports included in Table 1 averages 26 000 employees (compiled from airport annual reports)—comparable with that in many major central business districts. Airlines, along with security and support organisations, are responsible for much of that employment, but increasing numbers are

Table 1. Employment and payroll in airport-centric bands

	Airport	ID	Total annual (arriving and departing) passengers (2010)[a]	Year of first commercial service	Great-circle distance from CBD (miles)	Employment on-airport[b]	Total priviate employment within radius of[c]			Total private payroll (100s) within radius of[c]		
							2.5 miles	5 miles	10 miles	2.5 miles	5 miles	10 miles
1	Hartsfield-Jackson Atlanta Intl	ATL	86 733 811	1930	7	56 000	112 629	144 172	451 997	$4 696 563	$5 859 406	$20 708 534
2	Chicago O'Hare Intl	ORD	65 035 617	1955	14	51 000	166 472	451 695	1 072 205	$8 096 666	$20 919 815	$53 254 611
3	Los Angeles Intl	LAX	59 054 034	1946	9	59 000	220 041	479 128	1 382 763	$11 857 768	$24 954 312	$72 999 659
4	Dallas/Fort Worth Intl	DFW	54 813 742	1974	12		222 385	396 870	879 647	$10 774 132	$19 803 005	$39 891 444
5	Denver Intl	DEN	51 648 579	1995	16	30 000	20 857	21 471	141 550	$804 399	$831 402	$5 790 896
6	New York John F. Kennedy Intl	JFK	46 296 042	1948	13	39 110	135 080	244 145	626 082	$5 215 445	$9 077 711	$25 098 995
7	Phoenix Sky Harbor Intl	PHX	39 338 348	1951	3	31 437	189 024	480 640	844 277	$9 243 892	$22 605 702	$36 906 326
8	Houston George Bush Intercontinental	IAH	39 196 771	1969	23	28 559	92 148	171 278	378 460	$3 464 586	$8 104 452	$17 024 485
9	San Francisco Intl	SFO	39 120 291	1927	8		109 584	145 273	760 040	$7 635 121	$9 597 412	$53 352 208
10	Las Vegas McCarran Intl	LAS	38 878 944	1926	5	15 000	299 037	504 949	705 839	$11 761 943	$19 230 652	$26 441 760
11	Charlotte Douglas Intl	CLT	37 950 695	1937	4	16 500	34 787	221 569	377 105	$1 417 033	$11 382 467	$17 832 515
12	Orlando Intl	MCO	34 489 239	1970	6	16 600	27 616	145 008	466 172	$1 118 444	$5 431 036	$17 681 667
13	Miami Intl	MIA	34 209 657	1928	8	31 786	197 781	425 934	685 471	$8 159 033	$19 086 279	$27 809 747
14	New York Newark Liberty Intl	EWR	33 311 295	1928	16	29 810	146 919	306 657	899 968	$7 412 587	$14 182 281	$49 863 894
15	Detroit Metro Wayne County	DTW	31 529 452	1930	15	18 000	31 337	73 471	297 532	$1 266 680	$2 788 771	$11 838 470
16	Minneapolis/St Paul Intl	MSP	31 392 162	1929	6	28 545	117 809	340 844	871 263	$4 360 990	$13 963 512	$40 107 807

(continued)

Table 1. (Continued)

