EMERGENCE AND IMPACT OF SECONDARY AIRPORTS IN THE UNITED STATES

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Abstract

As major airports in the United States have reached their maximum capacity and became congested, available capacity at surrounding airports has been utilized by the emergence of secondary airports. Airlines have entered service at regional airports in order to capture and stimulate local and peripheral markets, also resulting in the emergence of secondary airports. Given the expectation of a larger number of operations in the National Airspace System (NAS) in the upcoming years, this trend of secondary airport emergence is likely to strengthen.

In order to understand the dynamics of regional airport systems, a study of the factors that led to the emergence of secondary airports was performed. The congestion at the core airport and the distribution of population at the regional level, ground access and airport infrastructure were identified as major factors. The nature of the regional airport system, in terms of percentage of connecting passengers at the core airport, was also identified as a contributing factor. Economic factors influenced the entry of a specific carrier -generally a low-cost carrier- at secondary airports. These carriers stimulated local and peripheral markets. The entries of other carriers –both legacy and low-cost- that followed this initial entry consolidated the airport growth at the emerging airport.

As a consequence of the emergence of secondary airports and their integration into a region wide multi-airport system, impacts are induced on the NAS structure. Recent consolidations of TRACONs (Terminal Radar Approach Control) were identified as primary impacts. With the increasing pressure of demand on core airports in the upcoming years, the development of additional secondary airports will be required. The transition from a single core airport to region wide multi-airport systems and the emergence of new secondary airports in existing multi-airport systems, impose new constraints that need to be taken into account in the future NAS improvements.

1. Introduction

Secondary airports have become increasingly popular, and now constitute viable alternatives for accessing metropolitan areas. In fact, most air travel ticket reservation websites offer the option of searching for flights availability to or from airports located within 50 miles of a major airport. The phenomenon of emergence of secondary airports started in 1950s with the emergence of what is currently J.F. Kennedy airport in New York. This airport served as a second airport in the regional airport system, La Guardia being the core airport. The secondary airport emergence phenomenon was amplified over the last 25 years due to the growth of demand[1] for air transportation and capacity constraints at major airports. Secondary airports have been key mechanisms by which the air transportation system met the growth of traffic in the past.

It is believed that the demand for air transportation will grow in the future. However, the capacity crisis that occurred in 2000 and 2001 with the saturation at key metropolitan airports such as New York La Guardia (LGA) showed the inability of the air transportation system to accommodate growth at key points in the system. The post September 11 hiatus in demand relieved some of the pressure on the system. However by 2005, traffic volume generated by air carrier and commuters have returned to 2000 levels leading to a resurgence of delays [2]. In 2004, over scheduling at Chicago O'Hare airport (ORD) amplified the capacity saturation problem.

In the past, the capacity crisis was amplified by factors such as the average size of aircraft that decreased by 12% between 1990 and 2000. This trend was significantly strengthened after 2000 because major carriers have pulled their oldest and large aircraft out of their fleets during the airlines downturn, starting early 2001, and exacerbated by September 11

[1] Total passenger enplanements [1] have been multiplied by a factor of 2.4 from 294 million in 1978, when the airline industry was deregulated, to 706 million in 2000.

into an industry wide crisis. The increasing use of regional jets by airlines contributed to this evolution. New developments in the air transportation industry, such as the future entry of Very Light Jets (VLJs) and Unmanned Arial Vehicles (UAVs), are suggesting an increase in the volume of operations that the NAS will have to accommodate in the upcoming years.

Increasing capacity at key congested airports is the obvious solution to address the congestion problem. However, the ability to increase airport capacity at these airports is limited due to lack of available space, environmental concerns, ground access and political opposition. In the current FAA Operational Evolution Plan [3] only 3 of the top 15 most delayed airports in 2000 are scheduled to receive runway capacity expansion.

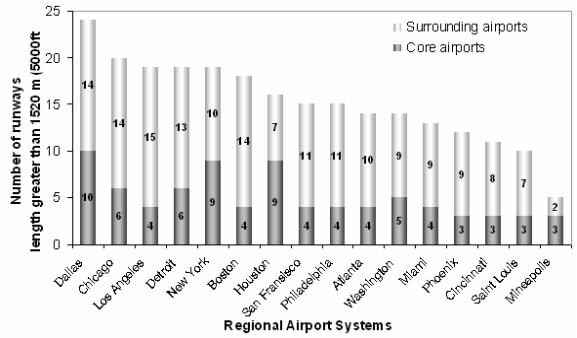


Figure 1. Runway capacity at major regional airport systems (runways longer than 5000 ft)

Even though capacity is limited at core airports, there is available capacity at the regional level. Figure 1 shows the results of an analysis of regional airport system capacity from FAA airport data **Error! Reference source not found.**. This analysis shows that the available capacity at surrounding airports is, on average, twice the existing capacity at core airports. Since many of these surrounding airports are underutilized, secondary airports represent a significant opportunity to increase capacity at the regional level. As a result, it is believed that the increased use of secondary airports is expected to be one of the key mechanisms by which future demand will be met in congested metropolitan areas.

