Spatial Concentration in Europe Versus the US

From Gini Analysis to Geopolitical Assessment

Liberalization of air traffic in both the US and Europe has resulted in distinct patterns of spatial concentration of traffic distribution on each of the continents. Statistical indices, such as the Gini coefficient, make it possible to measure inequalities in this distribution across airports. Applying this comprehensive measure of traffic to each common market (EU, US) helps to assess today's results of deregulation and to plan airline networks and airports for the future. The same approach can be applied to long-distance or intercontinental flights. The aim of this paper is to account for geopolitically induced differences that can be stressed when comparing traffic distributions across continents. Our research findings show important and potentially far-reaching asymmetries between (Western) Europe and the US for most of the geo-political dimensions. The implications of our analysis for policymaking are outlined in part 3 of this contribution.

By Dr. Hans Huber

The Perspective through Gini

The Gini index, when compared to more conventional indices of concentration such as the Herfindahl Index, has distinguished itself for being particularly useful when measuring traffic distributions inside airline networks. One of its salient features is that it reacts quite well to changes in all parts of its population rather than only its most important ones. The regularly observed unequal, log-like distribution of airline networks is quite well accommodated by Gini. Although one may argue about the proper units of analysis when using the index (some tend to favor passengers or number of aircraft movements, others choose available seat capacity), the adequacy of Gini for measuring traffic concentration across airports is not challenged. In that sense, comparing spatial concentration in Europe against that of the US may be a worthwhile exercise. The analysis might be performed more properly when available-seat-miles (ASM) is used as the unit of analysis to account for general differences in distances within both geographical areas.

Highlighting such geopolitical differences has far-reaching implications on a micro, airport planning level, as well as on planning for multi-modal connectivity alternatives, or, on a macro-political level, when evaluating the risks of bilateral "Open Skies" agreements. Interpreting Gini from such a geopolitical point of view, however, requires decomposing the index further into finer layers of traffic distributions that are particularly relevant to each policy perspective. The most obvious dimensions that come to mind are domestic routes (which would correspond to intra-state routes in the US), routes between the different EU member states against traffic connecting states in the US, and long-distance or intercontinental on both continents. These first results already show striking differences.

We find, in the first table, that considerably fewer US airports serve intra-state air traffic as compared to EU domestic (within the nation state). The difference in concentrations for such traffic is not statistically significant between both geographical areas. This empirical finding confirms the lack of sensitivity of Gini to the size or distance distributions between territories for each geographical area. However, when factoring in distance (see ASM), sensitivity becomes more important: with a 90 percent confidence interval, we can conclude that such traffic is spatially more concentrated under the

Table 1: *Spatial concentration in Europe versus the US for different route-types*

	W.Europe		USA	
Domestic/intra-state	**AS**	**ASM**	**AS**	**ASM**
No. of airports:	448	448	344	344
Unbiased estimator of pop. Gini coeff.:	0.779649	0.811864	0.797211	0.85173
Percentile 95% CI:	0.743091 to 0.801935	0.774797 to 0.832092	0.762265 to 0.816742	0.821402 to 0.867718
Intra-EU/inter-state				
No. of airports:	248	248	354	354
Unbiased estimator of pop. Gini coeff.:	0.79177	0.782314	0.844051	0.872197
Percentile 95% CI:	0.75502 to 0.814007	0.746387 to 0.805907	0.815349 to 0.862681	0.846503 to 0.890034
Intercontinental				
No. of airports:	104	104	64	64
Unbiased estimator of pop. Gini coeff.:	0.850955	0.892231	0.745139	0.788631
Percentile 95% CI:	0.785431 to 0.877977	0.828625 to 0.919577	0.660743 to 0.793833	0.706176 to 0.845027

Legend: AS =available seats, ASM = available seat miles, CI = confidence interval influence of longer intra-state routes in the US. We find that the number of airports serving such routes is some 43 percent higher in the US. On a 95 percent confidence interval, we find such traffic significantly more concentrated in the US in comparison to Europe. Although distance suggests little influence on such traffic concentration in Europe, again it adds to spatial concentration in the US. The results for long-distance/intercontinental routes are also surprising: although the US shows some 38 percent less airports serving long-distance/ intercontinental routes, concentration is significantly higher (90 percent CI) in Europe. Also, we found with Gini that the distribution of such routes across the different airports is the most even of all, given an average value of 0.745 for AS. These findings imply a strong national approach within the European 'Union'. As expected, distance does not stress the difference in concentration between both geographical areas due to the nature of the route. One important conclusion is that European airport hubs depend much more on long-distance/intercontinental routes, whereas spatial concentration in the US seems induced internally (domestically), and is able to take advantage of, on average, longer distances.