Airport	ID	Total annual (arriving and departing) passengers (2010)[a]	Year of first commercial service	Great-circle distance from CBD (miles)	Employment on-airport[b]	Total priviate employment within radius of[c]			Total private payroll (100s) within radius of[c]		
						2.5 miles	5 miles	10 miles	2.5 miles	5 miles	10 miles
17 Seattle-Tacoma Intl	SEA	31 024 973	1949	10	19 017	70 709	190 209	554 060	$2 993 543	$9 982 404	$30 477 922
18 Philadelphia Intl	PHL	30 445 322	1940	5	21 000	55 712	321 289	706 717	$2 442 493	$14 716 662	$31 558 535
19 Boston Logan Intl	BOS	27 199 600	1923	1	15 000	291 855	637 477	1 038 367	$22 541 567	$43 638 934	$62 447 199
20 New York La Guardia	LGA	23 957 471	1939	4	12 920	182 160	874 662	2 867 832	$7 601 418	$53 680 902	$205 691 937
21 Washington Dulles Intl	IAD	22 944 304	1962	20	18 800	133 831	239 643	412 405	$8 811 961	$15 994 125	$25 947 387
22 Baltimore-Washington Intl Thurgood Marshall	BWI	22 427 392	1950	9	12 030	76 024	128 718	555 280	$3 972 531	$6 309 891	$27 590 904
23 Fort Lauderdale-Hollywood Intl	FLL	21 854 098	1948	3	7 500	72 984	180 165	507 683	$3 433 079	$7 357 548	$20 010 129
24 Salt Lake City Intl	SLC	20 299 906	1933	4	13 000	55 728	195 655	398 516	$2 545 622	$8 149 891	$14 326 167
25 Chicago Midway Intl	MDW	18 186 586	1927	8		65 728	188 579	1 137 061	$2 512 323	$6 820 544	$65 235 393
Total						3 128 237	7 509 501	19 018 292	$154 139 819	$374 469 116	$999 888 591
Percentage of national total						2.82	6.78	17.17	3.38	8.21	21.92
National total						110 775 020.00			$4 560 723 525		

Source: Author's analysis and as follows:
[a]Bureau of Transportation Statistics.
[b]Airport reports (where available).
[c]Zip Business Pattern data.

working in the non-aeronautical functions (for example, retail) that contribute approximately half of total revenues to large US airports. As airports become major employment centres in and of themselves, their employees require a place to live and the full range of urban services, exerting a further influence on urban form.[4]

Airports become urban anchors because of the volume of passenger traffic and the on-airport employment directly supporting that movement. They also attract related and unrelated employment to their vicinities. Some of that employment, such as in the hotel sector, may service air and other travellers. Some of that employment is in sectors, such as producer services, which may be heavy consumers of air travel (Erie *et al.*, 1999) and other nearby employment may have no strong direct link to air travel but be attracted nevertheless.[5]

Much of the evidence about the effect of airports on nearby employment stems from case studies of particular metropolitan areas. In order to systematically assess the impact of airports on contemporary employment distribution across metropolitan areas, we use the 1995, 2002 and 2009 Zip Business Pattern (ZBP) data (including the earliest and latest available). Similar data have been used previously to explore the spatial distribution of metropolitan employment (Glaeser *et al.*, 2001; Kneebone, 2009). (See Appendix for a detailed description).

In addition to the information on airports themselves, Table 1 shows that 3.1 million jobs (2.82 per cent of US employment) were located within a 2.5-mile (Euclidian) distance of the boundary fence of the busiest 25 passenger airports in 2009.[6] Over 7.5 million jobs (6.78 per cent of US employment) were located within a 5-mile distance of those same airports while 19.0 million jobs (17.17 per cent of the total) were within 10 miles (vs 0.27 per cent of the land area). Data on wages and salaries offer an indirect method of assessing the quality of jobs. The respective percentages for the payroll were 3.38, 8.21 and 21.92—each higher than the respective percentage of employment—indicating that employment near the major airports is relatively well-paid.

The variation in employment and payroll among the airport areas was substantial, but four of these 25 airport areas provided sufficient employment within 2.5 miles of the respective airport fences to populate an entire metropolitan area on their own and employment sometimes ranged up to nearly 300 000. Employment topped 80 000 within a 5-mile radius for all but two of the sampled airports. With US air travel expected to double within the next 25–30 years, the employment attraction of airports, as central transport nodes of intermodal transfer, is likely to increase.

Results of studies of specific metropolitan areas, sometimes for earlier time-periods when air travel was not as common, corroborate these findings using different data sources and methods. The Los Angeles Airport has been found to impact the growth of employment independent of road accessibility (Giuliano *et al.*, 2012). The same has been found for Atlanta (Ihlanfeldt and Raper, 1990), Chicago (McMillen and MacDonald, 1998) and Minneapolis (Baerwald, 1978). The airport forms the nucleus for Miami's largest concentration of office space (Lang, 2003b).