2. Emergence of Secondary Airports

2.1. Methodology

In order to study the dynamics of multi-airport system evolution, a case study approach was undertaken. The 30 highest volume airports in the United States were selected for the case studies. A regional airport system was defined as all airports within 50 miles of the major airport. There were 275 airports identified and studied within the selected regional airport systems. Secondary airports were identified by analyzing traffic shares based on historical records of passenger enplanements from the Federal Aviation Administration Terminal Area Forecasts [1]. Airport traffic shares were computed as the traffic at the airport divided by the sum of traffic at all airports in the regional airport system. Airports with traffic share greater than 1% were considered to be core airports or secondary airports. In addition, the 1% threshold captured generally accepted secondary airports.

2.2 Results

The systematic study of passenger traffic led to the identification of 32 core and secondary airports that met the 1% regional airport system traffic share criteria. These airports were separated into four categories, based on their traffic share and their evolution in the regional airport system:

- **Core airports (Original)**: For the purpose of this study, an original core airport was defined as the initial airport in the region from historical and evolution stand points.
- **Core airports (Emerged):** These airports have emerged while an original core airport was already in place. They grew to a level where traffic now exceeds the passenger traffic of the original core airport.
- **Secondary airports:** A secondary airport was defined as an airport that had a traffic share above 1% but below the traffic share of the core airport.
- **Secondary airports (Re-emerged from an original core airport):** These airports met the secondary airport criteria. However, they were the original core airport in the system. At some point they lost traffic, then regained traffic and re-emerged.

Figure 2 shows the geographical location of the core and secondary airports that were identified.

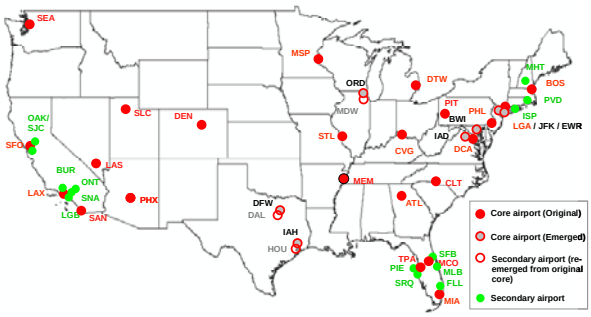


Figure 2. Core and secondary airports in the United States

3. Factors Influencing the Emergence of Secondary Airports

The identification of secondary airports triggered the need to understand the reasons that led one particular underutilized airport to emerge as a successful secondary airport rather than another closely located airport. A systematic study of factors such as demographic, socio-economic, infrastructure, business and airline operational behaviors were conducted for all multi-airport systems that were identified.

3.1. Congestion of the Core Airport

Airport delays are an essential component of the level of service observed at the airport. Historical data of delays were used to quantify the congestion at major airports. This data set was then compared with location of secondary airports. Table 1 shows the results of this comparison. It was found that there is a correspondence between the congestion of the core airport and the existence of secondary airports in the regional airport system.

Airport Code	Airport Name	Operations delayed	Existence of secondary airport
LGA	LaGuardia	15.6%	Yes
EWR	Newark	8.1%	Yes
ORD	Chicago	6.3%	Yes
SFO	San Francisco	5.7%	Yes
BOS	Boston	4.8%	Yes
PHL	Philadelphia	4.5%	
JFK	Kennedy	3.9%	Yes
ATL	Atlanta	3.1%	
IAH	Houston	2.8%	Yes
DFW	Dallas/Ft.Worth	2.4%	Yes
PHX	Phoenix	2.2%	
LAX	Los Angeles	2.2%	Yes
IAD	Dulles	2.0%	Yes
STL	St. Louis	1.8%	
DTW	Detroit	1.8%	
CVG	Cincinnati	1.5%	
MSP	Minn./St. Paul	1.3%	
MIA	Miami	1.1%	Yes
SEA	Seattle	1.0%	
LAS	Las Vegas	0.8%	
DCA	Reagan National	0.8%	Yes
BWI	Baltimore.-Wash.	0.7%	Yes
MCO	Orlando	0.6%	Yes
CLT	Charlotte	0.6%	
PIT	Pittsburgh	0.4%	
SAN	San Diego	0.3%	
DEN	Denver	0.2%	
SLC	Salt Lake City	0.2%	
TPA	Tampa	0.2%	Yes
MEM	Memphis	0.0%	

Table 1. Delays (in 2000) at core airports and presence of secondary airports

It is believed that the congestion of the core airport creates externalities and degraded level of service resulting in a decreased attractiveness of the airport to both airlines and passengers. This decreasing attractiveness of the core airport induces an increase of the attractiveness of closely located and underutilized airport that do not exhibit the same congestion problems increasing the probability of emergence of a secondary airport.

3.2. Air Carrier Entries at Secondary Airports

It was found, from the case studies, that the entry of a specific carrier –generally a low-cost carrier- was correlated with the emergence of secondary airports. Figure 3 illustrates, with the example of the Boston regional airport system, the entry of Southwest airlines at both Providence and Manchester respectively in 1996 and 1998 and its impact on passenger traffic.

