Airports as new urban anchors

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Transportation infrastructure and the resulting people and product flows have historically shaped urban growth and form. After summarizing the contemporary significance of commercial aviation, we use data from the 2002 Zip Business Patterns to document the effects of 25 major U.S. airports on employment location and urban growth patterns. Through these data and specific examples, we show that airports act as multi-nodal regional anchors and key urban organizers, similar to ports and rail terminals in earlier years. Nevertheless, appropriate land use and ground transportation planning are needed to address anticipated air transport growth and surface bottlenecks near major airports as well as promote greater efficiencies in urban development.

Airports as new urban anchors

Quietly, without attracting much academic notice, Americans and their businesses have become increasingly dependent upon air transport. As shown in Figure One, revenue passenger miles in the U.S. have approximately tripled over the past 25 years (Air Transport Association, 2004). Someone in the U.S. steps on a commercial airplane more than 700 million times per year. Flying is now more prevalent than reading Time and Newsweek (Bouvard & Williams, 2004). By 2015, more than one billion passengers are forecasted to travel through U.S. airports annually (Department of Transportation, 2005). Despite the recent prospect of rising fuel costs and continuing security concerns, there is no anticipated deviation from this upward trajectory.

Over 80 percent (90 percent for those who have household incomes of $30,000 or more and for those with more than a high school education) of American adults have flown at least once. Thirty-nine percent of U.S. adults fly in an average year and approximately 11 percent fly on commercial airlines in a month. Air travel accounts for 18 percent of the person-trips of 100 miles (one way) or more, 42 percent of the trips of 250 miles or more (vs. 4 percent for bus and train), and 55 percent and 68 percent of the person-miles on such trips, respectively (Bureau of Transportation Statistics, 2003).[1]

(Figure One about here)

Not only do many people fly, but a sizable minority does so very often. In 2003, an estimated 92 million different American adults flew. Half of the air passengers (46 million, nationally) flew only once that year, a third (30.54 million) flew two or three

[1] Some figures in this section are based on the authors' analysis of the National Transportation Survey, Arbitron's data on airport advertising, and other sources.

times that year, and 18 percent (16.6 million) flew four or more times in that year, the last accounting for approximately 60 percent of the flights taken. Among those flying on business, half (14.7 million) fly nine or more times per year, 17 percent (5 million) fly at least every two weeks, and two percent (618,000) – more than the entire population of the city of Milwaukee – fly at least once per week. A substantial number of people depend heavily on using air transport for their livelihoods and they tend to congregate in particular regions. Forty-six percent of frequent fliers reside in ten large metropolitan areas; less than 38 percent of all air travelers do.

Declining real costs of air travel have allowed many more to lay claim to membership in the recreational "jet set." One-fourth of all air travel is for vacationing with numerous resorts increasingly dependent upon air travel to deliver their guests. Miami and Las Vegas could not exist, as we know them, without mass air travel. New patterns of migration also lead to greater use of air travel. As parents retire to different states, children go to distant colleges, and adult siblings take jobs in distant cities, family visits often require air travel. Twenty eight percent of air travel is to visit family and friends or to take care of family business.

The most far-reaching factor in the growth of air travel may be the increasingly competitive business environment, resulting in both an increased specialization of function and a need for greater speed of interaction which have reinforced each other to make flying an essential part of doing business. Forty percent of commercial flying 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, inter-penetrating market areas of specialized firms as the revenue gains outweigh the additional costs of travel. Specialization requires frequent contact across long distances, whether engineers are being ferried aboard the "nerd birds" that connect distant high technology clusters or investment bankers are speeding between appointments in far-flung financial centers or IT consultants are commuting on early Monday and late Thursday flights.

Air transport is equally critical to the movement of goods in national and global supply and distribution chains. An amazing array of goods is shipped by air from gems to bendy-buses to breeder cattle but the goods shipped by air tend to share three characteristics: they have a high value-to-weight ratio, they are highly perishable, or 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 percent of international air cargo. In 2005, the U.S. exported $293 billion by air comprising 50 percent of all U.S. exports while importing $359 billion via air (36 percent of non-energy imports). Figure Two shows that air cargo revenue ton-miles have increased almost four and a half fold over the past 25 years. Accordingly, airports are among the nations top ports (Bureau of Transportation Statistics, 2005: Table 1-47). Air transport's increased speed, reducing real costs, and greater capability in overcoming physical barriers have resulted in the continuing substitution of rapid-response logistics and fast transport for warehousing (Bowersox, Closs, & Cooper, 2002). The use of air transport, therefore, continues to rise more rapidly than output. The new economy is clearly air-dependent.

(Figure Two about here)

We raise three questions about the heavy and growing dependence upon air transport. First, in what ways could we theoretically expect the growing reliance on air transport to affect the spatial pattern of employment? Less than 22 percent of metropolitan employment is within three miles of the center city of major metropolitan areas (Glaeser, Kahn, & Chu, 2001). Some of that employment may be in edge cities (Garreau, 1991) that sometimes form near highway interchanges and some scattered with no easily discernible pattern (Lang, 2003). Second, how is land use actually being influenced by the use of air transport, if it is at all? Some planners and architects have focused on encouraging center city preservation and revival while others have asserted that airports have become "the new downtowns" (Bruegmann, 1996) with terminals forming the central square (Sudjic, 1994). Finally, how could urban planners pro-actively deal with the air-land transport nexus? Planners have only recently begun to incorporate the mutual interdependence between ground transport and land use into their models (Miller, Hunt, Abraham, & Salvini, 2004). Despite the dramatic rise of passenger and cargo air transport, planners are just beginning to think systematically about the implications for land use, ground transportation, and the resulting urban form.

