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“Now everyone can fly”? Scheduled airline services to secondary cities in Southeast Asia



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ABSTRACT

Since the late 1990s, almost no world region has experienced faster air traffic growth than Southeast Asia. Much of that growth is attributable to new low-cost carriers (LCCs), which collectively accounted for nearly half of scheduled airline capacity on routes from Southeast Asian cities in 2013. Yet despite the expansion of traffic and the proliferation of carriers, airline traffic remains strongly concentrated in the key hubs of Bangkok, Singapore, Jakarta, Kuala Lumpur, Ho Chi Minh City, and Manila. Similarly, trunk routes, defined as sectors with more than 0.01 percent of global airline capacity, continue to account for 54 percent of all seat capacity in the region. LCCs have helped to perpetuate these imbalances as budget airlines like AirAsia have disproportionately favored already well-served markets. Such patterns are important because aviation plays an outsized role in Southeast Asian intercity transportation and in its economic development. The analyses reported here indicate that while the growth of aviation since the late 1990s has been impressive, that growth so far has not done much to improve Southeast Asia's entrenched patterns of spatial inequality.

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1. Introduction

Ranked by scheduled airline capacity, several Southeast Asian routes are among the most densely trafficked in the world. The corridors between Singapore and three other regional capitals – Jakarta, Bangkok, and Kuala Lumpur – have been leading routes for decades, but now there are new aerial arteries in the region such as the link between Jakarta and Surabaya. Measured by scheduled seats per week, the Indonesian domestic trunk route rose from being the 330th busiest city-pair in the world in 1998 to 10th in 2013, two places above Chicago–New York City (Author's analysis of OAG, 1998 and OAG, 2013). The Jakarta–Surabaya link is emblematic of a region in which air traffic has grown faster since the 1990s than in any other large part of the world except South & Central Asia (Fig. 1). Yet few analyses of air transportation networks in Southeast Asia have been published, and the studies that have been produced mainly concern the region's key hubs and are rather dated in light of the recent explosive growth of air traffic (e.g., O'Connor, 1995; Bowen, 2000; Rimmer, 2000), or the analyses subsume Southeast Asia in the larger Asia–Pacific region within which developments in China and the rest of Northeast Asia

predominate (e.g., Bowen, 2014b; O'Connor and Fuellhart, 2014; Vowles and Mertens, 2014).

This article focuses squarely on Southeast Asia, which is defined to include the 10 members of the Association of Southeast Asian Nations (ASEAN) and Timor-Leste (Fig. 2), and examines how growth through 2013 has altered the geography of air services in the region. In particular, how have the places historically marginalized in the region's transport systems been affected by the recent flourishing of the Southeast Asian airline industry? Cities such as Singapore and Bangkok have long been globally significant hubs, but in their hinterlands even moderately large cities have had weak services. Has recent growth ameliorated uneven patterns of accessibility?

The title of the article, “Now everyone can fly”, comes from the advertising slogan of AirAsia, a Malaysia-based low-cost carrier (LCC). The airline has emerged as one of the most influential in a region long dominated by the likes of Singapore Airlines and Thai International. Its low fares have made air travel affordable for the first time to a growing proportion of Southeast Asia's middle class (Ahmad, 2010). The same is true across much of the region, including Indonesia, where by 2013 among the airlines plying the aforementioned Jakarta–Surabaya route were Lion Air, Citilink, and AirAsia Indonesia – three relatively new LCCs. The lower fares ushered in by budget airlines have undoubtedly made air travel

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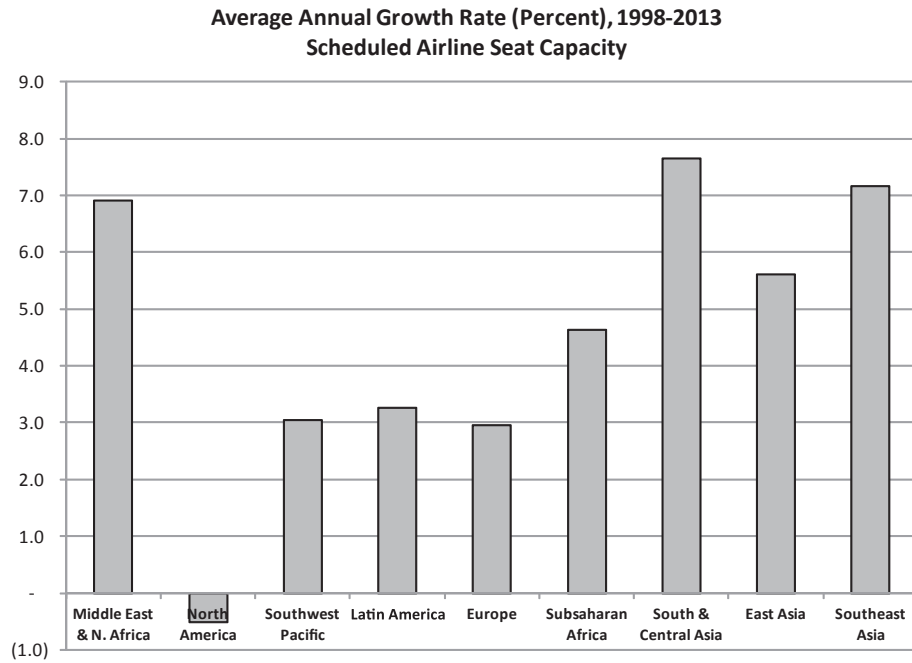


Fig. 1. Scheduled Airline Capacity Growth by Region, 1998–2013. Scheduled departure seat capacity per week for all carriers combined. Sources: OAG (1998, 2013).