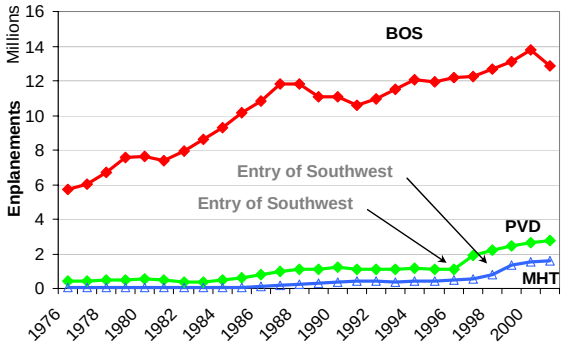


Figure 3. Impact of Southwest entry in New England [1]

In the case of Manchester, the year to year growth in passenger enplanements was on average 6% from 1990 to 1997. After the entry of Southwest in 1998, this average year to year growth grew to 45% from 1998 to 2000. The same phenomenon occurred in the case of Providence airport. This analysis of the entry of low-cost carriers has been performed for all regional airport systems with secondary airports. In the vast majority of the cases, Southwest (Table 2) was responsible for the emergence of the identified secondary airports.

Secondary airport	Low-cost carrier	Year of entry
Chicago Midway (MDW)	Midway	1979
	Southwest	1985
Fort Lauderdale (FLL)	Southwest	1996
Providence (PVD)	Southwest	1996
Manchester (MHT)	Southwest	1998
Orlando Sanford (SFB)		
Melbourne (MLB)		
St Petersburg (PIE)		
Sarasota (SRQ)		
Oakland (OAK)	Southwest	1989
San Jose (SJC)	Southwest	
Burbank (BUR)	Southwest	1990
Ontario (ONT)	Southwest	1985
Orange county (SNA)	Southwest	1994
Long Beach (LGB)	jetBlue	2002
Islip (ISP)	Southwest	1999
Baltimore (BWI)	Southwest	1993
Newark (EWR)	People Express	1980
Dallas (DAL)	Southwest	1971
Houston (HOU)	Southwest	1972

Table 2. Entries of air carriers at secondary airports

The entry of a low-cost carrier was identified having a stimulating effect in the emergence phenomenon. Before the entry of a low-cost carrier, secondary airports offered high fare service. However,

the entry of a low-cost carrier, with its low fares changed this situation. In the case of Manchester airport (Figure 4), where Southwest Airlines entered in 1998, the average aggregate yield at the airport level dropped by 27% between 1997 and 1999, while the enplanements increased by 154%. The impact of the entry of a low-cost carrier on fares was termed the "Southwest effect" [6] in 1993, by the FAA Office of Aviation. However, this effect was only studied and demonstrated at the route level between airports that are part of the Los Angeles and San Francisco airport systems. In the case of both Manchester, and Providence the impact of the entry of a low-cost carrier on the global level of service is clearly observed at the airport level.

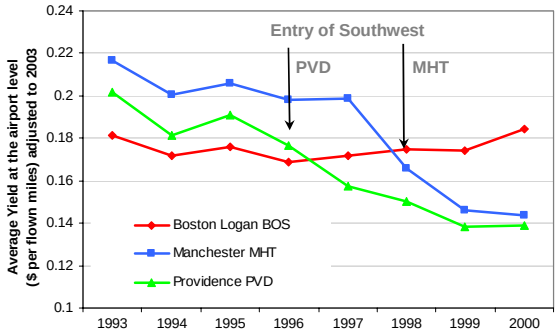


Figure 4. Average yield at the airport level for BOS, MHT, and PVD

Following the entry of Southwest in 1998 in Manchester, several other carriers, such as Northwest, Continental, Delta and ACA, started service at this airport (Figure 5). This dynamics was also observed at other airports such as Providence, Baltimore, Islip, etc.

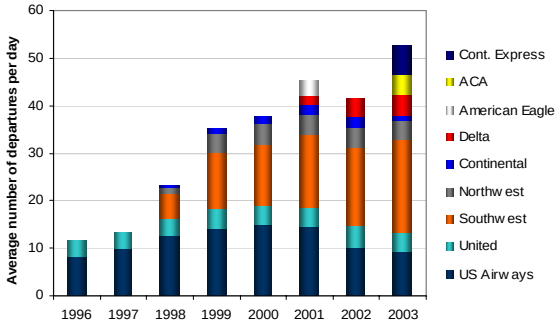


Figure 5. Traffic share [7] of airlines operating at Manchester airport (MHT) from 1996 to 2003

These subsequent entries changed the airport dynamics by increasing the level of competition at this airport which was found to be significant factor influencing the success of the emergence of secondary airports.

3.3. Distribution of Population

In order to study the role of population distribution in secondary airport emergence, systematic studies were conducted for each of the core and secondary airports identified in this study [9]. Figure 6 shows the distribution of population around Boston Logan airport. It was found that population is concentrated within 20 miles, where there is a local basin of 2.7 million inhabitants. The distribution of population around secondary airports is slightly different. In the case of Providence airport, the majority of the population was found in the 30 miles to 50 miles range and corresponds to the core metropolitan area basin of population. However, there is also a local basin of population in the closer range 0 to 20 miles of the secondary airports. A basin of 1.3 million inhabitants, almost half of the Boston population basin, surrounds Providence airport.