Transportation and urban development

Cooley, in his seminal work on transportation of over a century ago, laid the groundwork for considering the impact of transportation on urban form.

> 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 (1894: 91).

Mechanical breaks (a physical interruption) in the movement of goods require buildings for storage and persons to care for them and for the goods they contain. Logistics functions (kitting, packaging, labeling, and supply chain sequencing) locate in and around these structures. There must be loading, unloading, intermediate carriage, and longer distance distribution. The persons performing these activities require supporting retail and other services. 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. Historically, efficient locations for mechanical breaks have determined the location of transfer points and provided a nucleus for city formation (Vance, 1970). For example, the immediate points of passenger and cargo transfer between transport modes and routes rapidly became trading, financial, and hospitality centers throughout Chicago's development (Cronon, 1991).

The geographical extent of interaction is limited by the costs of carrying out interactions and the anticipated rewards to completing the interaction (Hawley, 1950). Thus, the spatial texture of social organization is determined by the combination of temporal rhythms and transportation technology, which influence the spatial extent of social interaction. When Cooley wrote, the combination between train, horse-drawn vehicle, and foot traffic articulated the spatial structure of most cities and towns. As average commuting time tends towards a constant whatever the transportation technology used (Shafer & Victor, 2000), automobiles, like street cars, and bicycles before them, reduced the time of travel even as they enlarged cities (Forer, 1978; Hawley, 1971). The

automobile's influence on land use was already apparent in the 1930s when only a minority of urban dwellers had access to an automobile (McKenzie, 1933). Today, 92 percent of all U.S. trips to work and 86 percent of all trips are made by automobile (Pucher & Renne, 2003).

The flexibility of automobiles and trucks, combined with a developed road network, removed many of the common points of transportation break, blurring urban form. Consequently, downtowns, most of which formed within easy sight of the original mechanical breaks in transportation between water and land or between railroad and local transportation, lost much of their accessibility advantage while the urban centrality due to the intersection of intra-urban rail lines declined. At least since Rockefeller Center was developed in the 1930s (Bacon, 2001), in the absence of operational advantages, the emphasis has shifted to promoting center city locations on the basis of image and symbolism (Suttles, 1984).

If the combination of long distance and local modes of transportation drove and shaped urban space in earlier time periods – even when only a minority used those modes on a daily basis – it would seem that the combination of air transportation and automobile/truck transport would drive and shape urban patterns today. Curiously, despite the prevalence and importance of air transport today and the close theoretical and empirical connection between means of movement and spatial form, little attention has been paid to the urban correlates of the growth of air transport.[2] Le Corbusier recognized the accessibility advantages of air transport to urban competitiveness and advocated

[2] Ogburn (1946) attempted to predict the impact of air transport on spatial form, but, since his pioneering speculations, efforts have been spotty despite the acknowledged importance of air transport on local economic development. Conway (1976; 1980; 1993) explored the concept of airport cities from the perspective of industrial development.

incorporating airports in central cities as early as 1925 but extensive land needs, noise considerations, and the marginal role of air travel in daily living in earlier decades pushed airports progressively further from city centers.[3] Today, however, air travel is neither tangential to business and recreation nor peripheral to many cities. With the addition of new residences and new employment at the urban fringe, many once-distant airport sites (e.g., Washington Dulles) are no longer remote. Events may have finally caught up with Le Corbusier's vision.

Airports and spatial form

We focus on the areas surrounding the busiest U.S. airports because large numbers of Americans live and work near them and travel through them. Table One shows the 25 busiest U.S. passenger airports. Collectively, they were responsible for 57 percent of all U.S. passenger traffic in 2004. Atlanta, with 82,975,667 total (41,451,809 departing) passengers annually, processed over five percent of national air traffic alone.

(Table One about here)

The huge volumes of people and products imply that airports serve as urban centers. The *daily* population traveling through Atlanta's Hartsfield-Jackson Airport, the world's busiest, is over 229,000. That is larger than the total residential (2000) populations of approximately 180 of the 390 U.S. Metropolitan Statistical Areas and only 11 countries worldwide have populations larger than the number of passengers Atlanta airport processes each year – which is the equivalent of almost 30 percent of the (2000) U.S. population. Approximately half of those passengers either begin or end their air travel in Atlanta which means that the origins and destinations of 115,000 air travelers

[3] LeCorbusier may have been inspired, in part, by Berlin's Tempelhof airport which opened in 1923.

daily must be accessible to the airport. Forty-six thousand are flying on business and therefore possibly heading toward or coming from a place of business. Chicago's O'Hare was not far behind Atlanta with over four and a half percent of the traffic. Los Angeles and Dallas-Fort Worth airports also process over 50 million passengers annually.

Employment servicing that travel can reach into the tens of thousands at the largest airports. Over 60,000 are employed on-site at Atlanta's Hartsfield-Jackson airport, exceeding the U.S. Census definition of a metropolitan area central city. Employment at the 25 airports included in Table One averages 29,000 employees – comparable to that in many major central business districts. Airlines along with security and support organizations are responsible for much of that employment but increasing numbers are working in the non-aeronautical functions (e.g., retail) that contribute approximately half of total revenues to large U.S. airports. As airports become mini-cities 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. For example, 60 percent of the employees at Frankfurt Airport, the largest single employment site in all of Germany, reside within 22 miles.

Examining the table, a loose correlation between the age of the airport and its great circle distance from the central business district of its city can be seen. Logan International Airport, founded in 1921, is one mile from Boston's CBD. Denver International Airport, opened in 1995, is 16 miles from Denver's CBD. The influence of airports on the spatial pattern of cities may be less discernible if they are located close to the historic center.