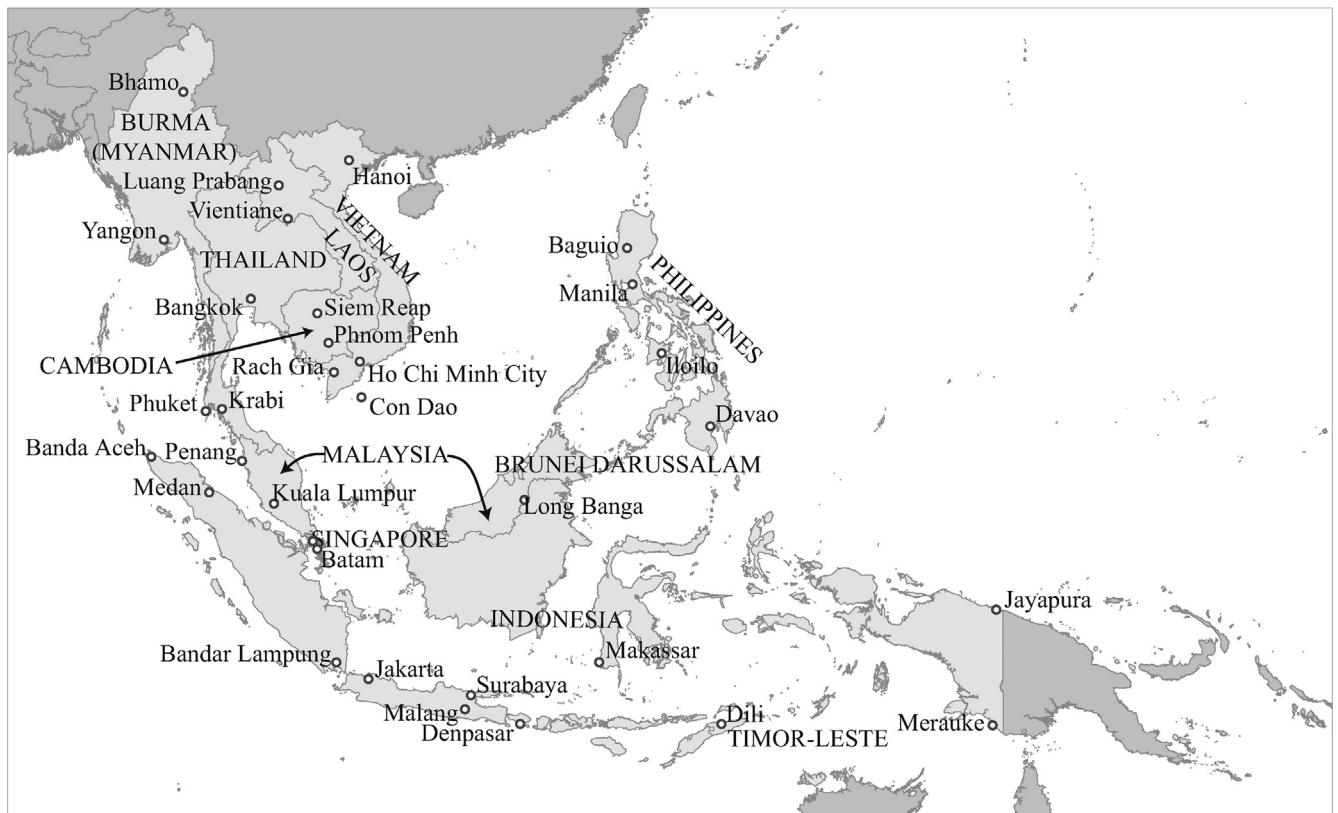


Fig. 2. Southeast Asia. The labeled places are mentioned in the text.

more accessible for more people in the region, but to what degree do the networks of these and other airlines extend to the region's periphery (defined as communities away from the core urban regions of Bangkok, Singapore, Jakarta, Kuala Lumpur, Manila, and Ho

Chi Minh City)? The analyses below answer this question.

Since the 1990s, numerous studies have used the air transport system as a means of discovering the architecture of the world city system and patterns of power in the global economy (e.g., Cattan,

1995; Smith and Timberlake, 2002; Bowen, 2002; Derudder et al., 2008; Taylor et al., 2009; Mahutga et al., 2010; Neal, 2010) including analyses of Asia in particular (Shin and Timberlake, 2000). Yet such studies focus on very large cities, especially the command and control centers that mediate the flows that define globalization. In the present article, the lens is shifted to encompass and engage with smaller cities in a developing region.

More specifically, this study assesses the network accessibility of Southeast Asian cities within the global airline industry in 1998, 2003, 2008, and 2013. The purposes of these analyses are to measure how the accessibility of different kinds of cities (e.g., hubs versus peripheral communities) changed over time measured both by seat capacity and network position, and separately to identify the impact of LCCs upon the periphery. The resulting analyses of network change provide evidence for the effects of domestic and international deregulation of aviation in Southeast Asia.

The remainder of the article is organized in seven sections. First, the present study is situated within the literature on airline network change, deregulation, and low-cost carriers – especially in Southeast Asia. Second, the data sources and methodology for the analyses are presented. Third, the distribution of scheduled airline seat capacity in Southeast Asian cities over the period 1998–2013 is described. Fourth, patterns of accessibility in the region are analyzed via network analysis. Fifth, the special role of low-cost carriers in the region's airline industry developments is explored. The penultimate section highlights the implications of the quantitative results. Finally, some conclusions and ideas for further research are offered.

2. Deregulation, competition, and airline network change in Southeast Asia

The deregulation of aviation in Southeast Asia began in the 1990s (Bowen and Leinbach, 1995; Hooper, 1997). In the region's larger domestic markets, new carriers including Grand Air in the Philippines and Sempati Airways in Indonesia, were allowed to compete alongside well-entrenched state-owned airlines. Hooper (1997) argues that this shift in domestic policy across Southeast Asia was driven by the inability of the incumbents to keep pace with demand – especially from the tourism sector – and by a kind of demonstration effect fostering the global spread of airline deregulation. Additionally, the political environment in much of Southeast Asia was conducive to deregulation as a means of promoting economic growth (Bowen and Leinbach, 1995).

The new entrants looked to the higher-yielding international market to balance loss-making domestic routes, but the deregulation of international routes was more laborious given the inertia inherent in the bilateral system of air service agreements (Bowen, 1997; Hooper, 1997). Nevertheless, opportunities for new carriers were opened in the 1980s and 1990s through the spread of liberalization from Asia's more developed economies (Bowen and Leinbach, 1995). As economies such as Taiwan and South Korea pushed for multiple designation in their bilateral air service agreements so that new carriers such as EVA Airways and Asiana, respectively, could expand, reciprocal traffic rights were created for existing and prospective secondary carriers in Southeast Asia.

Nevertheless, few of the new entrants survived for long; neither Grand Air nor Sempati lasted past 2000, for instance. The traffic slump during the Asian Financial Crisis (1997–1998) was particularly difficult to weather (Sadi and Henderson, 2000; Hooper, 2005); but ironically that same crisis proved catalytic to the flourishing of many more new airlines in Southeast Asia because national governments further deregulated the industry to spur tourism and economic recovery (Zhang et al., 2008). And so in the five years after 1998, the number of scheduled passenger airlines

Table 1
Airlines by domicile in Southeast Asia, 1998–2013.

	1998		2003		2008		2013	
	All	LCCs	All	LCCs	All	LCCs	All	LCCs
Brunei	1	0	1	0	1	0	1	0
Cambodia	3	0	4	0	4	0	2	0
Indonesia	5	0	12	3	10	3	12	3
Laos	1	0	1	0	1	0	2	0
Malaysia	6	0	2	1	5	2	5	3
Myanmar	2	0	4	0	5	0	5	0
Philippines	5	2	6	2	6	3	8	6
Singapore	2	0	2	0	5	3	6	3
Thailand	2	0	6	2	9	2	10	3
Timor-Leste	NA	NA	0	0	0	0	1	0
Vietnam	2	0	2	0	4	0	4	2
Total	29	2	40	9	50	15	56	20

Sources: OAG (1998, 2003, 2008, 2013). Low-cost carriers classification based principally on ICAO (2014). See Section 6 for explanation. Airline counts are from March or April of the respective year.

domiciled in Southeast Asia rose by more than 35 percent (Table 1), with many of the new entrants positioning themselves as low-cost carriers, including Lion Air (2001) and Adam Air (2002) in Indonesia; Tiger Airways (2003), Valuair (2004), and Jetstar Asia (2004) in Singapore; and the revamped AirAsia (formed as a government-linked airline in 1996 but then relaunched as a privately owned low-cost carrier in late 2001) (ICAO, 2014).

