

# PROFITABILITY OF THE KUALA LUMPUR-SINGAPORE HIGH SPEED RAIL

Policy Report  
October 2018

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and Akio Tanahashi

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## **Executive Summary**

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This paper analyses the profitability of the Kuala Lumpur-Singapore High Speed Rail (KL-SG HSR) based on the relationship between population density and profit margins of railway companies in several countries. For the KL-SG HSR to be as profitable as the Central Japan Railway Company (JR Central), for example, Kuala Lumpur will need to have a population of 20 million. Whether this happens or not, according to the rank-size rule, depends on the extent of regional economic integration and how urban agglomeration unfolds in mainland Southeast Asia.

## Introduction

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The KL-SG HSR project is under review following the election of a new government in Malaysia led by Prime Minister Mahathir Mohamad. Whatever the outcome of the review, the issue of profitability needs to be looked at more closely. The project's profitability will depend on the extent of regional economic integration—the free movement of people, labour, goods, and capital across national borders—as well as how urban agglomeration unfolds within ASEAN. Urban agglomeration refers to the development of a large, dense and contiguously populated area comprising a city and its suburbs. As a city grows, more companies in related fields of business cluster together, lowering their costs of production, attracting more companies, workers, and customers. Separately, households move to neighbouring areas, creating suburbs. Urban agglomeration forms and grows to exploit this increasing return to scale. An HSR expands urban agglomeration as it drastically enlarges the geography from which cities attract people and business seamlessly. So the cities where the HSR stops – HSR hubs – will interact with their suburbs and will form larger contiguous outgrowths. Ultimately, the denser the population linked to the HSR is, the more profitable a project is.

The KL-SG HSR project was announced in 2010 to connect Kuala Lumpur and Singapore. Malaysia and Singapore signed a memorandum of understanding in July 2016. The construction work was expected to start in 2018, followed by testing and commissioning from 2024-2026. Once in operation by 31 December 2026, provided the Mahathir government proceeds with it, the KL-SG HSR is expected to shorten travel time between the two cities to 90 minutes compared to 4-5 hours taken currently by road, 7 hours by conventional rail service, or 3 hours by air. The planned total length of this project is 350 kilometres, covering 335 kilometres in Malaysia and 15 kilometres in Singapore. Figure 1 shows the stations in planning and Table 1 shows the three services to be operated by two operators.<sup>1</sup>

The Kuala Lumpur-Singapore air route is one of the busiest globally, with approximately 60 flights a day. For rail to compete effectively with air travel, it is said that a three-hour station-to-station journey time is the maximum; and in the case of the KL-SG HSR, the total travel time is going to be 90 minutes.

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<sup>1</sup> "Singapore-KL high-speed rail: An interactive guide." *The Straits Times*, February 14, 2017. <https://graphics.straitstimes.com/STI/STIMEDIA/Interactives/2016/12/singapore-kl-high-speed-rail-line/index.html>

Figure 1: The route of the Kuala Lumpur-Singapore High Speed Rail

## Singapore-KL High Speed Rail (HSR) project



Source: Janice Heng. "Singapore-KL High Speed Rail targeted to start running by around 2026; journey will take 90 minutes," *The Straits Times*, July 19, 2016.<sup>2</sup>

Figure 2 plots travel time and the rail share – the share of people using the railway instead of air travel – for fifteen rail links in Europe and Japan. For example, the Paris-Brussels HSR takes 85 minutes and the rail share is 100 per cent. With a travel time of 90 minutes, the KL-SG HSR will have a rail share of 94 per cent based on the regression line. However, there are several challenges for the KL-SG HSR in terms of time savings as passengers have to travel across the border between Malaysia and Singapore. Currently, the immigration check at the causeway takes over an hour on holidays and early in the mornings on weekdays because of congestion. This check time needs to be reduced to lessen the total travel time.