Much of the evidence about the effect of airports on urban form stems from *ad hoc* sources. In order to systematically assess the impact of airports on contemporary employment distribution, we use the 2002 Zip Business Pattern (ZBP) data (the latest available). Similar data have been used previously to explore the spatial distribution of metropolitan employment (Glaeser, Kahn, & Chu, 2001). (See Appendix for a detailed description.)

Some may think that due to safety and other environmental concerns that development would shy away from airport areas. Yet, Table One shows that 2.8 million jobs (2.56 percent of U.S. employment) are located within a 2.5 mile radius of the center of the busiest 25 passenger airports. Over seven million jobs (6.48 percent of U.S. employment) are located within a five mile radius of the center of those same airports while 18.3 million jobs (16.57 percent of the total) are within ten miles (vs. .13 percent 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 are 3.21, 7.83, and 20.90, indicating that employment near the major airports is relatively well-paid.

The variation in employment and payroll among airports is substantial but 18 of these 25 airports provide sufficient employment within 2.5 miles to populate an entire metropolitan area on their own and employment sometimes ranges up to a quarter of a million. Employment tops 70,000 within a five-mile radius for all of the sampled airports. In some cases, the five-mile radius contains or nears a central business district but even when the airport is quite distant from the city center, employment can be quite large.

Chicago's O'Hare Airport, 14 miles from the Loop, contains over half a million jobs within a radius of five miles. Conference facilities, such as the Donald E. Stephens Convention Center which is less than 2.5 miles from O'Hare's terminals, locate near airports to facilitate same-day return trips by air travelers. Corporate headquarters, with a heavy dependence upon air travel, are also located near the airport. Dallas-Fort Worth Airport, 12 miles from downtown Dallas, is at the center of over 400,000 jobs. Over 200,000 jobs are located within five miles of Dulles International Airport which is 20 miles from Washington D.C. Houston Intercontinental Airport, 23 miles from downtown, has 140,000 jobs nearby. Detroit's Metro Wayne County Airport, 15 miles from the city center, has attracted over 90,000 jobs within a five-mile radius. Denver's Airport, open just over a decade at a relatively long distance from the CBD, is already the anchor for 72,000 jobs.

Sectors are differentially attracted to the vicinities of airports. Table Two 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. Some of these sectors, such as transportation 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. Total employment for each sector is included in the table as a basis for comparison.

(Table Two about here)

Manufacturing is less tied to airports than employment as a whole. While 6.48 percent of U.S. employment is within five miles of one of the 25 busiest passenger airports, only 3.81 percent of manufacturing employment is but we have not included the

cargo-intensive airports that might be attractive to some manufacturers. Wholesale trade is more tightly agglomerated around airports than average. Fully 9.84 percent of the nation's employment in transportation and warehousing is within 2.5 miles of these airports and the relative concentration continues at least as far as the ten-mile radius. E-commerce fulfillment centers are reportedly especially likely to locate near airports. 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 who never need to travel downtown.

Perhaps the biggest surprise is the degree to which sectors that are supposedly confined to the central business districts of the largest cities because of their need for face-to-face interaction are actually clustered around these busy airports. Finance and insurance is only slightly less likely than employment as a whole to be within 2.5 miles of an airport but information industries, professional services, administrative and support services, and even the management of companies and enterprises – the Census Bureau's terminology for corporate headquarters – are more likely than employment as a whole to be within 2.5, 5, and 10 miles of a major airport. Las Colinas, a 12,000 acre planned airport-linked city just to the east of Dallas-Fort Worth Airport has 25,000 residents, hosts more than 98,000 employees in 21.4 million square feet of office space, including the world headquarters of ExxonMobil, and 8.5 million square feet of light industrial and distribution space.

Accommodation and food services are more likely than average to be concentrated very close to major airports but somewhat less likely than the baseline to be

within the larger radii. Few large airports are without a hotel belt, such as that just outside Baltimore-Washington International Airport, which is identified as such by highway signs. 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 center. Las Vegas hotels are moving progressively closer to the city's airport with some large casino hotels sited barely one thousand feet from the airport back fence. The first new luxury hotel in Detroit in decades opened just a few years ago is connected directly to the main passenger terminal, attracting many non-flying as well as flying customers. The final row of the table shows the percentage change in the circles with the respective radii. Airports were clearly core areas of employment growth over the period for which data are available.

Compared to central cities, the employment surrounding airports is substantial but not yet dominant. Table Three repeats the analysis reported in Table Two basing the rings on the centers of the 24 largest central cities that the 25 airports serve (Kennedy and La Guardia airports are both connected to New York). Taken as an aggregate, employment within 2.5 miles of an airport is 75 percent as large as that within 2.5 miles of the city center. In some sectors, such as corporate headquarters and professional, technical, and scientific services, employment levels are 55 and 41 percent of central city levels, respectively. These sectors are said to be attracted to central cities but their employees are also frequent flyers. The second-to-last row of the table indicated that employment growth centered on the CBD was substantially lower than that in the vicinities of airports over the 1995-2002 time period that we are able to estimate.

Unfortunately, the change in classification does not allow for robust estimates of the employment changes in the most relevant sectors. The last row of the table, separating urban areas into concentric zones, indicates that although employment growth was higher in suburban areas than in central cities, the growth around airports is not merely a manifestation of the suburbanization of employment.