The emergence of AirAsia and other new budget airlines in early 2000s sparked greater interest in the region's airline industry, including several early evaluations of Southeast Asia's prospects for low-cost carriers (Dietlin, 2004; Kua and Baum, 2004; Hooper, 2005; Zhang et al., 2008). Compared to Europe, North America, and other advanced markets, Southeast Asia seemed to present limited opportunities for LCCs given the low number of potential short-haul markets, the competitive strengths of the incumbents, the greater importance of cargo and business travelers in the region's traffic, and the lack of lower-cost secondary airports to use as gateways to the main metro areas. Nevertheless, these initial assessments were at least guardedly optimistic about LCCs in a region with a rapidly growing middle class.

As in other global markets, the rise of LCCs has brought substantial gains to Southeast Asian consumers; Manuela (2007), for instance, found that deregulation in the Philippines had increased the number of routes with at least two competitors and that on such routes fares per kilometer were 10 percent lower than on monopoly routes. In a more specific example, one way fares on the Kuala Lumpur-Singapore route were just under US\$150 when it was largely a duopoly shared by Malaysia Airlines and Singapore Airlines; but within a few months of the route being deregulated in 2008, the average fare fell to US\$80 and the two main LCCs on the route (AirAsia and Tiger Airways) offered seats at much lower prices (Zhang et al., 2008; Hanaoka et al., 2014). The route in this example is among the busiest in the world (and was before deregulation, too), but the research presented below examines the role of LCCs and other carriers on routes beyond the main hubs.

The region's air transport liberalization is now moving into a new, multilateral phase. In 2004, transport ministers from ASEAN agreed to integrate and liberalize air services in a series of stages to 2015 (Tan, 2010). Over the next several years, negotiations culminated in the Multilateral Agreement on Air Services (MAAS) signed in 2009 and the Multilateral Agreement for the Full Liberalization of Passenger Air Services (MAFLPAS) signed in 2010. MAAS was intended to eliminate restrictions on third, fourth, and fifth freedom traffic among ASEAN capitals, and MAFLPAS was designed to do the same for all other cities in the region. Yet as Tan (2014)

explains, Indonesia and the Philippines did not accede to the first agreement, and neither Indonesia nor Laos joined the second. Recently, Indonesia has agreed to MAAS leaving only Manila out of the capital city liberalization (Arnaldo, 2015), but capacity constraints in Jakarta effectively limit competition from new entrants¹. More broadly, multilateral air services liberalization in Southeast Asia remains an incomplete patchwork rather than the sweeping integration of the Single Aviation Market in Europe. Further, even in those ASEAN countries which have participated in both agreements, the scope of rights conferred to carriers is narrower than in Europe (Tan, 2010).

The effect of deregulation on network changes is discussed below. There have been few previous studies of airline networks in Southeast Asia and those that have been published tend to focus on the region's main hubs. For instance, O'Connor (1995) explored the advantages of Bangkok, Hong Kong, and Singapore. He concluded, based on analysis of scheduled networks in 1970 and 1990, that Hong Kong was best positioned in terms of its centrality within Asia and its intermediacy along the main intercontinental corridors, but also found that Singapore's skillful use of bilateral agreements had augmented the importance of Changi Airport. Secondary cities played little role in his analysis except as places (ironically including Surabaya mentioned at the beginning of this article) rendered less important by the development of longer-range aircraft.

Bowen (1997) examined the development of the region's airline networks more generally between 1979 and 1997 and highlighted the proliferation of international linkages within the region and the increased number of gateway cities with nonstop international services. These changes were attributed to government policy and the emergence of new airlines – themes that are also central to the present article. Nevertheless, in no country across the region was the main gateway's share of international capacity less than 60 percent in 1997. In the analyses below, I examine whether the dominance of gateways like Bangkok and Jakarta has lessened in the nearly two decades since the end of the earlier study period.

In any case, both O'Connor (1995) and Bowen (1997) explored the region's networks before the liberalization and restructuring of the region's air transportation sector that has unfolded since the mid-1990s. A new assessment of network change in Southeast Asia is well-warranted.

3. Methodology

The analyses that follow are based on data drawn from editions of the Official Airline Guide (specifically, the searchable OAG Max database) from April 1998, March 2003, and April 2008, and a comparable customized OAG dataset from March 2013. The period encompassed by these data provides good coverage of the airline industry from the Asian Financial Crisis through the recent flourishing of LCCs and deepening liberalization. In all four time periods, data were collected by airline and city-pair for frequency and seating capacity on all scheduled, nonstop passenger airline routes (including those terminating both inside and outside the region) for a 28 day period beginning on the first day of the months indicated. To make the results more easily interpreted, each period's totals were divided by four so that the analyses show scheduled capacity per week. The data were then partitioned and aggregated as necessary for the analyses which follow.

The use of OAG data in studies such as this has been criticized for, among other reasons, its failure to show true origin-destination flows (Derudder et al., 2008). The OAG provides airline capacity by

sector, which tends to overstate the importance of hubs and to undervalue cities caught in the shadow of such hubs. Partly for this reason, some analyses use bookings data from global distribution systems (GDS) such as Sabre instead (e.g., Bassens et al., 2012). However, GDS data often exclude low-cost carriers (in particular AirAsia's traffic was not captured in any such system until 2011) and given the significance of LCCs to the region, GDS data would be a poor substitute in the analyses that follow. Further, the OAG is well-suited to the overarching goal pursued in this article, namely to assess how secondary cities in Southeast Asia have fit into airline networks over time; and the OAG has been utilized in similar studies on network structure in other regions, e.g., Reynolds-Feighan (2010) on Europe and North America.

Some analyses below separate low-cost carriers from other airlines. LCCs are defined here based primarily on the classification provided by ICAO (2014). Minor adjustments were made to the ICAO list to account for subsidiaries not captured in the list and name differences in the OAG database. In March 2013, there were 101 LCCs globally, with 20 domiciled in Southeast Asia.

4. Scheduled airline services in Southeast Asia, 1998–2013

From the eleven countries of Southeast Asia, there were a total of nearly 39,000 flights offering 6.3 million seats per week in 2013 (Table 2). By comparison, in Europe west of Russia, which has roughly the same population and physical extent, there nearly 17 million seats per week. But Southeast Asia has experienced robust growth, which has increased the region's clout in the global airline industry; seat capacity grew nearly threefold between 1998 and 2013, with expansion concentrated in recent years.