There is currently no HSR in operation in Southeast Asia – the HSR project in Thailand between Bangkok and Nakhon Ratchasima scheduled to be operational from 2021. The Thailand and Malaysia-Singapore projects are

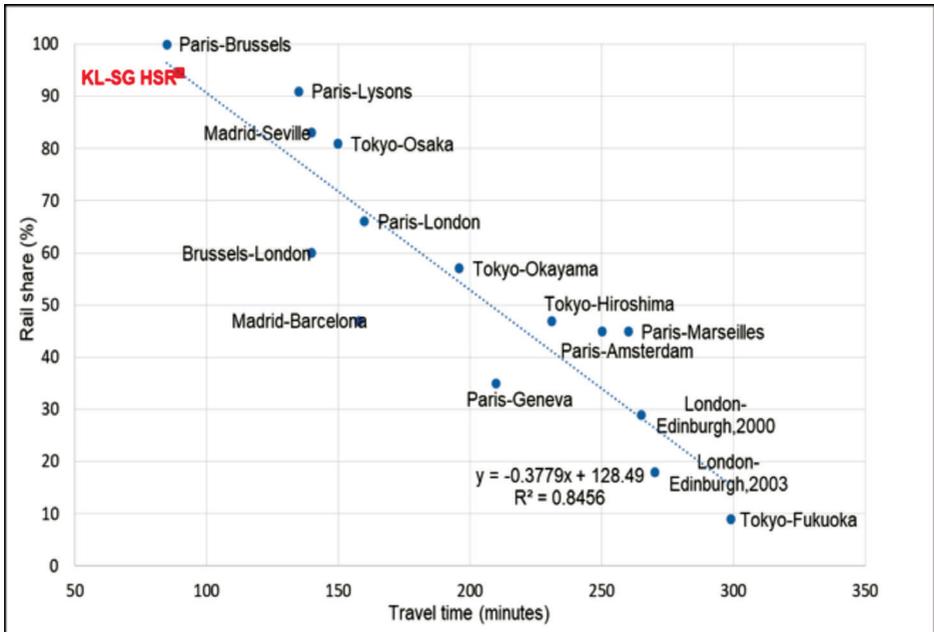
<sup>2</sup> <https://www.straitstimes.com/singapore/singapore-kl-high-speed-rail-targeted-to-start-running-by-around-2026-journey-will-take-90>

Table 1: The Kuala Lumpur-Singapore High Speed Rail project

Code	Station	Location	International line (Express)	Shuttle stops	Domestic line (Malaysia)
KL	Kuala Lumpur	Bandar Malaysia	•		•
PU	Putrajaya	Kampung Abu Bakar Baginda			•
SE	Seremban	Labu			•
AK	Ayer Keroh	Ayer Keroh, Melaka			•
MU	Muar	Bandar Universiti Pagoh			•
BP	Batu Pahat	Pura Kencana, Sri Gading			•
IP	Islandar Puteri	Gerbang Nusajaya		•	•
SG	Singapore	Jurong East	•	•	

Source: *Ibid. The Straits Times, 14 February 2017*

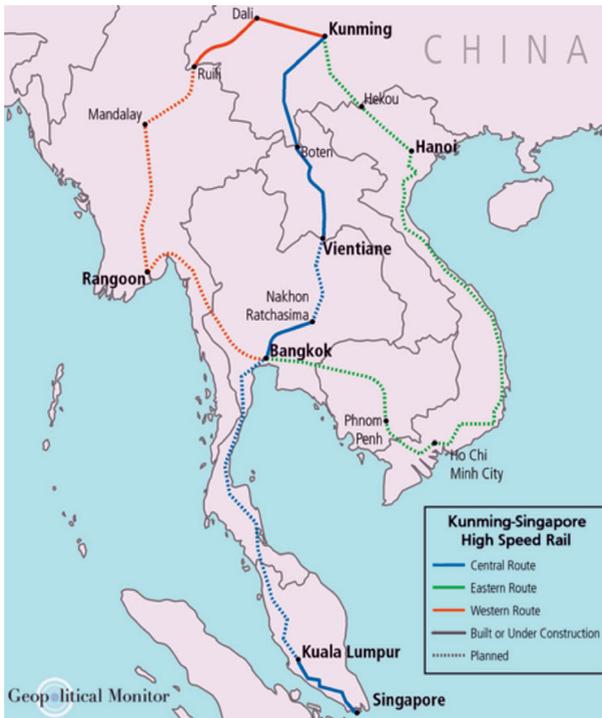
Figure 2: Rail usage vs travel time



Source: Nash, Christopher. "When to invest in high speed rail." *Journal of Rail Transport Planning & Management* 5, no.1 (2015): 12-22.