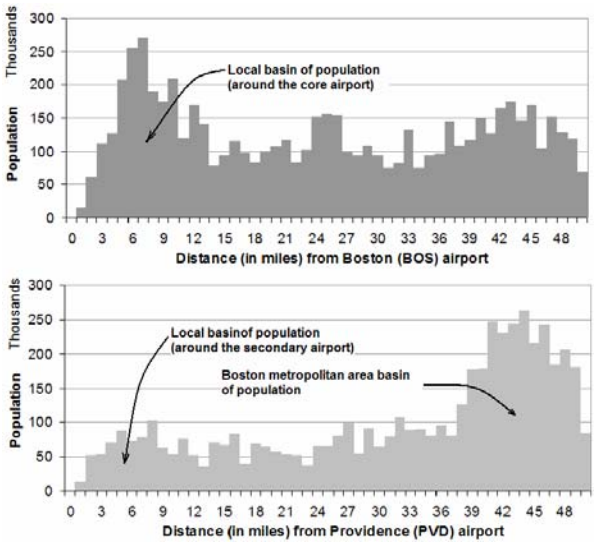


Figure 6. Distribution of population around the BOS and PVD

In order to quantitatively assess the relative size of the local basin of population around key airports, a systematic analysis was performed. The analysis was based on a gravitational model that solely included the distribution of population as input. FAA Form 5010 airport database was utilized and a set of 900 airports (all airports with a runway longer than 5500ft) was taken as reference. Using a database containing more than 65,000 geographical divisions (tracts) of the continental U.S. [9], the population corresponding to each tract was assigned to the closest airport. The results of this distribution model give the size of the local basin of population for each airport. Table 3 gives a summary of airports with the relative size of their local basin of population. It was found that in regional airport systems that feature an original and

emerged core airports (i.e. New York, Washington) the original core is surrounded by the largest local basin of population and the emerged core airports are located in areas with lower local basin of population. The observation is easily explained by the evolution of the multi-airport system. The original core airport was located downtown where the densities of population are large. When this airport reached saturation, airports further away from the city center emerged. These airports were surrounded by lower density of population areas.

Type of Regional Airport System	Region	Airports and population share							
Multi Core	New York	**LGA**	**JFK**	**EWR**	*TEB*	MMU	FRG	BLM	**ISP**
		32%	**18%**	**15%**	*11%*	8%	7%	5%	**5%**
	Washington	**DCA**	**BWI**	MTN	HEF	JYO	**IAD**	ESN	
		39%	**22%**	14%	9%	7%	**6%**	4%	
Single Core *(Centralized)*	Boston	**BOS**	**PVD**	*BED*	ORH	ASH	**MHT**	PSM	
		38%	**20%**	*16%*	11%	6%	**6%**	4%	
	San Francisco	**SFO**	**SJC**	**OAK**	APC				
		31%	**27%**	**24%**	18%				
	Miami	**MIA**	OPF	FXE	**FLL**	BCT			
		34%	24%	20%	**12%**	11%			
	Tampa	**TPA**	**PIE**	LAL	**SRQ**	BKV			
		29%	**25%**	19%	**16%**	11%			
Single Core *(Decentralized)*	Los Angeles	**LGB**	**BUR**	**SNA**	**LAX**	*VNY*	**ONT**	CNO	CMA
		24%	**17%**	**15%**	**14%**	*10%*	**8%**	7%	2%
	Orlando	*ORL*	**SFB**	ISM	**MLB**	TIX	DED	**MCO**	
		40%	**16%**	14%	**12%**	7%	6%	**6%**	
	Chicago	**MDW**	**ORD**	DPA	GYY	UGN	LOT	RFD	ARR
		31%	**26%**	10%	10%	8%	7%	4%	3%
	Dallas	ADS	**DAL**	RBD	FTW	**DFW**	TKI	DTO	MWL
		22%	**17%**	15%	14%	**12%**	5%	5%	4%
	Houston	SGR	**HOU**	**IAH**	EFD	CXO	GLR		
		30%	**24%**	**22%**	14%	7%	3%		

Core airport (original) — **Secondary airport**

Core airport (emerged) — **Secondary airport (re-emerged from an original core airport)**

Table 3. Population share at airports with runways longer than 5500 ft

Airport systems like Boston, San Francisco, Miami, and Tampa did exhibit the same evolutionary dynamics. As a result, identical patterns are observed. The original core airport is surrounded by the largest local basin of population, whereas the secondary airports are located at the periphery of the metropolitan area, surrounded by smaller local basin of population than the original core airport.

In the case of regional airport systems that feature emerged core airport and a secondary airport (re-emerged from an original core airport) the airport/population distributions are different. The core airport (emerged) is surrounded by weak local basin of population due to its location at the periphery of the metropolitan area, whereas secondary airports have strong local basin of population compared to the emerged core airport. This observation was explained by their historical role as original core airport. These airports are generally located close to the center of the city. Due to their inability to accommodate growth in the past, their operations were transferred to a larger airport that became the emerged core airport. However, due their central location and strong local basins of population that are attractive to airlines, these airports re-emerged.

3.4. Airport Infrastructure

Runways are the most constraining element in an airport system, as it defines the type of aircraft allowed to use this airport. Typically, wide body aircraft require a 7000 ft to 10,000 ft runways. As the size of the aircraft gets smaller, runway length requirement become less severe. Narrow body jets can operate at airports featuring runways from 5500 ft to 6900 ft. Interestingly, even though regional jets can carry less passengers than narrow body jets, they require runway lengths to range from 5000 ft to 6800 ft. Turbo props can operate at airports with smaller runways (3500 ft to 4500ft). Aircraft performance requirements limit the access to airports where infrastructure is sufficient.