The strong correlation between economic development and the relative size of the aviation industry (Bowen, 2014a) explains much of Southeast Asia's growth of airline capacity since the late 1990s. Fig. 3 expresses that correlation over the period 1998 to 2013 for most Southeast Asian countries and, for comparison, several countries outside the region (Fig. 3). The vertical axis measures economic development using gross national income per capita, adjusted for inflation. The horizontal axis measures per capita scheduled airline seat capacity for the two years. The pattern is clear: with higher levels of economic development, air transportation becomes more significant (Bowen, 2014a). The propensity to fly, both for leisure and for business, increases; and in turn greater per capita airline capacity is indicative of better air accessibility and the development advantages it brings.

That said, region-wide and national aggregates, such as those just presented, obscure the spatial articulation of capacity increases within Southeast Asian countries, and so the remainder of this article focuses on airline capacity at the city level. Across the region, 235 cities had scheduled services in 2013. Between 1998 and 2013, the number of cities with scheduled services in the region grew modestly overall, but with more pronounced increases in the Philippines, Vietnam, and especially Indonesia. Interestingly, there was considerable flux in the region's more marginal places: 29 cities lost all scheduled services between 1998 and 2013; and 64 cities were added to the network. That more than two dozen cities lost scheduled airline service during a period of brisk growth overall hints at the dynamism but also the capricious nature of air transportation in smaller cities and town such as Baguio, a city of more than 300,000 north of Manila, which had no scheduled passenger flights by 2013.

Conversely, the new destinations in the region fall into two main categories. First, new tourist destinations were opened to regular air services, including, for instance, Krabi on the Andaman Sea coast of Thailand and Con Dao in the South China Sea (see Fig. 1). More important from the perspective of improving spatial accessibility

¹ I am indebted to an anonymous reviewer for this important point.

Table 2
Scheduled airline capacity growth in Southeast Asia, 1998–2013.

	Scheduled departure seats per week (000)				Annual average growth rate, 1998–2013	Low-cost carrier share of capacity, 2013
	1998	2003	2008	2013		
Brunei	19.3	19.5	20.9	20.1	0.3	16.1
Cambodia	16.5	36.7	54.9	73.7	10.5	14.4
Indonesia	408.2	550.7	1036.0	2022.4	11.3	59.5
Laos	9.1	12.7	17.5	35.3	9.5	5.8
Malaysia	466.0	480.5	697.9	989.6	5.1	54.1
Myanmar	37.4	50.4	41.5	79.1	5.1	11.5
Philippines	315.7	315.0	446.5	850.5	6.8	70.4
Singapore	372.9	444.3	503.9	683.0	4.1	27.1
Thailand	514.9	603.7	842.0	1129.0	5.4	33.2
Timor-Leste	NA	1.2	3.3	1.0	NA	–
Vietnam	87.9	137.8	292.1	461.7	11.7	13.0
Southeast Asia	2247.9	2652.5	3956.5	6345.5	7.2	47.0
World	51,221.0	52,688.5	68,877.4	77,383.0	2.8	23.4

Low-cost carriers classification based principally on ICAO (2014).

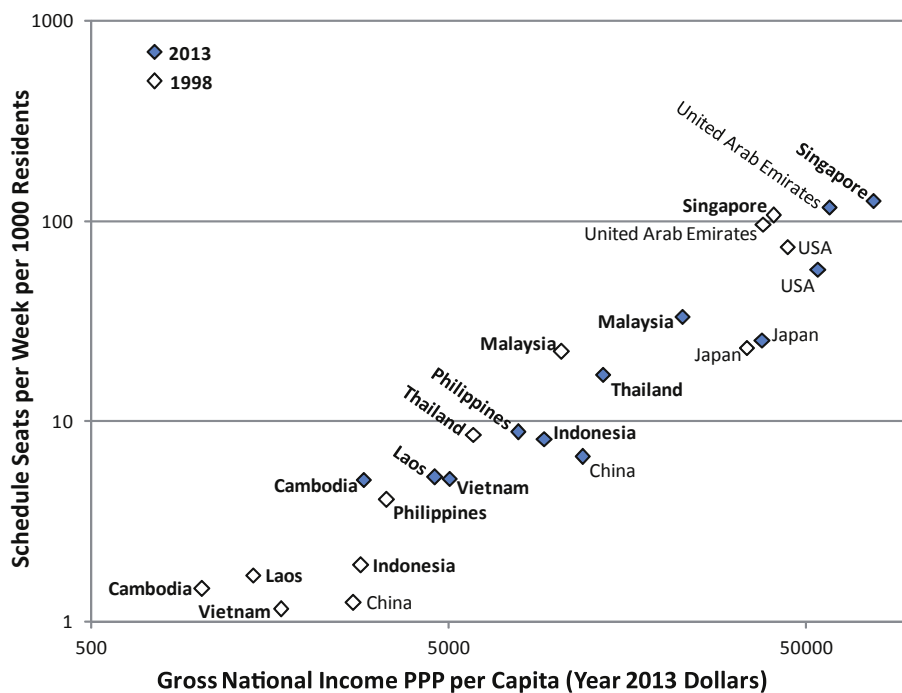


Fig. 3. Relationship between Development and Airline Capacity in Southeast Asia. Development measured by per capita gross national income adjusted for purchasing power parity. Airline capacity is scheduled departure seat capacity per week for all carriers combined. Sources: OAG (1998, 2013); World Bank (2015).

are the provincial cities that have gained new services including, for instance, Bandar Lampung in southern Sumatra and Malang in east Java. These were Indonesia’s two largest cities without scheduled air services in 1998 when they had metropolitan populations of approximately 863,000 and 778,000, respectively (estimates based on data contained in United Nations, 2014).

Along with the new cities with commercial service in the region were thousands of new routes. In 1998, commercial airlines served 1098 routes originating in Southeast Asia: 616 domestic, 192 international-intra regional (such as Bangkok-Jakarta), and 290 inter regional (such as Bangkok-Tokyo). By 2013, there were 1563 routes: 835 domestic, 287 international-inter regional, and 441 inter regional. The latter category expanded somewhat faster than the others. One might anticipate that with the consolidation of multilateral liberalization as described above, intraregional routes will witness faster multiplication in the future.

Despite the proliferation of new airports and new routes, there

was little flattening in the topography of aviation capacity in Southeast Asia. In 1998, flights from one the region’s top six cities (Bangkok, Jakarta, Singapore, Kuala Lumpur, Manila, and Ho Chi Minh City) accounted for about 62 percent of all seats on scheduled airline departures in the region (Table 3); their combined share in 2013 was 54 percent (Author’s analysis of OAG, 1998 and OAG, 2013).