In some cases, the 5-mile radius contained or neared a central business district but even when the airport was distant from the city centre, employment could be quite large. Older airports may support a centralised urban pattern. Logan International Airport, founded in 1923, is 1 mile from Boston's CBD. Among the airports included in Table 1, those founded before the Second World War average a 6.8-mile distance from their respective CBDs. Those founded after that war are located an average of 13.2 miles from their respective CBDs. Denver International

Airport, opened in 1995, is located 16 (aerial) miles from Denver's CBD. When airports are distant from city centres, they tend to become the focus of employment clusters of their own. Chicago's O'Hare Airport (14 miles from the Loop; over 450 000 jobs within a radius of 5 miles), Dallas-Fort Worth Airport (12 miles from downtown; over 395 000 jobs), and Dulles Airport (20 miles from Washington, DC; almost 240 000 jobs) are prominent examples.

Sectors are differentially attracted to the vicinities of airports. Table 2 shows the employment within the collective 2.5-, 5-, and 10-mile radii of the airports for selected aggregated North American Industry Classification System (NAICS) sectors. As noted earlier, some of these sectors, such as transport and warehousing and accommodation and food services, are partially linked to the provision of the transport of goods or people by air. Others may be heavy consumers of air transport. Still other may not be functionally related to air transport as suppliers or consumers. Total national employment for each sector is included in the table as a basis for comparison.

Manufacturing was less tied to airports than employment as a whole. While 6.8 per cent of US employment was within 5 miles of one of the 25 busiest passenger airports, only 2.6 per cent of manufacturing employment was. Wholesale trade was more tightly agglomerated around airports than average. Fully 9.3 per cent of the nation's employment in transport and warehousing was within 2.5 miles of these airports and the relative concentration continued at least as far as the 10-mile radius. Somewhat farther away, large wholesale markets like the Infomart and Market Center, each with easy access to both Dallas area airports, are responsible for the purchase of 300 000 airplane seats and 720 000 hotel rooms annually by vendors and buyers (author's database).

Sectors that are supposedly confined to the central business districts of the largest cities because of their need for face-to-face interaction were also clustered around these airports. Finance and insurance were more likely than employment as a whole to be within 2.5 miles of an airport as were professional, scientific and technical services, administrative and support services, and even the management of companies and enterprises—the Census Bureau's terminology for corporate headquarters. Information-sector employment was just slightly less likely than employment as a whole to be near these large airports.

Facilities supporting interaction among knowledge workers, such as the Donald E. Stephens Convention Center (less than 2.5 miles from O'Hare's terminals) and the 32 500-square-metre Georgia International Convention Center (connected to the Atlanta Airport by people mover), locate near airports to facilitate same-day return trips by air travellers. Las Colinas, a 4800-hectare planned airport-linked city just east of Dallas-Fort Worth Airport has 25 000 residents, hosts more than 98 000 employees in 2 million square metres of office space, including the world headquarters of ExxonMobil, and has 0.8 million square metres of light industrial and distribution space (author's database).

Accommodation and food services were as likely as employment overall to be concentrated very close to major airports but less likely than average to be within the larger radii. Few large airports are without a hotel belt. The largest agglomeration of hotels on the west coast surrounds Los Angeles International Airport. There are 49 hotels within 2.5 miles of Atlanta's airport terminal with the heaviest concentration 1–1.5 miles away. Fifty-one hotels are located within 2.5 miles of Atlanta's city centre. Las Vegas hotels are locating progressively closer to the city's airport, with some large