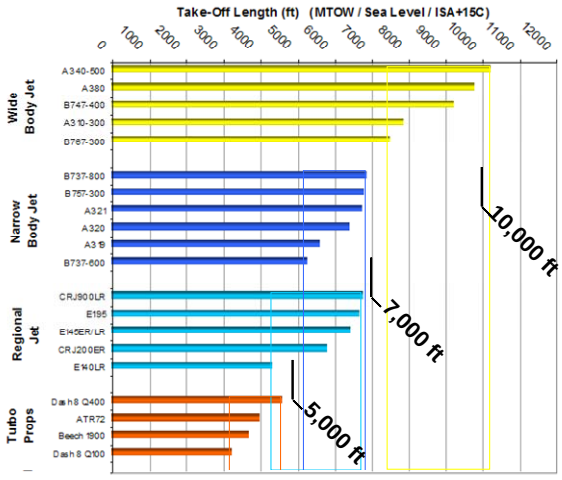


Figure 7. Take off field length [4] and runway length [10] (case: Boston region)

Figure 7 shows the comparison between available runway lengths at all airports within 50 miles of Boston Logan, and the take-off field length of four categories of aircraft. Boston Logan (BOS) and Pease (PSM) are able to handle most wide body aircraft and all smaller type of aircraft. The next group of airports composed of Manchester (MHT), Providence (PVD),

Bedford (BED), and Worcester (ORH), with 7000 ft runway length, can't handle wide body aircraft, however narrow body and smaller aircraft are able to operate at these airports. The remaining airports do not have suitable runways for narrow body jets, but 6 airports offer sufficient infrastructure to host turbo props.

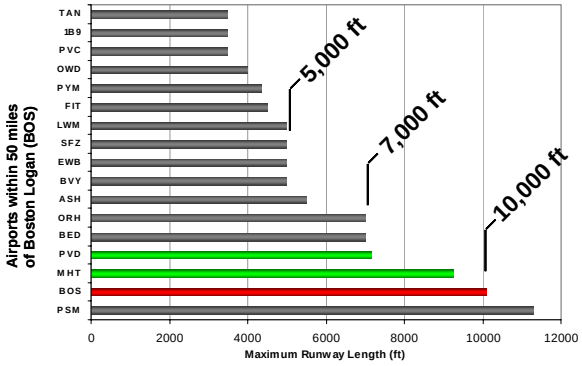


Figure 8. Take off field length [4] and runway length [10] (case: Boston region)

From the analyses of other multi-airport systems, it was found that secondary airport runway length ranged from 5700 ft in the case of Orange County (SNA) to 12,200 ft for Ontario. Therefore, in order to emerge as a secondary airport, an airport does not need long runways since SNA is able to handle 4 million enplanements per year with only one usable runway of 5700 ft. Therefore the current set of airports, which possess one or more runways with length greater than 5700 ft constitute potential secondary airports of the future.

3.5. Connecting Passengers at the Core Airport

From a location stand point, it was found from Figure 2 that secondary airports were generally located on the coasts of the United States and secondary airport that re-emerged from an original core airport were located inland. It is believed that the emergence of secondary airports is more likely to happen at an airport where connecting passengers are not predominant. Figure 9 shows that simple secondary airports emerged around core airports that had low level connecting passenger (below 25%).

It is thought that a secondary airport is less likely to emerge close to a major connecting hub because it is more challenging for the emerging airport to compete in terms of service. This is especially true when the local demand is not strong and the core airport relies heavily on connecting passengers. The case of the St. Louis region illustrates this dynamics. The failure of the St. Louis Mid America airport was partially due to the fact that Saint Louis is a transfer hub with 64% of its passengers connecting. In addition, a low-cost carrier (Southwest) already operated at the core airport, which made it difficult for the secondary airport to be significantly more competitive.

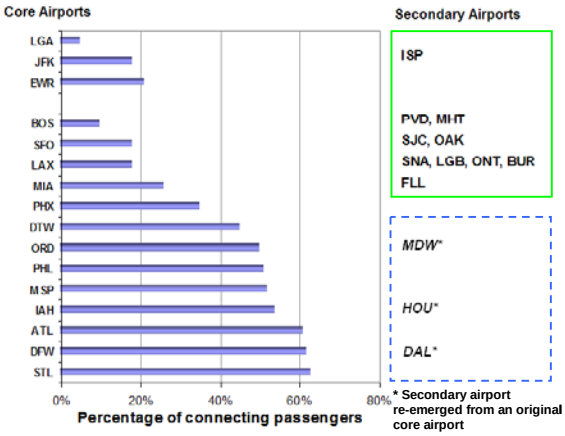


Figure 9. Degree of connectivity at the core airport and presence of secondary airports [11]

The only secondary airports that are found close to core airports with high level of connecting passengers are secondary airports that re-emerged from an original core airport (e.g. Chicago Midway (MDW), Houston Hobby (HOU) and Dallas (DAL), located inland close to a major hub airport Chicago O'Hare (ORD), Houston International (HOU) and Dallas Fort-Worth (DFW) respectively). These airports were able to reemerge because they had a location advantage compared to the emerged core airports.