(Table Three about here)

Despite the large amount of space consumed by runways, taxiways, hangars, and mandated open space, airports are important employment centers in themselves and that they serve as the major foci for employment growth, at least partially anchoring the spatial structure of what is often seen as unpatterned sprawl. In some metropolitan areas, CBD's have gained positions as specialty restaurant and entertainment zones even as they have sometimes ceased to be engines of wealth creation (Clark, 2004).

Businesses might locate near airports to improve operational efficiency through eased access to the transportation infrastructure, much as early traders located at quayside. 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. 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 that regard, airport-centered development is no different from central cities and, in some regions, there is concern that the aviation-dependent businesses might be crowded out, sub-optimizing land use.

Available data are not sufficient to sort out the various factors in location decision-making but each is consistent with the theoretical connection between

transportation breaks and urban form. Nevertheless, evidence suggests the minimization of ground travel plays a major role. Although major airports have wide catchment areas, fully 15 percent of the non-resident air travelers in Los Angeles begin their return trips to the airport in the RADAM (aggregate of Traffic Analysis Zones) that immediately surrounds the airport. Adding the four contiguous RADAMs brings the total to 32 percent – all of which are closer than downtown (Applied Management and Planning Group, 2004). Data from the San Francisco Bay area indicates that, among the most frequent travelers, median access time is a third less than that for occasional flyers. Even when particular businesses do not use air transport themselves, they may locate near airports as a convenience to their customers and suppliers.

Implications for urban planning

The analysis above documents the concentration of employment in many sectors surrounding major airports. Airport-centered employment is, on average, three-fourths as large as CBD-centered employment – and it is growing. Airports are major urban growth nodes. That growth is driven, directly and indirectly, by the increasing reliance on air transport for recreation, family visits, fast-cycle logistics, and conducting business.

In the main, airport area development is occurring spontaneously, haphazardly, and, oftentimes, in an unsightly manner. There is a need for both planning vision and coordinated action to improve the likelihood that such development is economically efficient, esthetically pleasing, and environmentally sustainable.

Existing infrastructure threatens to become a transportation bottleneck, inconveniencing travelers and raising business transaction costs. The rapid increase in air

traffic has led to congested air lanes, crowded terminals and jammed access roads. Both of the former issues are being addressed under Federal Aviation Authority guidance with renewed infrastructure investment but the nexus between air transport and the closely related issues of ground movement and land use – the wider airport region – receive little attention. A combination of land use and ground transportation planning that improved access time would reduce the costs of face-to-face interaction, increase economic efficiency, and strengthen regions. A trip between downtown Chicago and downtown New York, for example, often entails more time on the ground than in the air.

The aerotropolis concept (Kasarda, 2000; 2001) may offer a first step in strategic land use and multi-modal infrastructure planning. The aerotropolis model incorporates the hotels, conference halls, and office space that support face-to-face information processing into the design of airport regions while adding the retail and entertainment complexes that make travel less onerous. Integrated logistics and distribution centers facilitate the movement of goods. Airport expressways with dedicated truck or public transit lanes and trains to the downtown and other urban anchors reduce the frictions of ground travel.

Such planned development is most easily seen in the new large green field airports recently built in Asia, such as Hong Kong and Incheon (South Korea). Several busy European airports are systematically planning to accommodate increasing business reliance on air transport by channeling the location of office and industrial space on and near airport grounds. Schiphol airport, for example, has joined with local municipalities and planning agencies to form a quasi-public authority (the Schiphol Area Development Company) to guide development in the broader region so that it reinforces and is

reinforced by the airport. Frankfurt Airport is planning a massive nine-storey mixed use office and commercial center above its terminal-linked train station to serve as a regional urban anchor and preserve nearby green space.

The continuing success of Las Colinas, near Dallas-Fort Worth airport, suggests the potential for planned airport-linked development in the U.S. Denver's new airport was, in fact, sited to allow for extensive related land development. Much of this development is being coordinated by a regional public-private partnership (The DIA Partnership). Under the rubric of the aerotropolis, Wayne County (Detroit) is working with the University of Michigan's college of architecture and urban planning to plan and coordinate development on 25,000 acres of open land stretching up to eight miles west of Detroit Metropolitan Wayne County Airport.

The immediate applicability of this concept in the U.S. may be limited, however. New major green field airports are unlikely in the near future and most existing major airports are hemmed in by non-aviation land uses that hamper the operation, much less expansion, of air-dependent business. Nor is land banking for future airport-linked business development practical or economically feasible in most metropolitan areas.

Despite the importance of air transport, in many U.S. metropolitan areas, development toward an airport-centric urban form can proceed – like the concentration of industries already in place – only piecemeal through a slow succession of land uses and in-fill development that will likely take decades. Succession to more appropriate land use may be facilitated by zoning and other planning policies that encourage the location or redevelopment of aviation-oriented businesses in airport areas and discourage conflicting land uses.

Increasing ground transportation efficiency could be a viable alternative to airport-centric land development. Some architects have even advocated locating many terminal functions off-site, allowing, for example, dispersed-site check-in. Doing so would require a drastic improvement in airport ground transportation. While some overseas airports have been able to seamlessly integrate air transport with local and long-distance train travel (Güller & Güller, 2003), airports in the U.S. often lack the full complement of multimodal infrastructure. Only one U.S. airport is directly connected to Amtrak and only a few have direct local train service to their center cities. The highways surrounding airports are often full and unable to substitute accessibility for proximity.

Whatever the option chosen, travel time and with the implied costs of interaction can be reduced through the improved coordination of land use or more viable ground transportation options. Planners must give heightened attention to integrating air movements with land use and ground transportation. Moreover, any attempt at airport-centered smart growth will entail significant implementation problems in the absence of suitably empowered regional authorities (Downs, 2005). The net effect of the lack of coordinated ground transportation infrastructure and land use in the U.S. is to decrease economic welfare by increasing the costs of doing business and face-to-face interaction. New patterns of doing business and means of transportation call for new transit-oriented urban planning.