Table 2. Employment by sector within airport-centric rings

NAICS sector	*Sectoral employment within radius of*			*Total national sectoral employment*
	2.5 miles	*5 miles*	*10 miles*	
Panel A: 2009 employment and salaries				
Total employment	3 128 237 (2.82)	7 509 501 (6.78)	19 018 292 (17.17)	110 775 020
Manufacturing	138 503 (1.81)	313 946 (4.11)	747 373 (9.78)	7 640 968
Wholesale trade	135 686 (3.48)	304 988 (7.83)	743 521 (19.08)	3 896 607
Transport and warehousing	247 309 (9.25)	365 848 (13.68)	573 176 (21.44)	2 673 599
Information industries	60 669 (2.78)	167 668 (7.67)	489 399 (22.39)	2 18 045
Finance and insurance	122 007 (2.99)	301 152 (7.39)	904 995 (22.20)	4 077 036
Professional, scientific and technical services	149 190 (2.88)	388 206 (7.50)	1 179 795 (22.80)	5 174 400
Management of companies and enterprises	51 635 (2.91)	120 905 (6.82)	361 231 (20.36)	1 773 919
Administrative and support services	159 738 (3.35)	360 013 (7.55)	935 857 (19.62)	4 770 198
Accommodation and food services	221 459 (2.81)	500 937 (6.35)	1 260 220 (15.98)	7 885 539
Total wages and salaries ($)	154 139 819 (3.38)	374 469 116 (8.21)	999 888 591 (21.92)	4 560 723 525
Average wages and salaries ($)	49 273.70 (119.68)	49 866.05 (121.12)	52 575.10 (127.70)	41 171
Panel B: change over time (percentages)				
Employment change 2002–09	1.59	0.89	-0.50	0.87
Employment change 1995–2002	16.72	11.51	10.32	11.48
Aggregate salary change 2002–09	20.47	23.46	23.12	24.07
Aggregate salary change 1995–2002	54.13	46.58	45.75	42.94
Average salary change 2002–09	18.58	22.37	23.75	23.00
Average salary change 1995–2002	32.05	31.45	32.12	28.21

Note: In Panel A, percentages are shown in parentheses.
Source: Author's analysis of Zip Business Pattern data.

casino hotels sited barely 1000 feet from the airport boundary fence (author's database).

Panel B in Table 2 shows the percentage employment change in the circles with the respective radii over the 1995–2002 and 2002–09 time-periods. These major airports were core areas of rapid metropolitan employment growth over the first period for which data are available. As was the case for the nation as a whole, growth slowed in the second period but, for the inner 2.5-mile radius, growth still exceeded the national rate. Growth in aggregate payroll and average compensation exceeded the respective national averages in the first period but not in the second.

Compared with central cities, the employment surrounding airports was lower but nevertheless substantial. To provide a rough basis for comparison, Table 3 repeats the analysis reported in Table 2, basing the rings on the centres of the 22 largest central cities that the 25 airports serve (New York is served by three airports, Kennedy, Newark and La Guardia and Chicago by two, O'Hare and Midway). Although not fully comparable, the airport-centred and CBD-centred rings are an adequate basis for broad comparison. The airport-centred rings are measured from the airport fence while the CBD-centred rings begin at the geographical centroid of the zip code area with the highest employment density. The airport-centred rings, therefore, cover a larger land area. The difference is greatest for the inner rings where the individual airport-centred rings are an average of 2.6 times as large as the CBD-centred circles. The outer concentric bands surrounding airports are 1.3 times as large as the CBD-centred concentric bands.[7]

Taken as an aggregate, employment within 2.5 miles of the airports was 50.6 per cent as large as that within 2.5 miles of the city centres. In some sectors, such as the management of companies and enterprises and professional, technical and scientific services, employment levels were 32.1 and 24.0 per cent of central-city levels respectively. These sectors are thought to be attracted to central cities but their employees are also frequent flyers. Back-office employment (administrative and support services) and employment in accommodation and food services was 59.2 and 46.8 per cent as high as CBD employment respectively. Not surprisingly, manufacturing and transport and warehousing employment was more heavily represented near the airports than downtown.

The third-to-last row of the table indicates that downtown employment growth was substantially lower than that in airport areas between 1995 and 2002. CBD employment (inner circle) did better in the 2002–09 time-period, but the outer CBD-centred rings fared significantly worse than the outer airport-centred rings in that period. Accordingly, aggregate payroll followed the same pattern. Average compensation in the airport-centred zones has been declining from 82.3 per cent of that in CBD-centred zones in 1995 to 77.5 per cent in 2002 and 70.9 per cent in 2009, however, (not shown). Some of that difference is due to a still-evolving division of labour between central cities and the airport area, as reflected in a changing composition of sectors, occupations and skill levels, and some due to salary savings attributable to lower housing and commuting costs possible due to non-CBD employment location. A suburban location can benefit both employer and employee across all skill levels.