Interestingly, although the number of routes grew somewhat faster at the international level (see above), domestic seat capacity grew faster than international seat capacity in Southeast Asia during the period under review. This seemingly paradoxical result reflects the fact that airlines, especially LCCs, poured capacity onto a relative handful of domestic trunk routes during the intervening fifteen years. For instance, the one-way weekly flight frequency on Jakarta-Surabaya surged from 367 to 1418. These same factors help to explain why the five main domestic hubs (i.e. the six cities identified above less Singapore, which does not have any scheduled

Table 3
Capacity share of Southeast Asia's largest hubs, 1998–2013.

City	1998		2013	
	Scheduled departure seats per week (000)	Share of regional capacity (%)	Scheduled departure seats per week (000)	Share of regional capacity (%)
Bangkok	376.2	16.7	784.6	12.4
Jakarta	167.1	7.4	684.8	10.8
Singapore	372.9	16.6	683.0	10.8
Kuala Lumpur	231.0	10.3	584.6	9.2
Manila	202.7	9.0	448.5	7.1
Ho Chi Minh City	51.2	2.3	218.2	3.4
Subtotal	1401.2	62.3	3403.8	53.6
All other cities	847.0	37.7	2941.7	46.4
Total	2247.9	100.0	6345.5	100.0

Sources: Analysis of OAG (1998, 2013).

domestic flights) lost hardly any of their combined domestic capacity share (36 percent of domestic capacity in 1998 was on routes from Bangkok, Jakarta, Kuala Lumpur, Ho Chi Minh City, and Manila versus 35 percent in 2013).

And the same six cities mediated the great majority of international traffic within the region and beyond (Table 4). In most Southeast Asian countries, the main gateway's share remained above 60 percent; in the case of Malaysia, Kuala Lumpur's share actually increased. The latter result is partly attributable to the strategy of AirAsia as discussed below.

Turning from the main cities in the region to its main sectors, trunk routes were about as dominant in 2013 as they had been in 1998. A trunk route is defined here as any nonstop sector linking two cities with seat capacity of at least 0.01% of total worldwide traffic. In 2013, this criterion equated to 7748 seats per week, a threshold that 203 of the 1563 routes originating in Southeast Asia met; and of these 203 trunk routes, 184 originated, terminated, or both in one of the six big hubs in the region. Overall, about 63 percent of Southeast Asian airline capacity was deployed on trunk routes so defined in 2013. By contrast, the corresponding proportion for Europe west of Russia was 35 percent and for the world as a whole 46 percent. Furthermore, in Southeast Asia, trunk route dominance actually increased over the period under review, climbing from 58 percent of all traffic in 1998 (when the 0.01% threshold equated to 5107 seats per week). Domestic trunk routes (e.g., Jakarta-Surabaya, Hanoi-Ho Chi Minh City) grew substantially faster than all other kinds of routes (Fig. 4). Interestingly, intraregional routes (both trunk and nontrunk), which ought to be encouraged by the ASEAN's multilateral liberalization, expanded at about two-thirds the pace of domestic trunk routes.

Still, changes in the way networks in Southeast Asia and beyond are organized may improve the accessibility of peripheral places, even if the main gateways and trunk routes remain strongly dominant. In particular, during the period under review new spokes spun from Singapore, Kuala Lumpur, and other hubs gave more Southeast Asian cities – including some very small ones – one stop service to global command and control centers such as London and Tokyo. The next section of the article analyzes such changes in network structure.

5. Changes in network structure and the place of the periphery in Southeast Asia

Few places better illustrate the recent expansion of air transportation in Southeast Asia than Banda Aceh, Indonesia (see Fig. 1). The city, which is the capital of Aceh province, was devastated by 2004 Indian Ocean tsunami but has recovered since then through an influx of aid, earnings from nearby natural gas mining, and the recent end of a civil war in the region. All of these circumstances have combined with the growth of aviation in the Southeast Asia to improve Banda Aceh's airborne accessibility. In 1998, it had only a daily Garuda Indonesia flight to Medan (a larger provincial capital just to the east) and a twice-a-week Pelangi Air flight across the Strait of Malacca to Penang, Malaysia. By 2013, Banda Aceh was linked nonstop not just to Medan and Penang, but also Jakarta and Kuala Lumpur and the number of airlines serving the city's Sultan Iskander Muda International Airport had jumped from two to six. Among the latter were four low-cost carriers – Lion Air and Indonesia AirAsia from Indonesia and AirAsia and Firefly from Malaysia. Together, these changes have improved the ease of

Table 4
Distribution of scheduled airline capacity in Southeast Asia, 1998–2013.

Country	Cities with scheduled air services		Top city by scheduled departure seat capacity and percentage share of national total					
	1998	2013	1998	2013		1998	2013	
				All	Int'l		All	Int'l
Brunei	1	1	BS Begawan	100	100	BS Begawan	100	100
Cambodia	7	3	Phnom Penh	72	95	Phnom Penh	53	54
Indonesia	50	78	Jakarta	41	62	Jakarta	34	59
Laos	10	8	Vientiane	59	100	Vientiane	60	73
Malaysia	38	36	Kuala Lumpur	50	80	Kuala Lumpur	59	86
Myanmar	21	17	Yangon	50	100	Yangon	60	93
Philippines	31	38	Manila	64	93	Manila	53	80
Singapore	1	1	Singapore	100	100	Singapore	100	100
Thailand	26	32	Bangkok	73	95	Bangkok	69	88
Timor-Leste	NA	1	NA		100	Dili	100	100
Vietnam	15	20	Ho Chi Minh City	58	80	Ho Chi Minh City	47	61
Southeast Asia	200	235						

Source: Analysis of OAG (1998, 2013).

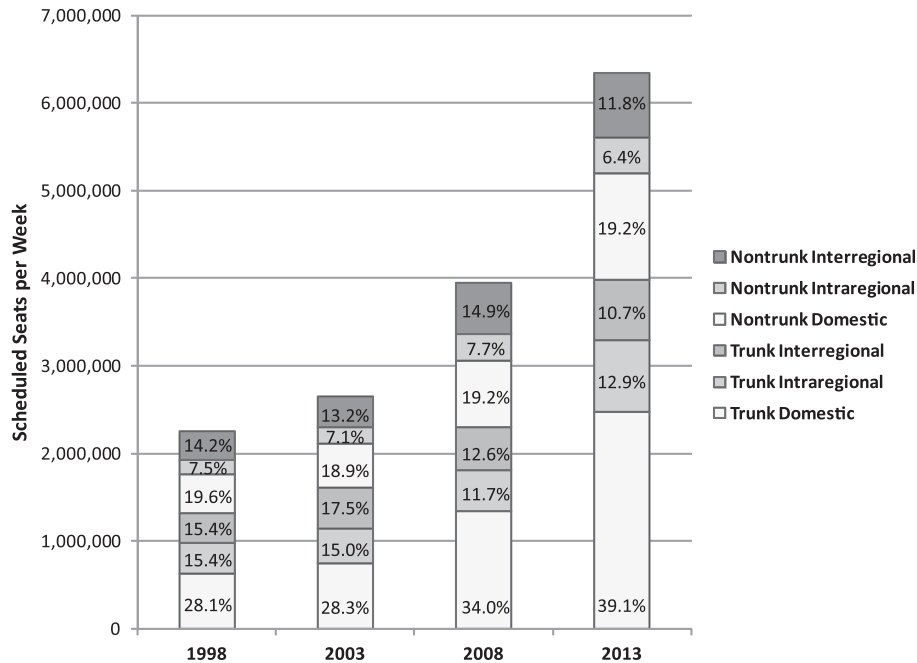


Fig. 4. Distribution of Airline Capacity across Trunk and Nontrunk Routes, 1998–2013. Scheduled departure seat capacity per week for all carriers combined with routes classified by trunk/nontrunk status. Sources: OAG (1998, 2003, 2008, 2013).

getting to and from Banda Aceh by air.