Appendix: Zip Business Pattern data

The Zip Business Pattern (ZBP) data, published by the U.S. Census Bureau, provide the most comprehensive small area employment information available. The ZBP data are systematically collected and establishment-based meaning they link economic activity, as closely as practical, to small geographic areas. Counties, numbering about 3,000, have the advantage of nearly constant boundaries, but cover a geographic unit too large for our purposes. Unlike commercial databases, they are not biased by a selective desire for particular commercial services. Unfortunately, detailed information is suppressed to preserve confidentiality, limiting us to the examination of relatively broad aggregations of sectors and self-employment is not reported. The Census Bureau changed the classification of economic activity used in 1998, hampering over time comparisons of sectoral employment.

The 2002 ZBP date represent a total of 39,451 zip codes; 39,283 (99.6 percent) of these could be linked to a reference dataset of 41,721 zip code area points produced by ESRI (formerly Environmental Systems Research Institute).[4] Each of the zip code points in our reference data set was linked via a spatial join to the nearest of the 25 busiest U.S. airports and to the nearest of 24 large central cities 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 reduce measurement error, the zip code areas within each ring were aggregated before analysis.

[4] Aside from the residual codes (which cannot be matched in any case), the non-matching zip codes generally represent little employment each.

Bibliography

Air Transport Association. 2004. Annual Operations, Traffic, and Capacity: US Airlines – Scheduled Services. website http://www.airlines.org/econ/d.aspx?nid=1032, accessed 15 August.

Applied Management and Planning Group. 2004. *2001 Air passenger survey final report, Los Angeles International Airport*. Los Angeles.

Bouvard, P. & Williams, D. (2004). *The Arbitron airport advertising study*. New York: Arbitron.

Bacon, M. (2001). *Le Corbusier in America: Travels in the land of the timid.* Cambridge: MIT Press.

Bowersox, D.J., Closs, D.J., & Cooper, M.B. (2002). *Supply chain logistics management*. Boston: McGraw-Hill.

Bruegmann, R. (1996). Airport city. In J. Zukowsky, (Ed.), *Building for air travel: Architecture and design for commercial aviation* (pp. 195-211). New York: The Art Institute of Chicago.

Bureau of Transportation Statistics. (2005). *National transportation statistics 2005.* Washington D.C.: Department of Transportation. Available on-line at: http://www.bts.gov/publications/national_transportation_statistics/2005/

Bureau of Transportation Statistics. (2003). *Highlights of the 2001 National Household Travel Survey.* Washington D.C.: Department of Transportation.

Clark, T.N. (2004). *The city as an entertainment machine.* Amsterdam: Elsevier JAI.

Conway, H.M. (1993). *The airport cities 21: The new global transport centers of the 21st century.* Norcross: Conway Data.

Conway, H.M. (1980). *The airport city: Development concepts for the 21st century.* Atlanta: Conway Publications.

Conway, H.M. & Liston, L.L. (1976). *Industrial facilities planning.* Atlanta: Conway Publications.

Cooley, C.H. (1894). The theory of transportation. *Publications of the American Economic Association* 9 (3), 13-148.

Cronon, W. (1991). *Nature's metropolis: Chicago and the Great West*. New York: W. W. Norton.

Dempsey, P.S. (2000). *Airport planning and development handbook*. New York: McGraw-Hill.

Department of Transportation. (2005). *FAA aerospace forecasts: Fiscal years 2005-2016*. Washington D.C.: Federal Aviation Administration, Office of Aviation Policy and Plans.

Dogan, M. (1988). Giant cities as maritime gateways. In M. Dogan and J.D. Kasarda, (Eds.), *Metropolis era: A world of giant cities* (30-55). Newbury Park: Sage Publications.

Downs, A. (2005). Smart growth: Why we discuss it more than we do it. Journal fo the American Planning Association 71, 367-378.

Forer, P. (1978). Time-space and area in the city of the plains. In T. Carlstein, D. Parkes, and N. Thrift, (Eds.), *Timing space and spacing time,* Volume 1, *Making sense of time* (99-118). London: Edward Arnold.

Garreau, J. (1991) *Edge city: Life on the new frontier*. New York: Doubleday.

Glaeser, E., Kahn, M., & Chu C. (2001). *Job sprawl: Employment location in U.S. metropolitan areas*. Washington D.C.: Brookings Institution.

Güller, M. & Güller. M. (2001). *From airport to airport city.* Brussels: Airport Regions Conference.

Hawley, A.H. (1971). *Urban society: An ecological approach.* New York: Ronald Press.

Hawley, A.H. (1950). *Human ecology: A theory of community structure*. New York: Ronald Press.

Kasarda, J.D. (2001). "Logistics and the Rise of the Aerotropolis." *Real Estate Issues* 25: 43-48.

Kasarda, J.D. (2000). "Aerotropolis: Airport-Driven Urban Development." Pages, 32-41 in *The Future of Cities.* Washington D.C.: Urban Land Institute.

Lang, R. (2003). *Edgeless cities: Exploring the elusive metropolis.* Washington, D.C.: Brookings Institution Press.

McKenzie, R.D. (1933). *The metropolitan community.* New York: McGraw-Hill.

Miller, E.J., Hunt, J.D., Abraham, J.E., & Salvini, P.A. (2004). Microsimulating urban systems. *Computers, Environment, and Urban Systems* 28, 9-44.