part of a pan-Asia railway network, construction for which has only begun in some parts, and will eventually connect Kunming to Singapore. Figure 3 shows the pan-Asia railway network that will connect Kunming to Singapore although a clear route has not been chosen yet. The idea of a pan-Asia railway network is not new, originating in the days of British Malaya and French Indochina. It was revived in November 2006 when 17 Asian and Eurasian countries signed the Trans-Asian Railway Network Agreement under the auspices of the United Nations Economic and Social Commission for Asia and the Pacific. There are plans for three major routes – the central route goes through Bangkok and Kuala Lumpur; the western route goes through Yangon, Bangkok, and Kuala Lumpur; and the eastern route goes through Hanoi, Ho Chi Minh City, Bangkok, and Kuala Lumpur. The KL-SG line is the last link in the network that will connect to all three routes, and is expected to increase the flow of goods and people, resulting in increased trade and economic cooperation.<sup>3</sup>

Figure 3: The pan-Asia railway network



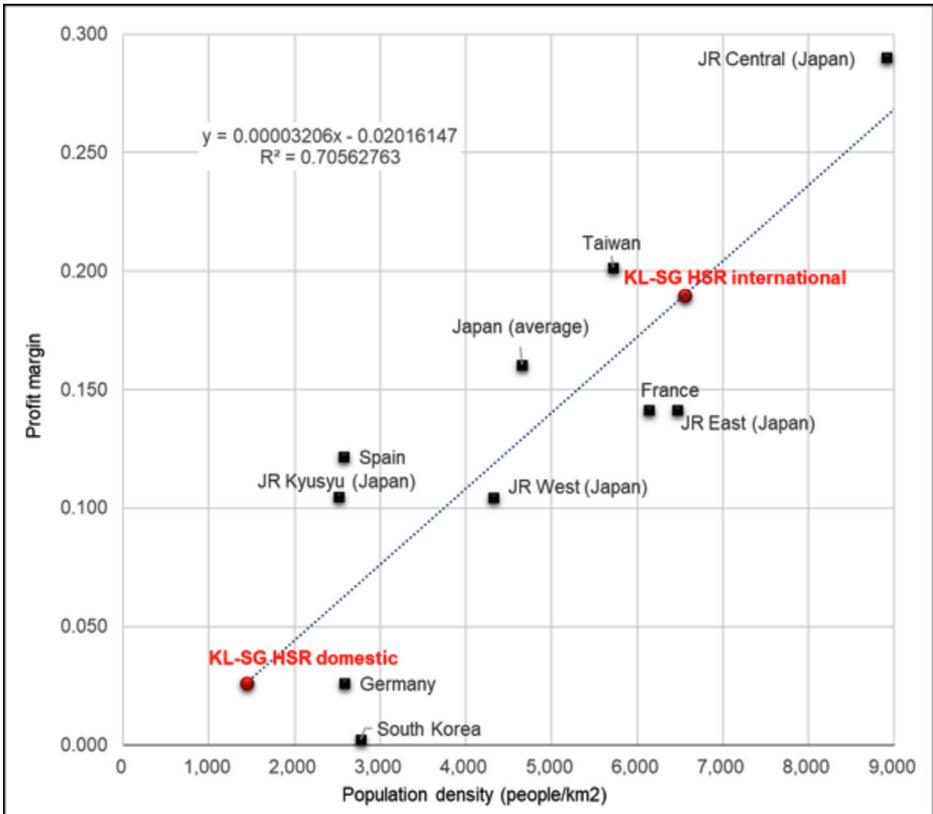
Source: Fact Sheet: Kunming-Singapore High Speed Rail Network, Geopolitical Monitor, 19 December 2017

<sup>3</sup> Pavličević, Dragan and Agatha Kratz. "Testing the China threat paradigm: China's high-speed railway diplomacy in Southeast Asia." *The Pacific Review* 31, no. 2 (2018): 151-168.

# Population Density and Profit Margins of HSR Companies

The KL-SG HSR project is expected to cost between \$24 billion and \$37 billion. However, there is not much analysis on whether the project will make operational profits to recover the cost. Various studies in other countries show that the operational profits of HSR projects are closely related to population density. Figure 4 plots the population density in 2015 and the average profit margin from 2014 and 2016 for HSR companies in France, Germany, Japan, South Korea, Spain, and Taiwan.