Clustering Airline Networks into Strategic Groups

The economic agents that determine these traffic distributions are, of course, the various airline operators. The networks that they operate differ from each other – grouping them along network features [1] into strategic groups is an intermediate step that shows differences in market structure between Europe and the US.

When examining the second table in detail, we find a much more fragmented market structure in Europe, with very small networks. At the other extreme, the largest US networks are significantly bigger than the European ones. There are more very large networks in the US: the largest 7 carriers easily outperform the largest 6 European in terms of monthly departures from their busiest hubs. The number of average routes per AP is significantly higher, and these US carriers show significantly steeper slopes (which indicate a higher spatial concentration) in traffic distribution as well. The case around American Airlines shows significantly more long-distance links than any EU-based airline. More airlines operating smaller networks in the 7 to 25 AP range can be found in Europe, but they show a lower tendency towards spatial concentration. The same number of mid-size carrier networks can be found in the US and Europe (there are 17 of them in either geographical area): European ones show more connections, on average, per airport (4.5 versus 3.2 in the US), although the European ones tend to be less spatially concentrated at their main airports (showing departures in a range of log(2.79 to 2.96) versus a log(3.25) in the US). A final distinctive feature for these 17 mid-sized airline networks is that the US groups show almost no long-distance links as compared to significant intercontinental route service in the EU.

Table 2: *Clustering of airline networks into strategic groups*

W.Europe	**APcount**	**AvLink**	**MaxDep** (log)	**lnSlop**	**IntScop**
JetX [107]	3.14	1.27	0.98	-0.094	2.58
Niki [45]	10.76	2.10	1.87	-0.128	1.73
Air One [25]	25.00	2.88	2.44	-0.089	2.36
SN Brussels [10]	41.20	4.49	2.96	-0.071	16.60
Britannia [7]	46.86	4.49	2.79	-0.052	52.29
Iberia [3]	80.67	4.45	3.36	-0.038	26.33
Air France [3]	90.67	4.43	3.61	-0.037	113.33
USA					
Chicago Express [29]	7.55	2.74	2.38	-0.158	1.59
Ata [8]	23.38	4.15	2.74	-0.096	32.13
MidWest [17]	41.88	3.22	3.25	-0.071	3.18
Mesaba [12]	97.17	6.12	3.42	-0.046	10.25
American [2]	98.50	9.72	4.01	-0.046	184.00
United [5]	102.40	11.60	4.00	-0.037	88.40

Decomposition of Route-Type traffic Distribution along Strategic Groups

In the final step of our analysis, we can now highlight how different strategic groups in both geographical areas manage traffic for distinct route types, i.e. intra-state/ domestic versus inter-state/ intra-European versus intercontinental. Our findings (detailed statistical results can be obtained from the author upon request) can be summarized as follows.

The US geopolitical environment allowed for the emergence of national or even regional hubs that cater to the operations of mostly large, high density networks. They serve larger geographic distances on average and their respective market coverage shows little overlap with airports that are being covered by other strategic groups. Intra-state traffic contributes to higher spatial concentration, which is probably enhanced by distance advantages in a common market. One may argue that this configuration is likely to be adopted in Europe as well, given the longer period for which the US market has been de-regulated. On the other side, the underlying geo-political drivers in Europe (for example: national policies by Member States, etc.) are not likely to change soon and