One way to assess changes in the network accessibility of a city such as Banda Aceh is to compute its Shimmel index, a graph-theory measure of the number of edges (in this instance, non-stop flights) required to link a vertex (e.g., Banda Aceh) to every other vertex in a network. The Shimmel index is low for highly accessible vertices and high for those that are more marginal. It can be more easily interpreted if divided by the total number of other cities in a network; this modified form of the index has a value of 1.00 for a hub connected to every spoke city by nonstop flights and is higher for less well-connected places.

Shimmel indices for Southeast Asian cities were computed within a network comprising 838 cities: all 152 cities in the region that had scheduled services in 1998, 2003, 2008, and 2013 plus all 686 cities outside Southeast Asia that had at least one scheduled international flight in the same four years. The scope of the analysis therefore excludes cities that lacked air services in at least one of the four sample years (in order to establish a consistent frame of reference) and the nearly 2500 cities (in 2013) outside with Southeast Asia with purely domestic air services. Given the role of international gateways in mediating the connections between Southeast Asia and the rest of the world, there would be little value added in extending the scope of the analysis to include all such vertices (e.g., there would be minimal difference in the relative rankings of Southeast Asia cities if all 633 US vertices with air services across the four sample years had been included instead of just the 47 American gateways that are incorporated in the analyses that follow).

To calculate Shimmel indices, an adjacency matrix (a set of zeroes and ones) showing nonstop connections among the 838 cities was multiplied by itself to produce a second order matrix whose elements show the number of two-step paths (i.e. routes requiring a connection in an intermediate point) from each vertex_i to every other vertex_j. The second order matrix was then multiplied by the adjacency matrix to produce the third order matrix, the elements of which show the number of three-step paths from each

vertex_i to every other vertex_j, and so on. In this fashion, the minimum number of edges or flights required to link each vertex with every other vertex was determined (e.g., in 2013, the most distant place from Banda Aceh in this network was Kosrae in the Federated States of Micronesia, which lay a minimum of 6 edges or nonstop flights away). These values were summed and then divided by 837 (the theoretical minimum if a city were connected to every other via nonstop flights) to produce a set of readily compared modified Shimmel indices.

Within the network of 838 cities, Bangkok ranked as the most accessible Southeast Asian city in 1998, 2003, and 2008, but was narrowly edged out by Singapore in 2013 (Table 5). Other highly accessible cities include the region's other main business centers and key tourist destinations (e.g., Siem Reap, the gateway to Cambodia's Angkor World Heritage site).

The aim of this article is to look beyond the major hubs to the peripheral, spoke cities. To return to example of Banda Aceh, its Shimmel index fell from 3.85 to 3.09 between 1998 and 2013. These values indicate that in 1998 it took an average of about four nonstop flights – domestic and/or international – to get from Banda Aceh to the other 837 cities in the sample (including 33 other cities in Indonesia, 118 cities elsewhere in Southeast Asia, and 686 cities beyond the region); by 2013, it took an average of about three flights to reach the same cities. The new nonstop connections to Kuala Lumpur and Jakarta were instrumental in producing this improvement in accessibility for Banda Aceh. Many new routes were added to those hubs during the period under review. Consequently, Banda Aceh (and other cities like it) gained more from its new connections to these hubs than they would have if Kuala Lumpur and Jakarta had maintained the same set of spoke cities as in 1998.

In addition to Banda Aceh, other Southeast Asian cities with large reductions in the index included: Dili, capital of the region's newest sovereign state (Timor-Leste gained its independence in 2002); Jayapura and Merauke, cities that serve as gateways to the mineral wealth and tourist attractions of Indonesia's far eastern

Table 5
Modified Shimbels indices for selected Southeast Asian cities, 1998 and 2013.

Shimbels Index rank (2013)	City	Modified Shimbels index		
		1998	2013	Change
1	Singapore	2.16	2.00	(0.16)
2	Bangkok, Thailand	2.15	2.04	(0.11)
3	Kuala Lumpur, Malaysia	2.20	2.11	(0.09)
4	Ho Chi Minh City, Vietnam	2.78	2.25	(0.53)
5	Hanoi, Vietnam	2.73	2.29	(0.45)
6	Phuket, Thailand	2.88	2.35	(0.53)
7	Manila, the Philippines	2.32	2.47	0.14
8	Yangon, Myanmar	2.86	2.48	(0.37)
9	Siem Reap, Cambodia	3.14	2.51	(0.64)
10	Jakarta, Indonesia	2.72	2.51	(0.21)
11	Denpasar (Bali), Indonesia	2.86	2.55	(0.31)
12	Bandar Seri Begawan, Brunei	2.73	2.62	(0.11)
14	Phnom Penh, Cambodia	2.93	2.75	(0.18)
16	Vientiane, Laos	3.10	2.76	(0.34)
47	Dili, Timor-Leste	3.86	2.99	(0.86)
49	Luang Prabang, Laos	4.10	3.01	(1.09)
68	Banda Aceh, Indonesia	3.85	3.09	(0.76)
83	Rachgia, Vietnam	4.77	3.25	(1.53)
116	Jayapura, Indonesia	5.09	3.50	(1.59)
149	Merauke, Indonesia	6.09	4.49	(1.60)
151	Long Banga, Malaysia	4.15	4.91	0.76
153	Bhamo, Myanmar	4.84	4.98	0.15

Source: Analysis of OAG (1998, 2013). See Section 5 for explanation.

Papau province; Rachgia, a Vietnamese provincial capital near the Cambodian border; and Luang Prabang, a World Heritage site in Laos (see Fig. 1).

So the largest improvements in accessibility were recorded by cities other than the main hubs, but the cities with the greatest erosion in accessibility were likewise in the periphery. For instance, Long Banga and several other small communities in Sarawak, a mainly rural state in east Malaysia, were marginalized by changes in the airline industry. A Malaysian Airlines affiliate called MASwings was the main (and often only) carrier serving these places in 1998; but by 2013, it had deemphasized puddle-jumping services among remote communities in Sarawak and neighboring Sabah in favor of improved longer range links from the main population centers in these states (Naeg, 2013).