Figure 4: Population density in 2015 and profit margin for 2014-2016 for major operators in Europe, Japan, South Korea, and Taiwan



Source: Railway companies' websites; United Nations. "World population prospects: The 2017 revision." United Nations Population Division, 2017; United Nations. "The world's cities in 2016 – Data booklet." United Nations Population Division, 2016; Federal Government of Malaysia. "Population distribution and basic demographic characteristics 2010." Department of Statistics, Malaysia, 2011.

The population density of each HSR company is calculated based on the population density of cities where the main stations are located. The profit margin is calculated as ordinary income divided by operating revenues. The plot shows a positive correlation between population density and profit margin. For example, JR Central, which has a density of 8,910 per square kilometre, had a profit margin of 0.29 on average for the 2014-2016 period. In contrast, KORAIL in South Korea, which has a density of 2,771 per square kilometre, had a profit margin of 0.002 on average for the period. This means that every dollar of sales makes a profit of 29 cents for JR Central and a profit of 0.2 cents for KORAIL.

It is important to note that HSR companies diversify their business to achieve the profit margins shown in Figure 4. For example, most Japan railway companies run deficits from their HSR operations but make a profit in other areas such as retail and services, and real estate and hotels. Similarly, Europeans have started freight services in recent years to boost their operational profits. JR Central, which connects Tokyo and Osaka, is the only Japanese railway company that makes an annual operational profit of roughly \$8 billion and derives over 90 per cent of its revenue from HSR passenger transport alone.

## **Profitability of the KL-SG HSR in 2030**

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Given that only JR Central has managed to make a profit solely from passenger traffic, will the population density of the KL-SG HSR project be high enough for it to make a profit from passenger traffic alone? The KL-SG HSR international and domestic lines have a population density of 5,454 and 1,441 per square kilometre respectively. (Data is available only for 2015 for the domestic line while for the international line we take the projection by the United Nations for 2030.) Even the KL-SG HSR international line falls short of the population density of JR Central, which stood at 8,910 per square kilometre in 2015. The regression line in Figure 4 predicts that the international line's profit margin will be 0.19 and that of the domestic line in Malaysia will be 0.03. This means that every dollar of sales will make a profit of 19 cents for the international line and a profit of three cents for the domestic line. This may look promising, especially for the international line. However, the profit margin of the KL-SG HSR will mostly likely be lower as it is planned to solely serve passenger transport, while the 0.19 figure is based on operation of other companies, who have a diversified business model.

The United Nations predicts that the population density of Singapore will be as high as that of JR Central but that of Kuala Lumpur will only be half as high by 2030. Therefore, the population density of Kuala Lumpur has to increase if the international line is to match the population density of JR Central. Table 2 shows calculations based on the population density of JR Central in 2015 as our benchmark. We see that the population shortage in Kuala Lumpur in 2030 will be -10,581,752. For Kuala Lumpur to match our benchmark population density, its population would need to reach 20 million, which would be over half the total population of Malaysia. The following sections examine the likelihood of Kuala Lumpur's population reaching 20 million in this period.

Table 2: Comparison of population density of JR Central in 2015, and Kuala Lumpur and Singapore in 2030

City	Population density (person/km <sup>2</sup> )	Population density (person/km <sup>2</sup> ) needed	Population needed	Population shortage
Kuala Lumpur	4,201	8,919	20,004,752	-10,581,752
Singapore	8,901	8,901	6,400,000	0
Average	6,551	8,910 (JR Central benchmark)	13,202,376	-5,290,876

Source: *Ibid. United Nations (2016, 2017); BMI Research. "Freight transport & shipping report Malaysia." BMI Research, 2017.*

## The Rank-Size Rule in Malaysia

There is strong evidence that the population distribution across cities follows the so-called "rank-size rule", showing a relationship between the population size of cities and their ranking by size. For example, the largest city in a country will tend to have twice the population of the second-largest city