Ogburn, W.F. (1946). Inventions of local transportation and the patterns of cities. *Social Forces* 24 (4), 373-379.

Pucher, J. & Renne, J.L. (2003). Socioeconomics of urban travel: Evidence from the 2001 National Household Travel Survey. *Transportation Quarterly* 57(3), 49-78.

Schafer, A. & Victor, D.G. (2000). The future mobility of the world population. *Transportation Research Part A* 34, 171-205.

Sudjic, D. (1992). *The 100 mile city.* San Diego: Harcourt Brace and Co.

Suttles, G.D. (1984). The cumulative texture of local urban culture. *The American Journal of Sociology*. 90 (2), 283-304.

Vance, J.E. (1970). *The merchant's world: The geography of wholesaling.* Englewood Cliffs: Prentice-Hall.

Figure One

Growth of U.S. Air Passenger Travel, 1928-2004

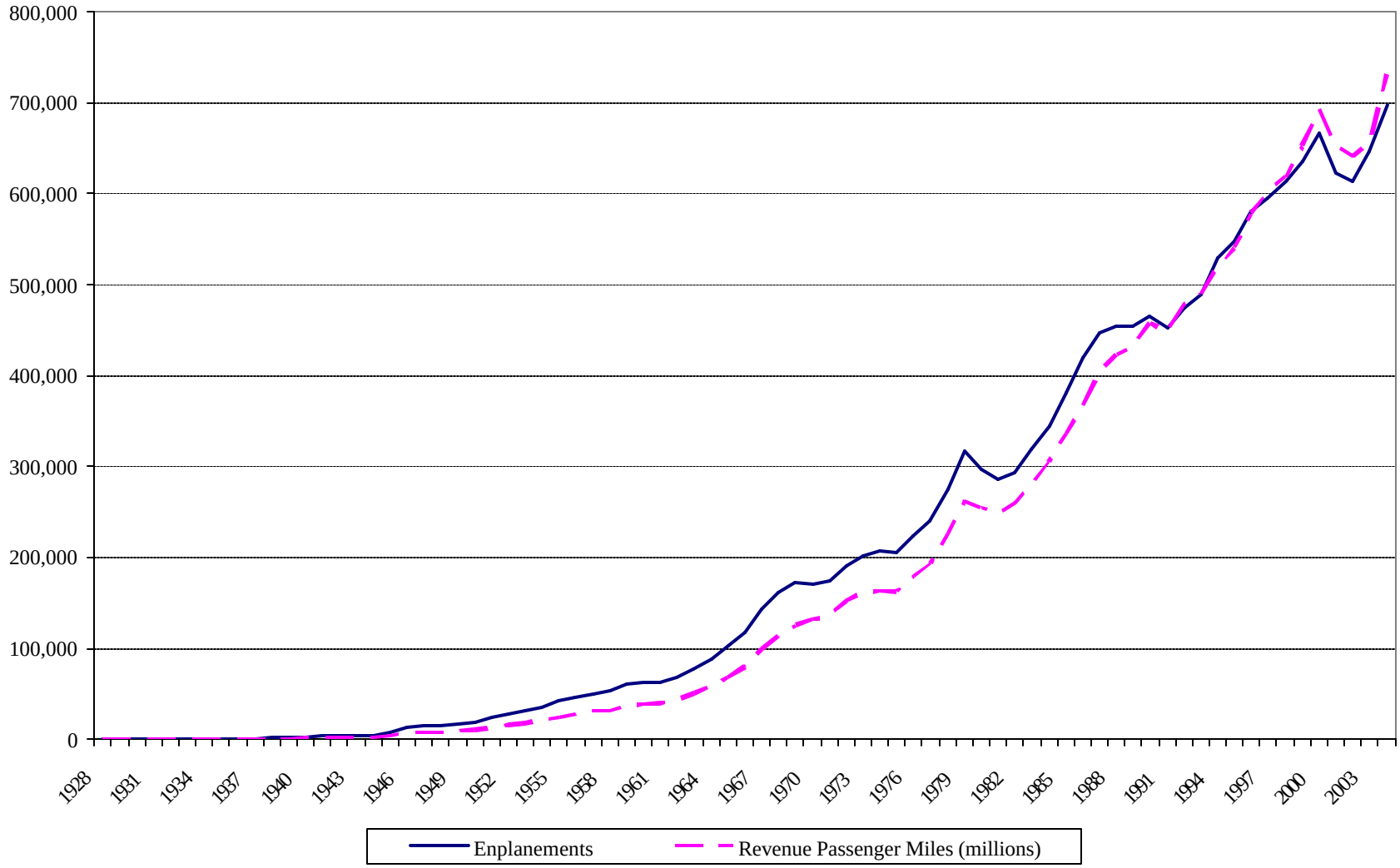

Figure Two

Growth of U.S. Air Freight Service, 1935-2004

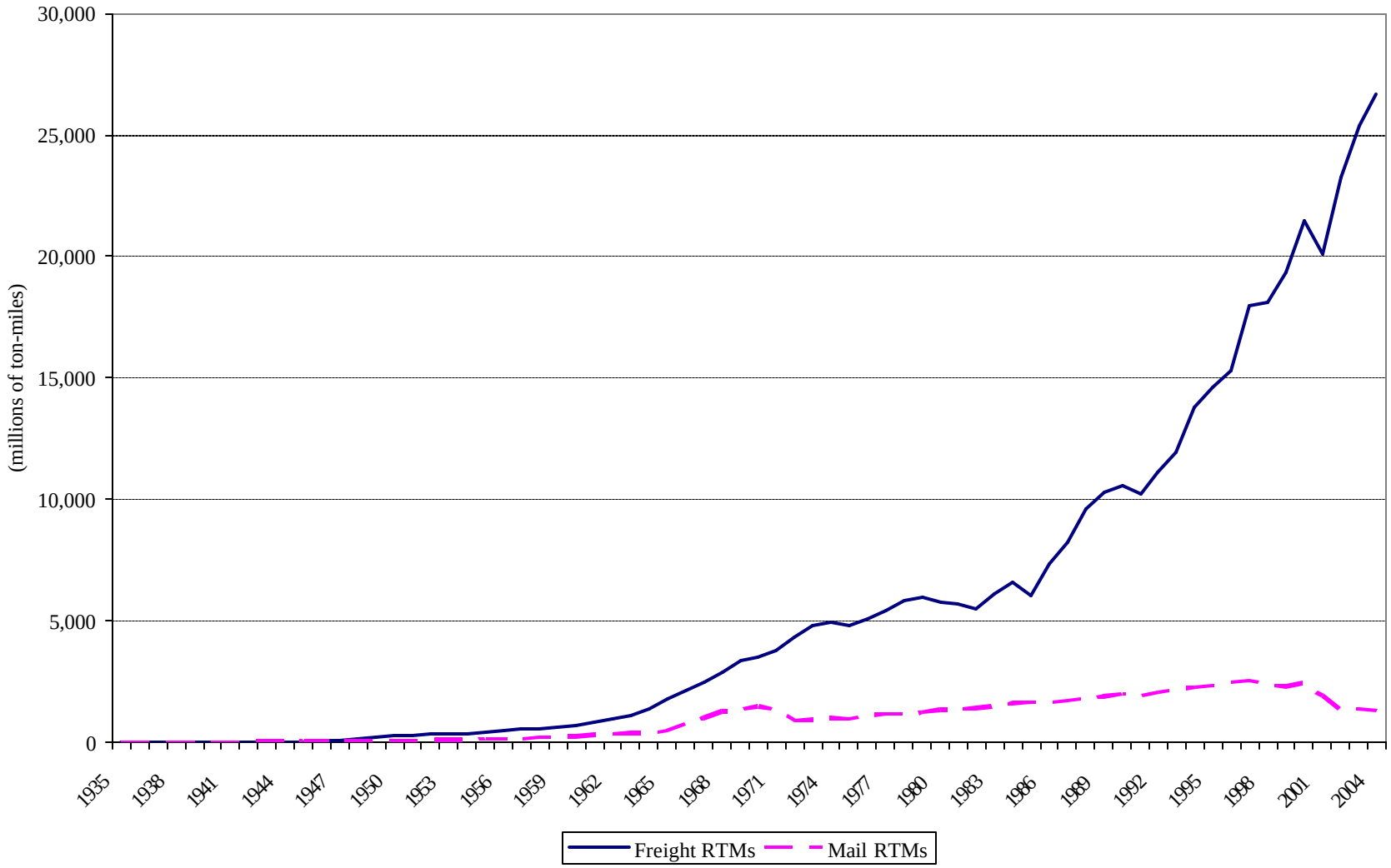

Table One: Employment and payroll in airport-centric rings

	Airport	ID	Total annual (arriving and departing) passengers (2004)	Year of first commercial service	Great circle distance from CBD (miles)	Total employment within radius of:			Total payroll within radius of:		
						2.5 miles	5 miles	10 miles	2.5 miles	5 miles	10 miles
1	Atlanta, GA: Hartsfield-Jackson	ATL	82,975,667	1930	7	115,650	161,625	515,453	4,818,972	6,330,416	19,436,447
2	Chicago, IL: O Hare	ORD	73,112,984	1955	14	193,106	552,227	1,255,962	8,617,615	22,953,992	51,614,870
3	Los Angeles, CA: Los Angeles International	LAX	59,512,194	1946	9	224,606	391,173	1,455,801	11,272,882	18,049,896	60,864,834
4	Dallas/Ft.Worth, TX: Dallas/Ft Worth International	DFW	56,868,010	1974	12	226,633	415,864	986,817	11,377,342	17,899,711	38,451,828
5	Denver, CO: Denver International	DEN	41,442,549	1995	16	16,499	72,543	190,528	828,270	2,752,061	6,538,373
6	Las Vegas, NV: Mc Carran International	LAS	41,000,529	1926	5	216,888	444,293	607,072	7,117,694	14,018,353	18,913,582
7	Phoenix, AZ: Sky Harbor International	PHX	40,746,216	1951	3	145,418	436,092	875,844	5,137,376	15,383,302	29,075,340
8	New York, NY: Kennedy International	JFK	37,680,678	1948	13	122,922	236,247	578,391	4,282,374	7,840,754	18,773,436