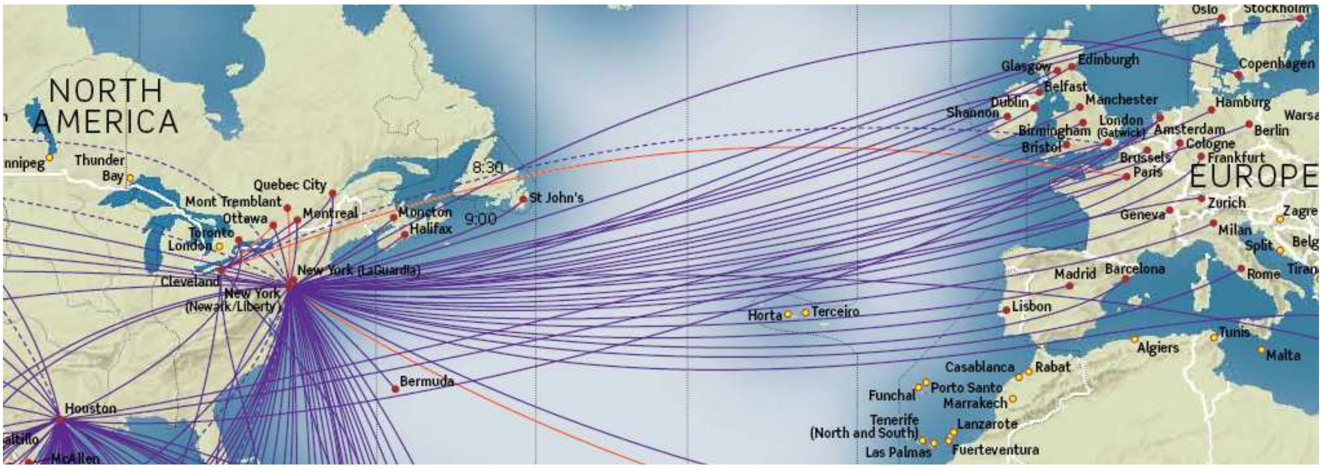

Figure 1: *A part of the route network of Continental. Courtesy of Continental Airlines*

European legacy carriers, who are becoming profitable again, have already been shown to be closely correlated to the spatial patterns observed before. It is suggested that low-cost carriers (LCCs) in the US have been highly instrumental in reshaping the major airlines' route networks. As for Europe, most LCCs are still little-developed in comparison, and many of them are (still) operating from major airports, where economic rents are safe, but where little potential remains to turn these airports into intra-European, low-cost based hubs. Also, the less densely travelled routes in Europe are currently served by highly fragmented medium and small airline networks, which exhibit considerable overlap in terms of airports served. In other words, lack of competition at the big airports between major airlines, along with high rivalry by numerous small players at medium and small airports hinders the emergence of US-like structures.

Much fewer airports serve trans-European routes in Europe, relative to the US, but relatively many serve long-distance and intercontinental (ICA) routes. However, the EU shows a disproportionate *concentration* of intercontinental routes at very few airports compared to the US. This suggests that spatial concentration in the EU is largely induced by intercontinental routes. A very high dependency on intercontinental routes of Europe's biggest airports may imply increased international (geopolitical) vulnerability, compared to the US situation. Of course, such vulnerability would also depend on the specificity for ICA demand, etc. Our research, however, clearly highlights a specific positioning of these EU airports that allocate their scarcest resource (i.e. slot capacity) in a very different way from their biggest US counterparts. This finding further leads to the current discussion (and actual emergence) of dual hub structures of major airlines in Europe. A more specific study may elaborate on the detailed relevancy of ICA dependency and the robustness of operations when faced with shocks on such dual hubs.

Further empirical studies may examine the effects of asymmetrical traffic distributions for airport planning in terms of catchment areas for the different types of routes. The European context appears to offer, at first glance, more opportunities for complementary intra-European multimodal connectivity. However, deploying such alternative technology, i.e. high-speed trains, on longer distances to free capacity for the domestic, shorter distance, flight connections are a path that could easily be contested. Common sense would, a priori, suggest the opposite. The domestic feeder system into intercontinental routes in Europe raises the same questions with regards to the adequate catchment area, and whether the feeder capacity would not be better provided by another mode of transport, rather than by carriers with a dominant market share at the same hubs. This certainly opens up new avenues for fresh research into the integration of European air traffic that, by many accounts, risks missing out on the fundamental opportunities that are presented by a single market.

Reference:

Huber, H., *Comparing spatial concentration and assessing relative market structure in air traffic*, World Conference in Transport Research, University of California at Berkeley (June 2007) – the full article is currently reviewed by academic journals.

http://en.wikipedia.org/wiki/Gini_coefficient.

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Footnote:

1**Size**, i.e. the **number of airports** that are being served within the airline's European network: **APcount**

The **average number of routes** that an **airline serves** from each airport: We constrain this variable to airports and routes inside the geopolitically distinct home markets (i.e. the EU and the US): **AvLink**

Traffic distribution among airports inside the airline network can be approximated by a log-linear relationship of monthly departures by decreasing airport rank order. Two variables allow defining this traffic distribution: the **most heavily travelled airport** inside the airline network (log-value of monthly departures of carrier) present a y-intercept: **MaxDep**; whereas the log-linear plot of its rank-ordered distribution provides the **slope variable**: **lnslop**

The **number of intercontinental links** of an airline at its **best connected airport** is important for two reasons: a) it exemplifies the feeder-hub logic of many airline networks, and b) it may be an element of market power that transcends the geopolitical scope within a liberalized and/ or unified market in the EU and the US: **IntScop**