Despite the gains and losses of individual places, there was little consistent change in the relative accessibility of small and medium-sized cities between 1998 and 2013. In 1998, the average Shimbels index for the bottom third of Southeast Asian cities (e.g., the lowest-ranked 51 cities out of the 152 for which it was possible to calculate the index in all sample years) was about 1 unit greater than for the first third (i.e. 4.08 versus 3.09). Fifteen years later, the gap was still about 1 (i.e. 3.82 versus 2.78).

There was, however, one kind of city for which there was a significant trend towards improved Shimbels indices: those for which LCCs accounted for a *smaller* share of total capacity. There was a moderate positive correlation ($r = 0.195$; $p = 0.016$; $N = 153$) between the 1998–2013 change in the Shimbels index and the 2013 LCC share of outbound capacity. This result indicates that in those cities with the greatest improvement in the index (i.e. greater magnitude negative change), the LCC share tended to small. As described in the next section, LCCs have generally reinforced the existing spatial pattern of air services, and so where they dominate there is surprisingly little change in spatial patterns of accessibility.

6. Low cost carriers and the pattern of air services in Southeast Asia

The most significant new carriers plying Southeast Asian routes are LCCs. Indeed, in 2013 budget airlines had a greater overall

capacity share in Southeast Asia than in any other major world region (Table 6). By 2014, there was evidence that the massive expansion of the LCC sector in Southeast Asia had become unsustainable as some of the new entrants struggled financially (Economist, 2014). Nevertheless, the experience of other world regions (e.g., North America, Europe) suggests that budget carriers will be a durable feature of the region's airline industry (Zhang et al., 2008).

The proliferation of LCCs has had a profound effect on the Southeast Asian airline industry, but have such carriers fostered greater accessibility in more peripheral communities within the region? The answer is no, at least not compared to their role in Southeast Asia's main city-pair markets. On routes departing from Southeast Asia (combining domestic, intraregional-international, and interregional routes), LCCs had a combined capacity share of 47.0 percent in 2013, but if those are routes are segmented by stature, the significance of LCCs in spreading access becomes clearer. Specifically, on the region's principal trunk routes (defined as above), their share was 49.5 percent (domestic trunk: 61.5 percent; intraregional trunk: 43.8; interregional trunk: 12.5); on other routes their share was 42.8 percent (domestic nontrunk: 57.4; intraregional nontrunk: 49.8; interregional nontrunk: 9.2). More than airlines generally, LCCs favor highly trafficked routes (Author's analysis of OAG, 2013).

In fact, there was a weak positive correlation ($r = 0.08$; $p = 0.002$; $N = 1563$) between total seat capacity and LCC capacity share for Southeast Asian routes. LCCs in Southeast Asia have targeted very densely trafficked routes (e.g., Kuala Lumpur-Singapore, where budget carriers accounted for 62.7 percent of capacity in 2013) rich with opportunities to challenge the main flag carriers. Still, it is worth noting that LCCs are also prevalent on some routes away from the core. Examples include Davao-Iloilo in the Philippines (100 percent) and the international sector from Medan, Indonesia to Penang, Malaysia (100 percent).

The spatial organization of LCCs depends in part on individual airline strategies. Of the 20 LCCs based in the region in 2013, the largest by seat capacity were Lion Air (Indonesia) and AirAsia (Malaysia). A useful contrast can be drawn between these carriers. Both have stunned the aviation world with the pace of their growth

Table 6
Low-cost carrier share of scheduled airline capacity by world region, 2013

Region	Scheduled departure seats per week (000)	Low-cost carrier share (%)	Number of low-cost carriers by domicile
Southeast Asia	6345.5	47.0	20
South & Central Asia	2993.7	37.6	8
Southwest Pacific	2503.3	37.3	4
Latin America	7257.6	34.3	7
North America	19,767.1	28.2	9
Western Europe	15,759.9	23.1	26
Eastern & Central Europe	2152.3	18.2	6
Middle East & North Africa	4081.1	10.9	6
Subsaharan Africa	1651.2	5.6	3
Northeast Asia	14,871.1	5.5	12
World	77,383.0	23.4	101

Source: Analysis of OAG (2013). Low-cost carriers classification based principally on ICAO (2014).

and the scale of their ambitions. In early 2012, Lion Air, which started with a single plane in 2000 (Kaur, 2013), placed one of largest ever orders for new aircraft in the history of the aircraft industry – a blockbuster deal for 230 Boeing 737s worth more than \$22 billion (Kaur and Sim, 2012). Then in 2013 the same airline ordered 234 Airbus A320s worth \$24 billion. AirAsia, too, has ordered hundreds of narrow-body aircraft. Both carriers' massive fleet expansion is testament to the new "aeromobility" (Lassen, 2006) in Southeast Asia, a reality captured as much in Lion Air's corporate slogan, "We make people fly", as in the less insistent tone from AirAsia: "Now everyone can fly".

Despite their similarly large ambitions, the two carriers do differ in ways that affect the spatial structure of their networks. Lion Air's network emphasizes domestic connections, a tendency encouraged by the vast market of Indonesia. It has established hubs not only in Jakarta, but also Makassar, Surabaya, and Batam. In 2013, 70 percent of the airline's seat capacity was on domestic trunk routes (defined as above). Conversely, AirAsia, based in the substantially smaller Malaysian market, emphasizes medium-range links – most international – within Southeast Asia and beyond. Indeed, in 2013 AirAsia served as many cities in Indonesia as in Malaysia. For the Malaysian LCC, 45 percent of seat capacity was on intraregional trunk routes versus 31 percent on domestic trunk routes. For both carriers, however, seat capacity was strongly concentrated on trunk sectors.

The two airlines differ in the centrality of their main hubs. In 2013, 79 percent of AirAsia's seat capacity was on flights to or from the Malaysian capital. As Zhang et al. (2008) note, AirAsia does not exhibit the point-to-point networks associated with Southwest Airlines and some other LCCs, but rather strongly emphasizes services to and from Kuala Lumpur. For Lion Air, meanwhile, Jakarta was certainly vital but not as overwhelmingly so: the Indonesian capital's share of Lion Air's seat capacity was 61 percent.

So AirAsia's strategy helps to explain why Malaysian air services are even more concentrated in Kuala Lumpur than they were a decade and a half ago (see Table 4). Yet if we broaden the lens of our analysis somewhat, AirAsia's network has interesting implications. Many more cities across Southeast Asia, including some medium-sized ones like Banda Aceh, now have nonstop services to Kuala Lumpur and the global connections it offers, albeit indirectly.