9	Minneapolis/St. Paul, MN: Minneapolis St Paul International	MSP	35,390,406	1929	6	75,099	321,438	868,931	3,030,832	11,925,581	35,253,395
10	Houston, TX: Houston Intercontinental	IAH	35,108,358	1969	23	48,723	140,105	293,443	1,929,195	5,330,949	10,239,443
11	Detroit, MI: Detroit Metro Wayne County	DTW	34,613,219	1930	15	37,372	91,928	358,382	1,797,570	3,728,161	13,347,348
12	Newark, NJ: Newark Liberty International	EWR	31,995,478	1928	16	176,427	350,489	1,005,097	7,143,990	13,032,402	44,018,465
13	San Francisco, CA: International	SFO	31,934,189	1927	8	55,108	132,349	748,090	2,304,397	6,380,153	41,706,910
14	Orlando, FL: Orlando International	MCO	31,022,725	1970	6	24,320	123,041	422,101	749,493	3,652,632	13,282,822
15	Miami, FL: Miami International	MIA	29,737,237	1928	8	215,157	473,256	721,654	6,013,125	15,693,820	22,348,777
16	Seattle, WA: Seattle/Tacoma International	SEA	28,886,457	1949	10	72,091	165,679	517,461	2,592,930	7,448,734	22,054,018
17	Philadelphia, PA: Philadelphia International	PHL	28,150,817	1940	5	52,448	194,379	735,223	2,006,923	7,480,777	28,347,493
18	Boston, MA: Logan International	BOS	25,605,254	1927	1	288,222	616,658	992,409	16,054,791	31,950,808	45,728,919
19	Charlotte, NC: Douglas Municipal	CLT	25,531,937	1937	4	36,048	162,358	369,765	1,483,788	6,202,534	13,306,139
20	New York, NY: La Guardia	LGA	24,568,558	1939	4	172,757	795,254	2,784,154	6,248,576	37,545,128	165,196,369
21	Washington, DC: Dulles International	IAD	22,179,118	1962	20	121,010	217,753	325,777	6,574,221	10,806,059	14,729,653
22	Covington, KY: Cincinnati/ Northern Kentucky International	CVG	22,138,707	1947	13	4,301	105,361	309,165	97,292	3,367,935	11,194,981
23	Baltimore, MD: Baltimore/Washington International	BWI	21,086,508	1950	30	76,925	133,018	560,025	3,310,488	5,282,366	21,597,205
24	Fort Lauderdale, FL: Fort Lauderdale International	FLL	20,322,749	1948	3	54,858	184,824	537,392	1,835,274	6,185,073	17,078,423
25	Honolulu, HI: Honolulu International	HNL	19,811,511	1940	3	53,418	241,581	291,128	1,906,221	8,070,215	9,380,161
						2,826,006	7,159,535	18,306,065	118,531,631	289,311,812	772,479,231
	Percent of national total					2.56%	6.48%	16.57%	3.21%	7.83%	20.90%
	National total					110,467,450			3,696,165,985		