4. Synthesis: Regional Airport System Dynamics Model

The model was built based on the standard system dynamics approach using stock and flow diagram and causal loops. The factors that were identified in the analysis of emergence of secondary airports were included in the causal loops. As shown in Figure 10, the model is centered on two main composite variables;

- the airport attractiveness to airlines
- the airport attractiveness to passengers

These composite variables are also included into four major loops that capture the core dynamics of the system:

- **The airport growth loop:**

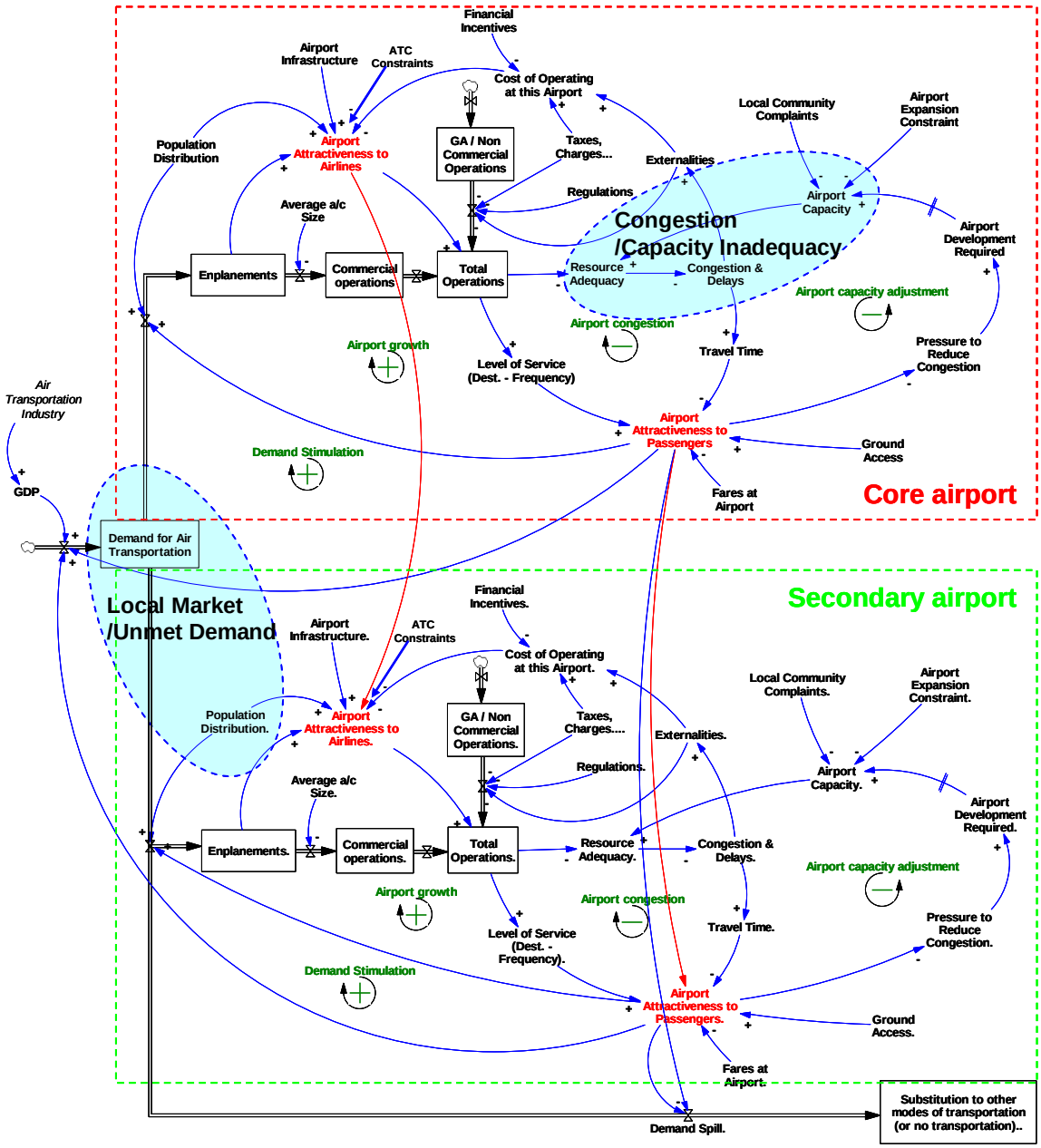
Starting from the variable "level of service", an improvement in level of service at an airport will increase the attractiveness of this airport to passengers. In passenger choice models, the relative attractiveness

of transportation modes dictates the market share of each mode. If the airport becomes more attractive, it is likely to capture demand that was "flowing" to other modes. This excess of demand will translates into an increased airline capacity and level of service. This loop is a self reinforcing loop and will be triggered until a balancing loop limits its strength.

- **The demand stimulation loop:**

Starting from the variable "level of service", an improvement in level of service at an airport will increase the attractiveness of this airport to passengers. As it was demonstrated, the level of service at an airport triggers stimulation of demand for air transportation. If the airport is able to accommodate this new excess demand, it will materialize into passenger enplanements. Assuming that airlines are willing to keep high load factors, a capacity adjustment will be performed, leading to an increase in the number of operations. This upsize adjustment of capacity translates into increased frequency and/or new destinations, which in turn increases the overall airport attractiveness to passengers. As described, this loop is a self reinforcing loop and will be triggered until a balancing loop limits its strength.