The sectoral pattern of employment change between 2002 and 2009 is nuanced (not shown). As might be expected given central-city costs, back-office employment increased in inner airport rings compared with central cities, but so did employment in finance and professional services. The representation of employment in corporate

Table 3. Centre-city and airport area employment compared

	Sectoral employment within radius of			*Total national sectoral employment*	*Airport area employment as a percentage of CBD-centred employment Sectoral employment within radius of*		
NAICS sector	*2.5 miles*	*5 miles*	*10 miles*		*2.5 miles*	*5 miles*	*10 miles*
Panel A: 2009 employment and salaries							
Total employment	6 175 581 (5.57)	10 122 400 (9.14)	18 597 368 (16.79)	110 775 020	50.65	74.19	102.26
Manufacturing	85 718 (1.12)	268 580 (3.51)	633 530 (8.29)	7 640 968	161.58	116.89	117.97
Wholesale trade	157 620 (4.05)	302 291 (7.76)	639 526 (16.41)	3 896 607	86.08	100.89	116.26
Transport and warehousing	73 826 (2.76)	183 611 (6.87)	436 752 (16.34)	2 673 599	334.99	199.25	131.24
Information industries	226 792 (10.37)	304 106 (13.91)	520 248 (23.80)	2 186 045	26.75	55.13	94.07
Finance and insurance	445 185 (10.92)	631 566 (15.49)	923 075 (22.64)	4 077 036	27.41	47.68	98.04
Professional scientific and technical services	622 790 (12.04)	825 698 (15.96)	1 259 753 (24.35)	5 174 40	23.96	47.02	93.65
Management of companies and enterprises	160 892 (9.07)	230 472 (12.99)	374 700 (21.12)	1 773 919	32.09	52.46	96.41
Administrative and support services	269 948 (5.66)	463 533 (9.72)	927 648 (19.45)	4 770 198	59.17	77.67	100.88
Accommodation and food services	473 331 (6.00)	717 351 (9.10)	1 252 174 (15.88)	7 885 39	46.79	69.83	100.64
Total wages and salaries ($)	428 934 548 (9.40)	625 061 937 (13.71)	998 646 892 (21.90)	4 560 723 525	35.94	59.91	100.12
Average wages and salaries ($)	69 456.55 (168.70)	61 750.37 (149.98)	53 698.29 (130.43)	41 171	70.94	80.75	97.91

(continued)

Table 3. (Continued)

NAICS sector	*Sectoral employment within radius of*			*Total national sectoral employment*	*Airport area employment as a percentage of CBD-centred employment Sectoral employment within radius of*		
	2.5 miles	*5 miles*	*10 miles*		*2.5 miles*	*5 miles*	*10 miles*
Panel B: change over time (percentages)							
Employment change 2002–09	2.57	−0.75	−1.29	0.87	62.10	−119.28	39.15
Employment change 1995–2002	6.39	4.36	6.90	11.48	261.45	263.87	149.52
Aggregate salary change 2002–09	32.78	27.77	25.62	24.07	62.45	84.50	90.25
Aggregate salary change 1995–2002	49.38	42.15	41.06	42.94	109.62	110.49	111.42
Average salary change 2002–09	29.45	28.73	27.26	23.00	63.08	77.85	87.11
Average salary change 1995–2002	40.40	36.21	31.95	28.21	79.33	86.85	100.50

Note: In Panel A, percentages are shown in parentheses.
Source: Author's analysis of Zip Business Pattern data.

headquarters and the information sector declined somewhat compared with centre cities as did employment in accommodation and food services. Relative employment in blue-collar fields—manufacturing, transport and wholesaling—increased over the time-period. Unfortunately, the change from SIC to NAICS classification does not allow for robust estimates of sectoral employment changes between 1995 and 2002.