Table Two: Sectoral employment within airport-centric rings

	Sectoral employment within radius of:			
NAICS sector	2.5 miles	5 miles	10 miles	Total national sectoral employment
Total employment	2,826,006 2.56%	7,159,535 6.48%	18,306,065 16.57%	110,467,450
Manufacturing	134,043 1.43%	358,427 3.81%	922,945 9.82%	9,397,147
Wholesale trade	118,774 2.97%	312,762 7.81%	767,344 19.17%	4,003,381
Transportation and warehousing	211,323 9.84%	321,348 14.97%	502,717 23.42%	2,146,858
Information industries	70,767 2.98%	176,188 7.42%	517,812 21.80%	2,375,451
Finance and insurance	105,615 2.53%	265,146 6.36%	888,233 21.32%	4,166,924
Professional, scientific, and technical services	122,641 2.59%	336,836 7.11%	1,027,736 21.70%	4,735,593
Management of companies and enterprises	47,465 2.58%	125,006 6.79%	378,211 20.56%	1,839,833
Administrative and support services	156,975 3.14%	389,269 7.80%	977,373 19.58%	4,991,893
Accommodation and food services	182,230 2.62%	435,699 6.27%	1,055,911 15.18%	6,953,719
Wages and salaries	$118,531,631 3.21%	$289,311,812 7.83%	$772,479,231 20.90%	$3,696,165,985
Employment change 1995-2002	15.98%	12.05%	10.07%	

Table Three: Comparing center city and airport area employment

NAICS sector	Sectoral employment within CBD-centric rings: Sectoral employment within radius of: 2.5 miles	5 miles	10 miles	Total national sectoral employment	Airport area employment as a percentage of CBD-centric employment: Sectoral employment within radius of: 2.5 miles	5 miles	10 miles
Total employment	3,759,600 3.40%	9,281,949 8.40%	20,084,559 18.18%	110,467,450	75.17%	77.13%	91.14%
Manufacturing	116,750 1.24%	317,683 3.38%	856,328 9.11%	9,397,147	114.81%	112.83%	107.78%
Wholesale trade	98,939 2.47%	280,842 7.02%	730,117 18.24%	4,003,381	120.05%	111.37%	105.10%
Transportation and warehousing	70,515 3.28%	173,845 8.10%	453,103 21.11%	2,146,858	299.69%	184.85%	110.95%
Information industries	126,029 5.31%	318,161 13.39%	613,488 25.83%	2,375,451	56.15%	55.38%	84.40%
Finance and insurance	209,411 5.03%	557,393 13.38%	1,053,839 25.29%	4,166,924	50.43%	47.57%	84.29%
Professional, scientific, and technical services	297,510 6.28%	717,903 15.16%	1,278,992 27.01%	4,735,593	41.22%	46.92%	80.36%
Management of companies and enterprises	87,023 4.73%	198,961 10.81%	413,767 22.49%	1,839,833	54.54%	62.83%	91.41%
Administrative and support services	182,252 3.65%	482,827 9.67%	1,084,335 21.72%	4,991,893	86.13%	80.62%	90.14%
Accommodation and food services	239,377 3.44%	537,833 7.73%	1,161,153 16.70%	6,953,719	76.13%	81.01%	90.94%
Wages and salaries	$161,626,470 4.37%	$427,771,534 11.57%	$847,733,453 22.94%	$3,696,165,985	73.34%	67.63%	91.12%
Employment change 1995-2002 (within cumulative radii)	2.31%	3.35%	6.25%				
(within core and concentric bands)	2.31%	4.07%	8.88%				