Figure 10. System Dynamics model of the multi-airport system.



- **The airport congestion loop:**

The key variable in the airport congestion loop is the resource adequacy, defined as the difference between the airport capacity and annual operations. Thus the lower the resource adequacy, the more likely the airport will incur high delays. Delays are also a measure of airport attractiveness to passenger since they influence the door to door travel time. When airport attractiveness diminishes, some passengers will choose other modes of transportation, thus limiting the growth in the number of enplanements and operations. When the airport growth loop remains active and the resource adequacy diminishes (with constant capacity) the congestion loop will balance the growth and level off the number of operations at the airport to a level of delays that passengers will be willing to bear.

- **The capacity adjustment loop:**

In the previous loop, we have assumed that the capacity of the airport remained constant in time. As the attractiveness to passenger decreases, there will be more pressure to reduce the congestion through airport capacity adjustment. However, there exists a delay in the airport improvement process, due to the time required for planning, design, project approval and construction.

From the structure of the multi-airport system, two models explaining the emergence of secondary airports were found. Figure 10 shows these two subparts on the system dynamics model:

- **the core airport congestion model** (lack of supply)
- **the local market demand model** (excess/unmet demand)

The *core airport congestion model* is triggered by the lack of supply (capacity) at the core airport. It negatively impacts the attractiveness of the core airport to passengers which translates into an increase in regional airport attractiveness to passengers. This increased attractiveness will only materialize in actual traffic if an airline enters service at this airport. This dynamics includes several of the factors that were identified; lack of capacity at the core airport, availability of capacity at the regional level, airport infrastructure, entry of a low-cost carrier (and subsequently legacy carriers), nature of the core airport, etc.

The *local market demand model* is triggered by the unmet demand at the local level. It directly impacts the attractiveness of the secondary airport to airlines. A carrier willing to enter this market and serve this unmet demand will trigger both the stimulation and the airport growth loops, resulting in the emergence of the secondary airport. This dynamics includes several of the factors that were identified; availability of capacity at the regional level, airport infrastructure, distribution of population, size of the local basin of population, air carrier entry (and subsequently other carriers), etc.

5. Implications of the Emergence of Secondary airports

5.1. Implications at the Regional Level

The emergence of secondary airports and more generally the transition from a single airport system to a multi-airport system modify the dynamics at the regional level. Secondary airports offer both advantages and disadvantages depending on stakeholder perspective.

As it was demonstrated, in most cases secondary airports are a response to congestion at core airports. From this perspective, the newly emerged airports relieve core airports by diverting traffic while providing additional capacity to the system. From a passenger stand point, the expanded set of regional airports with service provides new options of travel, which translates into better access to air transportation for suburbs and neighborhood towns' residents. In general, passengers originating from the local basin of population have a facilitated access to air transportation since they avoid congested highways often serving the core airport (e.g. Los Angeles region, Boston region). As it was demonstrated earlier, in addition to relieving the core airport, often, secondary airports and their new service stimulate a local market. From a regional economy development stand point, the new airport activity not only provides direct employments, revenues sources for cities from taxes, etc but it also generates indirect impacts by attracting new companies, etc. It is difficult to isolate and quantify the impacts of the emergence of a secondary airport on the local economy since it is usually not the only cause of regional development. In the cases of the emergence of secondary airports based on the combined core congestion and market it is believed that there was a potential for regional economical development before the emergence of the secondary airports.

On the other hand, secondary airports offer several disadvantages. From an environmental stand point, the development of secondary airports increase the population exposure to noise. Long term strategies applied at the beginning of the airport development can reduce these negative impacts by protecting land areas from housing development.

From an airline perspective, the transition from a single airport system to a multi-airport system dilutes the operations, in the case where the same airlines

decide to operate at both airports. This reduces the opportunity for economies of scale. For a network carrier, operating at both the core and secondary airports reduces the efficiency of its network since it cuts the connections. Connecting passengers are less likely to transfer between two airports. It is not cost efficient since it implies ground transportation costs

for passengers and requires additional slack time (between flights) accounting for ground transportation time variability.

5.2. Impact on the Regional Airspace System

The spread of operations has great impacts on the way the airspace is managed. Once traffic grows at secondary airports, interactions between airports appear and airport operations become dependent. In the case of the Boston region, since both Manchester and Providence are about 50 miles away from Boston Logan airport and traffic at secondary airports remains limited, the interactions are still weak (Figure 11).

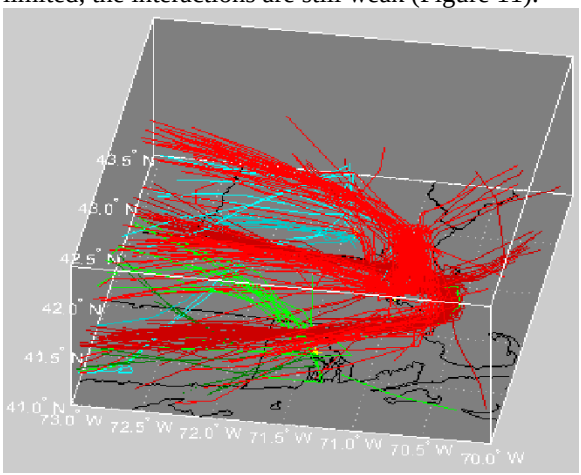


Figure 11. Traffic patterns over the BOS, MHT and PVD (Data source: ETMS)

However, in the case of multi-airport systems where airports are more closely located, this dependence increases. The airports in the New York airport system face operational constraints due to these interactions [12].