The last several rows of Table 3, separating urban areas into concentric zones, suggest that the growth around airports is not merely a manifestation of the suburbanisation of employment. If it were, the suburban rings would show equivalent growth. Nor, since each of the metropolitan areas examined has an extensive network of limited-access highways radiating out in several directions, is airport area employment growth simply a result of a need for roadway access. Despite the large amount of space consumed by mandated open space, airports are important employment centres in themselves and they serve as major foci for employment growth, at least partially anchoring the spatial structure of what is often seen as unpatterned sprawl.

Understanding Firm Location Decisions

As might be expected on the basis of prior studies of firm location (Kimelberg and Nicoll, 2012; Schmenner, 1982), the reasons firms locate near airports are not fully clear. Businesses might locate near airports to improve operational efficiency through eased access to the transport infrastructure, much as early traders located at quayside. Our knowledge of operations supports those decisions for firms in some sectors. Airport area business locations can also attract firms because they lend a cosmopolitan image reflecting a need for frequent long-distance travel and because high-status firms that require frequent travel locate nearby. Reports from some firm location specialists support that factor. It is also possible that employment grows near airports because firms take advantage of available space created by real estate developers who sensed a potential demand. In some regions, local officials have expressed concern that aviation-dependent businesses might be crowded out, sub-optimising land use.

Firms often have multiple motives in choosing locations. Thus each of the factors mentioned earlier may have a role in driving airport-centred growth. Moreover, a mixture of firms—some strongly motivated by a need for rapid access to the airport, either as suppliers or consumers of air transport services; and others; possibly indifferent from their location within the metropolitan area but which, for a range of reasons, value proximity to other firms—could still create airport area employment concentrations. Despite the absence of a universal operational need, it is likely that these concentrations would not develop without a threshold of firms being dependent upon air transport.

Available data are not sufficient to sort out the weights of the various factors in location decision-making but each is consistent with the theoretical connection between transport breaks and urban form identified by Cooley. Nevertheless, evidence suggests that the minimisation of ground travel plays a major role. Data for 10 of the 25 busiest passenger airports indicate that, despite their large catchment areas, major airports draw between 20 and 50 per cent of their passengers from small geographically concentrated areas (TRB, 2002). Fully 15 per cent of the non-resident air travellers in Los Angeles begin their return trips to the airport in the RADAM zone (an aggregate