7. Discussion

In the decade between 2005 and 2015, Southeast Asia's main hub cities witnessed massive investment in new and expanded airports. Bangkok's US\$4 billion Suvarnabhumi Airport debuted with an annual capacity of 45 million passengers in 2006 (Ghosh, 2006). Singapore's Changi Airport added its \$1.3 billion Terminal 3 in 2008, increasing the hub's capacity from 44 million to 66

million passengers per year (Ramchandani, 2008). And at Kuala Lumpur International Airport (KLIA), a third runway and a new Terminal 2 dedicated to low-cost carriers, opened for service in 2013 and 2014, respectively, boosting KLIA's capacity from 45 million to 70 million passengers annually (Teo, 2014). Looking forward, Jakarta's main airport is to have a greatly expanded third terminal by the end of 2016, and construction of a new international airport for Ho Chi Minh City has been authorized by the Vietnamese government.

The airport infrastructure build-out at the region's principal gateways is unsurprising given the rapidity with which Southeast Asia's air traffic has grown; indeed some of region's main airports (e.g., Seokarno-Hatta International in Jakarta and Ninoy Aquino International in Manila) are severely congested (Tani, 2015). Yet most people in Southeast Asia do not live in or near one of the main hubs. The region's top ten cities ranked by airline capacity in 2013 (a group which includes each of the hubs just mentioned) had a combined metropolitan population of about 58 million (based on data in United Nations, 2014) or slightly less than a tenth of the region's total population. In fact, Southeast Asia remains a mainly rural region. In this and other developing areas, it is critical to look beyond the main hubs in assessing changes in aviation accessibility. And that has been the purpose of the analyses above.

Deregulation has been conducive to the growth of the Southeast Asian airline industry generally and the LCCs in particular. However, despite the proliferation of competitors and nearly threefold increase in capacity between 1998 and 2013, the overall spatial structure of scheduled air passenger services in the region has changed little. A handful of cities were and remain dominant, partly because the region lacks secondary airports. So flights from six Southeast Asian cities accounted for more than 54 percent of scheduled airline capacity in 2013. By comparison, routes from the six largest hubs in Europe (London, Paris, Istanbul, Frankfurt, Amsterdam, and Madrid) accounted for only 30 percent of all capacity in that region. Likewise, network analysis indicates that Southeast Asia's primary hubs continue to play a pivotal role in mediating the linkages within the region among the secondary cities and between those cities and the rest of the world.

These patterns matter because more than in most regions, intercity passenger transportation in Southeast Asia is heavily reliant on aviation (Leinbach et al., 2000). To date, one factor conducive to air transport in the region has been the weakness of surface transportation, though that is changing. In Malaysia, for instance, the improved highway network likely has diverted some traffic from the skies; as an example, air services to the provincial capital of Ipoh were cut sharply between 1998 and 2013, a period during which the completion of the country's North-South Highway and other expressways significantly improved ground accessibility (Williamson, 2003). Ipoh is now a little more than two hours

from Kuala Lumpur by car according to Google Maps. Highway construction is advancing apace in other countries in the region, too. Meanwhile, the expansion of passenger rail—some of it high-speed — is underway or planned in several corridors across Southeast Asia (Economist, 2011). In the meantime, though, air travel is likely to continue to play a disproportionate role.

In the past, national governments sought to use airlines as instruments of development, including via subsidized services to rural regions (e.g., Pioneer Air Services in Indonesia) (Leinbach, 1989). To a limited degree such services continue (Rahim et al., 2012), but the Southeast Asian airline industry is increasingly led by privately owned low-cost carriers. The LCCs have focused on the main markets more than other carriers, and in so doing have established airline networks that largely reflect and perhaps perpetuate the historically imbalanced spatial development (Rigg, 1997) of Southeast Asia's economies.

8. Conclusions and future research

Between 1998 and 2013, Southeast Asia experienced faster air transport capacity growth than almost any other large world region. Seat capacity grew nearly threefold, the number of routes expanded by more than 50 percent, and the number of airports served by commercial flights grew by about 15 percent. Over the same period, dozens of new airlines, especially low-cost carriers, began flying. Indeed, LCCs have become the leading players in several countries and for the region as a whole account for almost half of all seat capacity.

Yet the region remains heavily dominated by a handful of hubs, especially Bangkok, Singapore, Jakarta, Kuala Lumpur, Ho Chi Minh City, and Manila. The combined capacity share of these six hubs fell but only modestly during the 15 years under study. Likewise, in both years the region's trunk routes accounted a similar share of overall seat capacity.

Fast-growing LCCs have helped to reinforce the dominance of key hubs and major routes. But the degree to which budget airlines extend and improve services in the region's periphery does depend on the carrier and its strategy. The two leading LCCs, AirAsia and Lion Air, have an important presence in scores of cities across Southeast Asia, but Lion Air has probably done more to broaden access to the region's airways, especially through its secondary hubs in places such as Makassar.

Looking forward, the prospect of deepening multilateral liberalization may create new opportunities for carriers and communities. In fact, the rapid growth of the airline industry in Southeast Asia has been paralleled by the increased integration of the region's economies. These two trends should reinforce one another: on the one hand, expanded cross-border commerce has opened new opportunities for airlines; and on the other hand, airlines themselves ought to be catalytic in forging stronger ties among the ASEAN countries. In 2015, these twin developments — regional economic integration and airline industry growth in Southeast Asia — took a further step forward with the implementation of the ASEAN Economic Community (AEC), a part of which is the introduction of a Single Aviation Market (SAM) (Tan, 2014). As noted above, the SAM is less comprehensive and ambitious than the comparable initiative in the European Union (Tan, 2013). But in the longer term, it may foster increased trade within the region and a proliferation of intra-regional airline services including more nonstop international flights linking secondary cities. In 2013, there were 287 international, intra-regional city-pairs in Southeast Asia, and 61 directly linked two secondary cities (i.e. not involving one of the region's six main hubs). By comparison, in 1998, there were 192 intraregional city-pairs and 55 of them linked two secondary cities. So there has been some progress in this regard, but Southeast Asia's

development remains well behind that of Europe where there were more than 5600 intraregional routes in 2013, with 4300 linking two cities not involving one of that region's six main hubs. The SAM in Southeast Asia should facilitate additional cross-border routes, and their evolution along with other effects of multilateral liberalization in the region is a potential theme for future research. At the same time, however, the aforementioned capacity constraints in the key hubs (especially Jakarta and Manila) are important hindrances to future growth; and so the relationship among infrastructure, deregulation, and the LCC phenomenon is another theme worth of further investigation.

It is not only in Southeast Asia that such patterns of aviation development matter. In other emerging regions, including Sub-Saharan Africa and Latin America, rapid growth of air travel has not yet been met with a commensurate level of scholarship to analyze the drivers and implications of those changes. Given the vast potential for increased air traffic volumes in places where aviation's takeoff has barely begun, it is imperative that more attention be given to such regions.

Ultimately, it is hyperbole to claim that “Now everyone can fly”, but especially in developing regions such as Southeast Asia, it is vital that not just the well-known hubs but also secondary cities have access to good aviation services. Future research ought to more fully consider the spatial articulation of airline networks — especially those of rapidly proliferating LCCs — in this and other world regions.

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