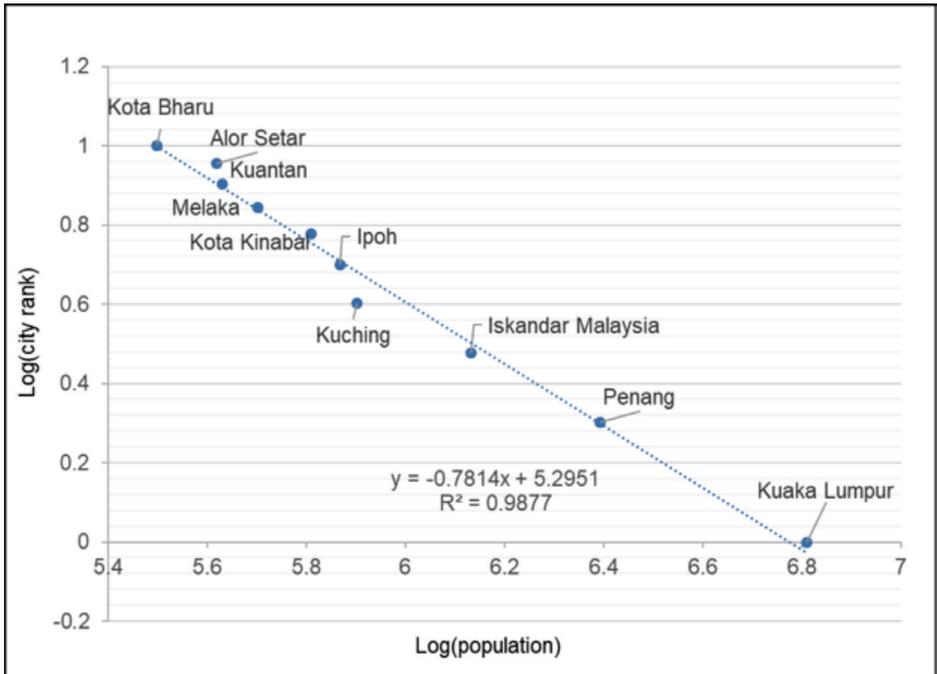
and three times the population of the third. More formally,  $P_x = \frac{P_1}{x}$  where  $x$  is the rank of the city's population, that is 1 for the highest population, 2 for the second highest and so on,  $P_x$  is the size of the population of the city ranked  $x$ , and  $P_1$  is the size of the population of the largest city. The rule can be generalised as

$$P_x = \frac{A}{x^b}$$

where  $A$  and  $b$  are parameters that do not necessarily conform to  $P_1$  or 1 respectively. Taking logarithm, we can rewrite the form as  $\log(P_x) = \log(A) - b\log(x)$ . The generalised form of the equation usually fits very well to

data pertaining to a nation's cities. For example, Figure 5 plots  $\log(\text{city rank})$  and  $\log(\text{population})$  for the 10 main ten cities in Malaysia in 2010 and shows that cities in Malaysia fit almost perfectly to the rank-size rule.

Figure 5: Rank-size rule in Malaysia in 2010



Source: *Ibid.* Federal Government of Malaysia (2011)

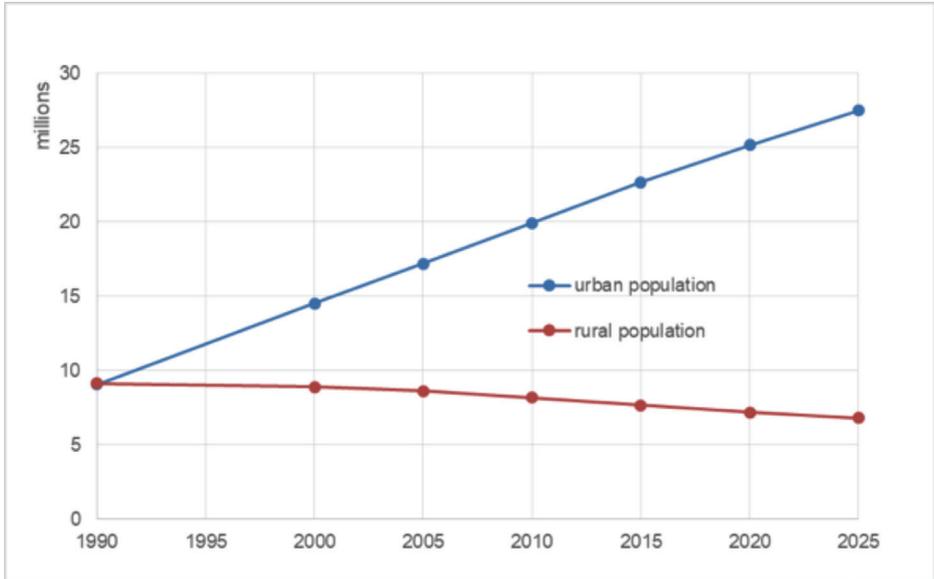
One source of population growth for Kuala Lumpur is urbanisation in Malaysia. Urbanisation is a continuous population concentration process in the city and metropolitan areas, which acts as an important economic catalyst in the development and modernisation of the surrounding peripheries.<sup>4</sup> There is a strong relationship between the level of urbanisation and economic development.<sup>5</sup> Figure 6 shows that the urban population in Malaysia has been growing rapidly while the rural population has steadily declined since 1990, when both populations were roughly equal. The level of