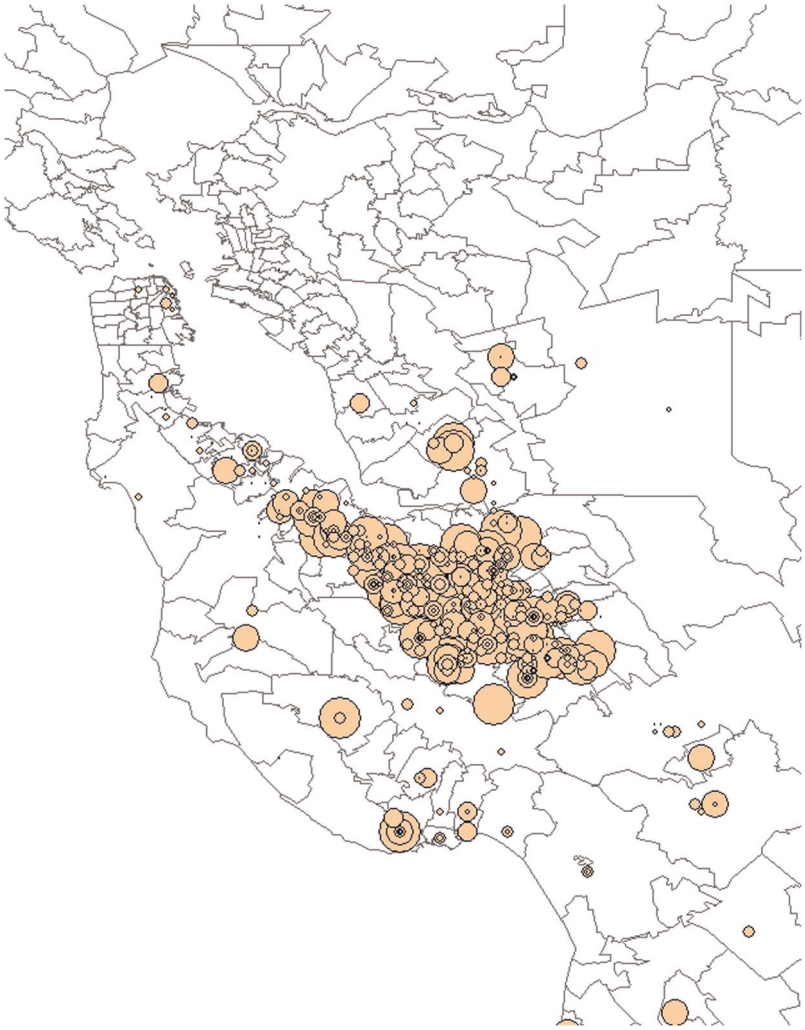

Figure 2. Origins of passengers flying through San Jose Airport.

of traffic analysis zones) that immediately surrounds the airport. Adding the four contiguous RADAM zones brings the total to 32 per cent—all of which are closer than downtown (Applied Management and Planning Group, 2004). Half of LAX passengers are concentrated in 5 per cent of the region's area and one-quarter are concentrated in two per cent of the area around LAX (Thomas, 2000). Data from the San Francisco Bay area indicates that, among the most frequent travellers, median airport access time is a third less than that for occasional flyers, while Figure 2 shows that those who use San Jose Airport most frequently (as seen by relative circle size) have a strong tendency to be located near the airport.[8] The locations of fliers, especially frequent fliers, suggest that airport access is an important component of firm location decision-making. Even when particular businesses do not use air transport themselves, they may locate near airports as a convenience to their customers and suppliers.

Implications of Large Airports for Urban Spatial Differentiation

We focus on the US because it is (still) the largest aviation market and because comparable small area employment data are available. Similar spatial patterns may be emerging around major airports in Europe and Asia. Employment on and around the edges of major airports, some of it providing transport and travel services, some not, is on average half as large as CBD-centred employment. During the initial half of the time-period examined (1995–2002), the areas immediately surrounding the sampled airports increased in employment at over twice the rate of their corresponding CBDs and significantly faster than suburban rings. More recently, national employment growth has slowed but CBD employment growth slowed less than other areas of the metropolitan regions, including the core airport areas. Nevertheless, the airport areas are still growing faster than most other areas of the metropolitan area. Wages in CBDs increased relative to airport areas throughout the entire time-period. While our systematic data reach back only to 1995, case studies of specific metropolitan areas suggest that airport area employment has been expanding for decades.

Three broad hypotheses about the impact of air transport on intrametropolitan structure can be discerned. Some have maintained that, in a major rearrangement of space, airports are becoming 'the new downtowns' (Bruegmann, 1996), with terminals forming the central square (Sudjic, 1992). According to a popular quote: "The airport leaves the city. The city follows the airport. The airport becomes a city".[9] Into the 1960s, when aircraft eclipsed ocean liners for transAtlantic passenger traffic, one could easily walk from New York City's major ocean and rail passenger terminals to Times Square. The city centre was anchored in place by the major transport nodes. Railroads and ships are no longer important means of long-distance passenger travel, however.

Today, an air trip between Chicago's downtown 'Loop' and New York's midtown Manhattan—both adjacent to their historical rail and water transport interchanges—often entails more time travelling on the ground than in the air. Accordingly, businesses dependent upon air transport may increasingly prefer locations near air interchanges. Interestingly, as growth in passenger travel slowed over the past decade, so did employment growth near airports.

A second hypothesis holds that cities are bifurcating into work and entertainment zones (Clark, 2011). Amsterdam may offer the clearest example of such a bipolar city. Four factors have been central in determining the new spatial structure of Amsterdam. First, a strong producer services economy which requires larger floor plates than possible in older buildings meant that firms needed newer facilities. Secondly, the suburbanisation of the labour force over the past several decades made a commute to the central city inconvenient. Thirdly, strong tourism has been able to exploit the museumisation of Amsterdam's historical central areas, thereby encouraging preservation. Finally, a heavy dependence upon rail meant that concentrating facilities near the express stations along a rerouted central trunk line which stretches from the south side of Amsterdam's central city (Zuidas) past Schiphol Airport created an accessibility advantage. Evidence for this pattern in the US is limited, however.