The impact of the emergence and growth of secondary airports is illustrated by the recent consolidation of TRACONs (Terminal Radar Approach Control). In 2003, the Potomac TRACON in Washington was the result of the merger of 4 single airport TRACONs that became inefficient because of the greater interactions between Washington National, Washington Dulles, Baltimore and the Andrews Air Force base airports, due to the large increase in operations at both Dulles and Baltimore. The same merger phenomenon also happened in February 2004, in the Boston region, where both Boston and Manchester TRACONs merged in order to run more efficient operations at both airports. Therefore the impact of emergence and growth of secondary airports forces the National Airspace Structure (at least at the TRACON level) to become more centralized. With the emergence of secondary airport, interactions appeared inside regional airport system. As multi-airport systems tend to spread laterally, in addition to being closely located to each other, as this is the case in the North East of the United States, inter-dependence will appear between systems. A new level of centralization may be needed to manage these inter-related multi-airport systems.

5.3. Implications on the National Infrastructure

The inability of core airports to accommodate the growth of demand at the local level has led, in part, to the development of secondary airports and the creation of multi-airport systems. This dynamics implies a decreasing concentration of activity at major airports, but it also implies that the air transportation system relies on a larger set of airports.

From reliability stand point; this trend is actually beneficial since the effects of a disruption of activity at an airport are lower than what they would have been if all activities were located at the same airport. For example, during intense fog conditions due to Los Angeles (LAX) airport's exposure to the ocean, some of the traffic that cannot be handled at LAX is diverted to Ontario airport, a closely located secondary airport. On the other hand, from an infrastructure investment stand point, the expansion of the set of critical airports requires a greater dilution of funds and a more difficult fund allocation process.

5.4. Implications of Multi-Airport Systems at the National Level

The emergence of a new secondary airport implies new connections to the rest of the airport network. For example, the emergence of Providence airport part of the Boston regional airport system has lead to the creation of OD pairs such as PVD-ORD (a secondary to core airport market) and PVD-MDW (a secondary to secondary airport market). These routes are parallel to the core to core airport route; BOS-ORD.

In order to quantify the impact of the emergence of secondary airports on the national air transportation network, a systematic analysis of regional airport systems has be performed, using Form 41 traffic data for the month of March in 1990 and 2003.

It was found that the size of the semi-parallel network -core airport to secondary airport OD pair (or inverse)- has increased from 13 % in terms of

connections, from 439 to 493 connections between 1990 and 2003. More over, the major growth was observed in the parallel network category (secondary to secondary airport OD pairs) where a 49% growth occurred between 1990 and 2003. This phenomenon is mainly due to the emergence and growth of secondary airports in the 1990s (Baltimore, Providence, Manchester, etc). The introduction of new OD pairs between secondary to secondary airports is the result of the strategy of carriers like Southwest that operate largely at secondary airports and connect them together with point to point flights.

6. Conclusion

The emergence of secondary airports is an expression of the adaptation and transformation of the national air transportation system to capacity constraints and market opportunities. Secondary airports have proven to be a viable option for increasing the capacity of regional airport systems in the past. As traffic is expected to grow in the upcoming years the phenomenon of secondary airport emergence is likely to continue and develop in other major metropolitan areas. In addition, current secondary airports will grow to a point where some will become considered as core airports and ultimately become congested. In these regions additional secondary airports will emerge to accommodate this growth.

This study found that the distribution of population at the regional level and the existence and proximity of a secondary basin of population close to secondary airports were major factors influencing the emergence of secondary airports. Airports with runway length as low as 5700 ft, were found to be viable secondary airports. The nature of the regional airport system, in terms of percentage of connecting passengers at the core airport was also identified as a contributing factor. It is believed that secondary airports are not likely to emerge close to a core airport with high connecting traffic unless they compete on a location advantage basis. Most importantly, market stimulation through the entry of a specific carrier - generally a low-cost carrier- was determined to be a key factor in the emergence phenomenon. These entries modify the airport dynamics, in terms of fares and new destinations, resulting in a stimulation of the local and peripheral markets. Following the entry of a low-cost carrier several other carriers, both legacy and low-cost, enter and consolidate the growth of the emerging airport.

However, the transition from single core airport to region wide multi-airport systems and the emergence of new secondary airports in existing multi-airport systems, impose new constraints that need to be taken into account in the management and modernization of the National Airspace System. In addition, the expansion of the set of critical airports impacts the funding and resource allocation for future airport improvements. Extending the operations at a larger number of airports also results in the creation of parallel networks that impact airlines strategies.

The results of this research highlight the need to consider existing underutilized resources as an opportunity to exploit through the emergence of secondary airports. These airports can add significant amount of capacity to the system in addition to enhancing people's access to air transportation. Acknowledging that secondary airports will be key mechanisms for meeting future demand for air transportation, there is a real need for establishing national and regional strategic plans for the development of regional airport systems.

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