<sup>4</sup> Hasan, Abdul Rahman and Prema Letha Nair. "Urbanisation and growth of metropolitan centres in Malaysia." *Malaysian Journal of Economic Studies* 51, no. 1 (2017): 87-101.

<sup>5</sup> Florida, Richard. "Does Urbanization Drive Southeast Asia's Development?" *Citylab*, January 18, 2017. <https://www.citylab.com/life/2017/01/southeast-asia-martin-prosperity-institute/511952/>

urbanisation in Malaysia has increased from 27 per cent in 1970 to 71 per cent in 2010, and is expected to increase further to 79 per cent in 2025. This suggests that urbanisation will soon level off. Therefore, we cannot expect domestic population movement to have a significant positive impact on the population of Kuala Lumpur beyond 10 million after the year 2030.

Figure 6: Urbanisation in Malaysia



Source: *Ibid.* BMI Research (2017)

## Urban Agglomeration in Mainland Southeast Asia

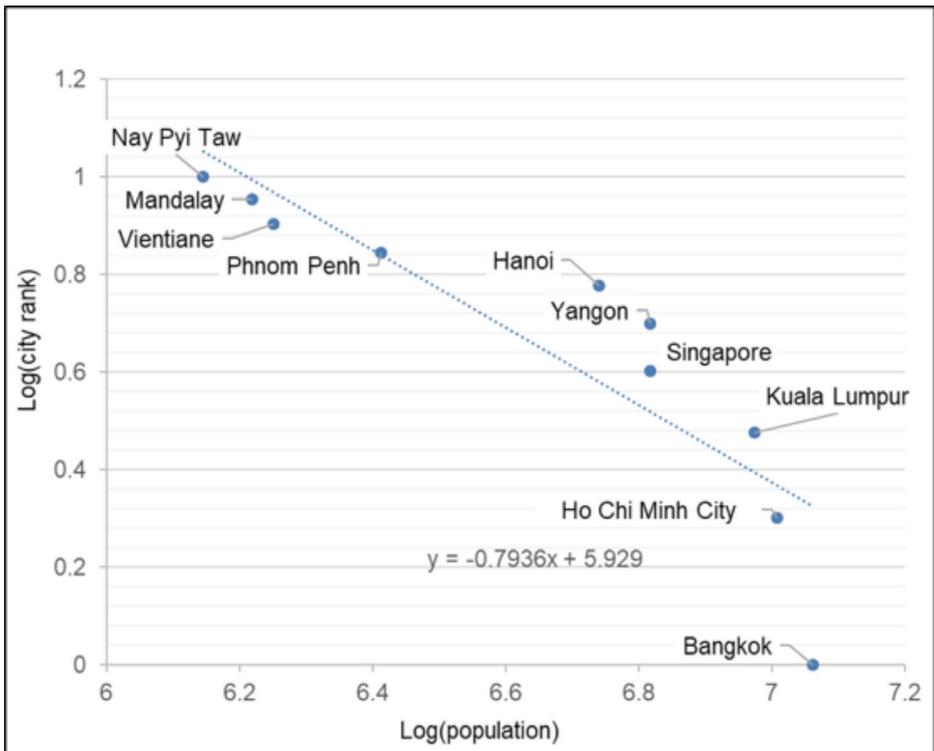
Since the United Nations' population forecasts already consider international migration, we now look at the potential of urban agglomeration effects due to regional economic integration beyond its projections. Figure 7 plots  $\log(\text{population})$  and  $\log(\text{city rank})$  for the 10 main cities in mainland Southeast Asia in 2030. In contrast to Figure 5, the fit of the rank-size rule is not good and the variance is too large. In particular, the population size of Bangkok, the largest city in the sample, will reach 12 million by 2030, which is still significantly below the regression line. According to the rank-size rule, the largest city should have a population of around 20 million since Ho Chi Minh City, the second largest city, is predicted to reach a population of 10

million by then. This gap indicates limited urban agglomeration effects due to the lack of regional economic integration. On the other hand, it suggests that the largest cities in the region such as Bangkok, Kuala Lumpur or Ho Chi Minh City can potentially grow up to 20 million if regional economic integration deepens.