A third view envisions only partially specialised urban realms (Vance, 1990). Edge cities anchored by major airports are only one of several distinctive types of employment concentration in the polycentric form which has evolved in major cities (Hall,

2001). In this view, the CBD functions as a site of high-status employment. Our data on employment level, sector and average salaries over time provide partial support for this view. The financialisation of the US economy over the past decade may have helped produce this pattern, but the long-term effects remain to be seen. This view perhaps garners the most support from our data, but any of the three patterns could still prevail.

Notes

1. Analysis based on author's calculations across the National Household Travel Survey (Bureau of Transportation Statistics, 2003), Arbitron's data on airport advertising (Bouvard and Williams, 2004; Williams, 2007) and other cited sources.
2. While we do not have rigorous data, our impression from speaking with a sample of informants is that, particularly since the onset of the continuing economic crisis in the US, firms have substituted video conferencing and other technologies for air travel for internal communication needs. Client contact remains face-to-face. As some sectors of the economy have improved, business travel has increased and the substitution of video conferencing for travel has relaxed.
3. Based on the author's analysis of US International Trade in Goods and Services data.
4. The median commuting distance in the US in the early 2000s was 12.1 miles (Pisarski, 2006).
5. Our methodology differs from that of the typical airport economic impact study which estimates direct, indirect and induced employment supporting air travel. The employment generated need not be near the airport (although a large portion is on-site). We are concerned here with spatial structure and therefore examine geographical proximity, rather than economic linkage.
6. Airport employment statistics and the ZBP employment statistics are compiled using different methodologies and include different information (public employment is not included in the ZBP and all employment is listed as occurring at the office location) so that the figures are not always consistent. That protocol appears to be responsible for the aberrant figures for the Denver airport.
7. Alternate spatial specifications, including centring the CBD on major surface transport interchanges (which are generally close to the CBD), city geographical centroids (which are not necessarily in the CBD) and using airport centroids (which are surrounded by considerable open space) as the basis for airport-centred rings, yield somewhat different results, but the broad patterns and trends are robust to the several specifications. The specifications reported yield the highest employment numbers for both airport and CBD-centred rings.
8. This is not one of the 25 busiest passenger airports but it is one of the few airports for which such detailed ground access data are available.
9. Originally coined by Maurits Schaafsma, chief planner at Schiphol Airport.

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Appendix: Zip Business Pattern Data

The Zip Business Pattern (ZBP) data, published by the US Census Bureau, provide the most comprehensive small area employment information available. The ZBP data are systematically collected and establishment-based, meaning that they link economic activity, as closely as practical, to small geographical areas. Counties, numbering about 3000, have the advantage of nearly constant boundaries, but cover a geographical unit too large for our purposes. Unfortunately, detailed information is suppressed to preserve confidentiality, limiting us to the examination of relatively broad aggregations of sectors. Public employment and self-employment are not reported. The Census Bureau changed the classification of economic activity used in 1998, hampering some over-time comparisons of sectoral employment.

The 2009 ZBP data represent a total of 40 477 (38 494 with employment data) zip code areas which were linked to a reference dataset of 40 477 zip code area points produced by ESRI (aside from the residual codes, which cannot be matched in any case, the non-matching zip codes generally represent little employment each). The 2002 ZBP data represent a total of 39 451 zip code areas and the 1995 ZBP 41 721 areas linked to a reference dataset of 41 721 zip code area centroids. Each of the zip code points in our reference dataset was linked via a spatial join to the nearest of the 25 busiest US airports (point to polygon distance) and to the nearest of 22 large central cities (point to point distance) using ESRI data files. Using the information on the distance to the nearest airport and central city respectively, circles were constructed around each with 2.5-, 5- and 10-mile radii. In order to ameliorate the random noise created by local spikes in employment change and to reduce measurement error, the zip code areas within each ring were aggregated before analysis.