Urban agglomerations such as metropolitan Bangkok, Ho Chi Minh City, and Kuala Lumpur will continue to grow separately. For example, the distance from Kuala Lumpur to Bangkok (1,187 kilometres) is too long for an HSR to compete with airlines. Hence, urban agglomeration effects generated by an HSR link between the two cities will not be significant as not many people will use the link. Tokyo-Fukuoka for example, has a shorter distance, 883 kilometres, and still has an HSR ride-share of less than 10 per cent.

Only one city will emerge as a 20-million population metropolitan area, according to the rank-size rule. Or perhaps, we will never see that level of

Figure 7: Rank-size rule in mainland Southeast Asia in 2030



Source: *Ibid.* United Nations (2016, 2017)

regional integration in mainland Southeast Asia. While the KL-SG HSR may not be profitable if we look at the Kuala Lumpur and Singapore populations separately, it can serve as a catalyst for the two cities to strengthen their positions as regional economic hubs to form mega urban agglomerations. This can attract populations from other cities and increase the likelihood of the project being profitable.

## Policy Recommendations

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The KL-SG HSR project is a critical part of the HSR network that is emerging in Southeast Asia. It is not clear at this point how extensive this network will be, but the KL-SG HSR project will certainly affect the development of Malaysia and Singapore. The international line that connects Kuala Lumpur and Singapore directly within 90 minutes can have a rail share of 94 per cent (Figure 2). However, if we take the population projection in 2030 for Singapore and Kuala Lumpur, the project will not have a population density to make it as profitable as JR Central (Figure 4). To match the profit margin of JR Central, Kuala Lumpur needs a population of 20 million in 2030 (a shortfall of 10 million according to current population projections). We find that this number is similar to the population size of the largest city in mainland Southeast Asia, predicted by the rank-size rule of major cities. However, our analysis does not reveal which city will have the largest population size and to what extent regional economic integration will proceed.

Regardless, Kuala Lumpur and Singapore should use the KL-SG HSR to take the lead in regional economic integration efforts and strengthen the role of both cities as regional hubs. From this perspective, the KL-SG HSR should consider a freight service. This would be particularly important for Malaysia as HSR freight supports regional areas by facilitating the transportation of agricultural and manufacturing goods.<sup>6</sup> Malaysia's trade with Thailand and Singapore is growing and the proportion of rail freight is expected to rise between 2017 and 2021.<sup>7</sup> HSR freight will provide advantages to supply chains and could result in rail appropriating a

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<sup>6</sup> Ishi, Yoshitaka. *Jinkougenshou to tetsudou* [Population decline and railway]. Asahi Shinsho, 2018.

<sup>7</sup> Ibid. BMI Research, 2017

certain amount of the bilateral trade from road and maritime freight modes.<sup>8</sup> Moreover, seamless linkages between the railway network, airports and seaports are vital for the overall transportation system. Finally, HSR freight is also important in the context of the Belt and Road Initiative, which among other things, aims to link China and Southeast Asia through a railway network.<sup>9</sup>

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<sup>8</sup> It is estimated that HSR freight is faster than truck and the value of express freight is about 100 times higher than truck. On the other hand, HSR freight is cheaper and the size of shipments is more flexible and larger than air. For example, the cost of air cargo is 10 times more expensive than rail freight in the United States. Troche, Gerhard. "High-speed rail freight: Sub-report in efficient train systems for freight transport." (2005).

<sup>9</sup> The CEO of DB Schenker sees a lot of business potential in serving the growing Chinese goods traffic in the region. "High-Speed Rail: The future of freight." *World Finance*, August 9, 2013. <https://www.worldfinance.com/infrastructure-investment/high-speed-rail-the-future-of-freight>

## About the Authors

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Mr **Akio Tanahashi** is a Civil Engineer at the Urban Renaissance Agency, Japan. He worked as an Urban Planning Management Officer covering the construction of infrastructure such as land, road, water supply, and sewerage at the Office for Support of Earthquake Disaster Reconstruction for Iwate. He obtained his Bachelor of Civil Engineering degree in 2009 from Waseda University in Tokyo.

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